An *Innovation* Approach Towards Sustainable Mobility in 2035

Appendices
Strategic Product Design
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EMBRAER

TU Delft

Contents

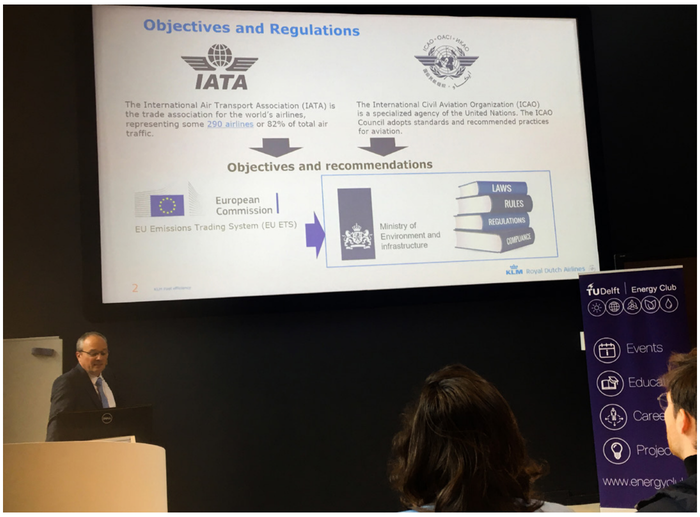
OVERVIEW

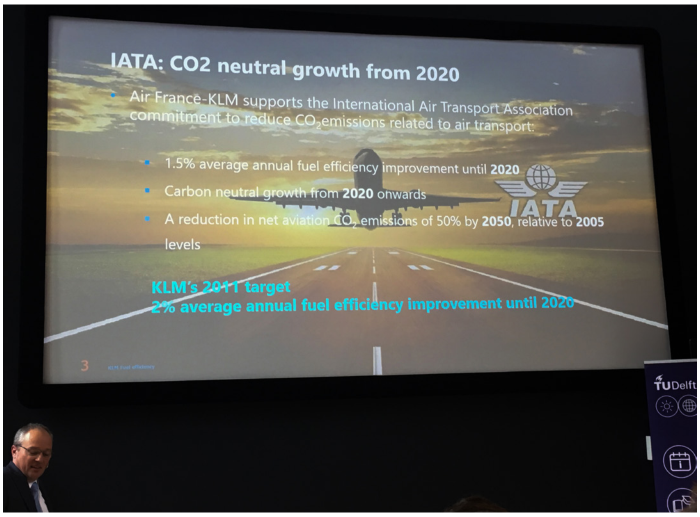
A.2

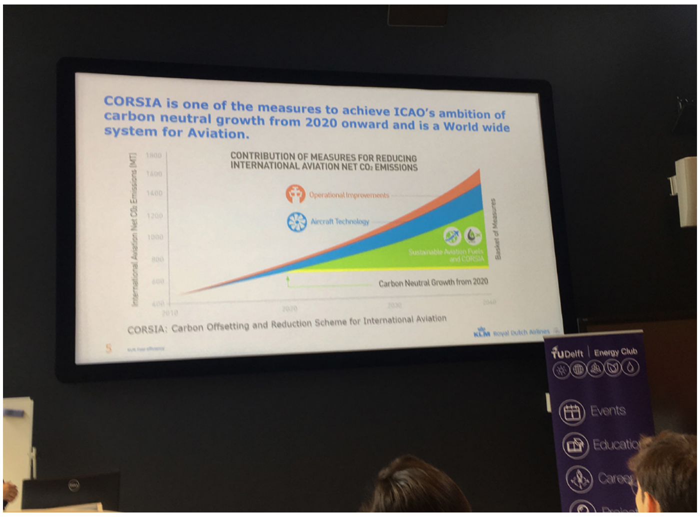
Lunch Lecture
KLM

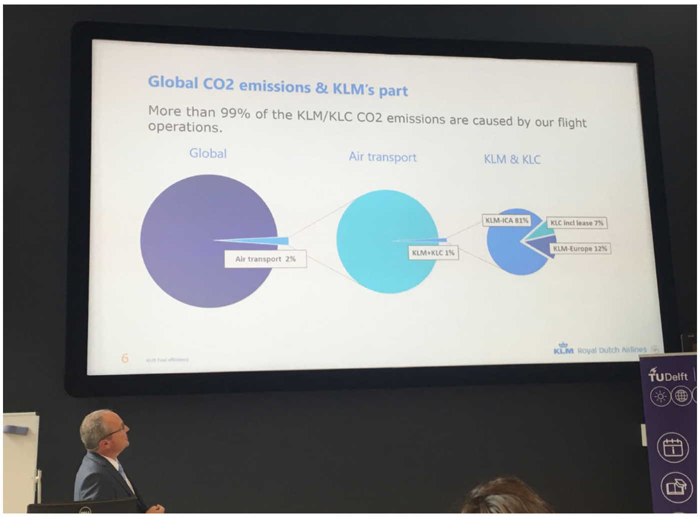
ON FUEL EFFICIENCY

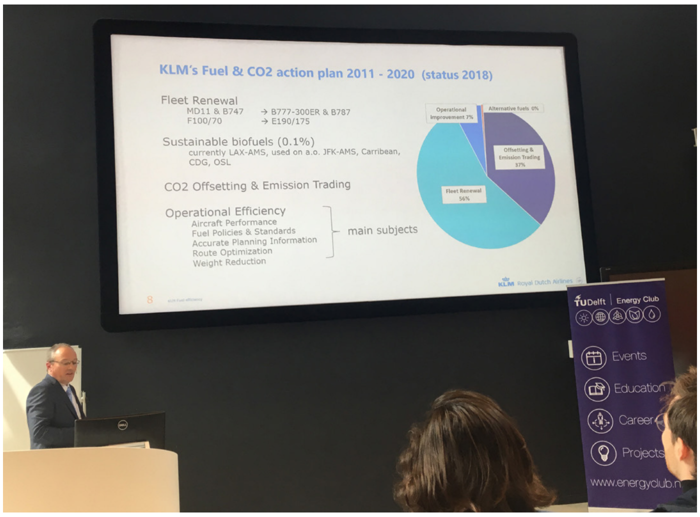
The lunch lecture of KLM was visited in order to find out more about the stakeholder. KLM is one of the biggest buyers of Embraer aircrafts in Europe. Insights could be retrieved about KLMs perspective on sustainable mobility and the company context (influence of politicians and competitors on KLM). The information was used for the main report.

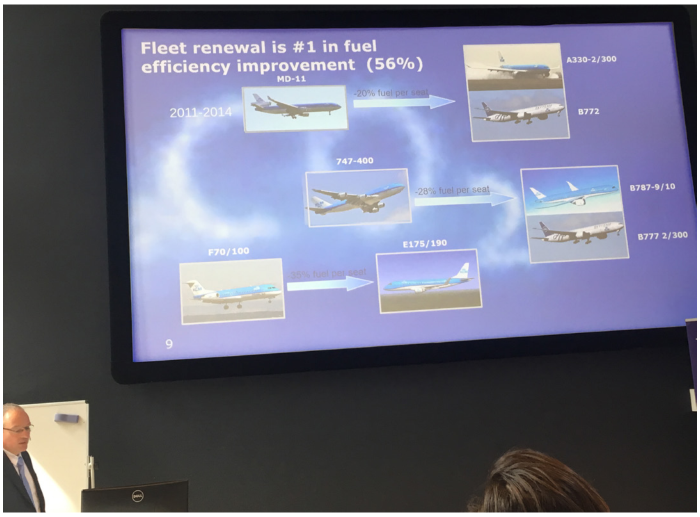

Objectives and Regulations
IATA
The International Air Transport Association (IATA) is the trade association for the world's airlines, representing some 290 airlines or 82% of total air traffic.
The International Civil Aviation Organization (ICAO) is a specialized agency of the United Nations. The ICAO Council adopts standards and recommended practices for aviation.
Objectives and recommendations
European Commission
EU Emissions Trading System (EU ETS)
Ministry of Environment and Infrastructure
LAWS
RULES
REGULATIONS
COMPLIANCE
TU Delft Energy Club
Events

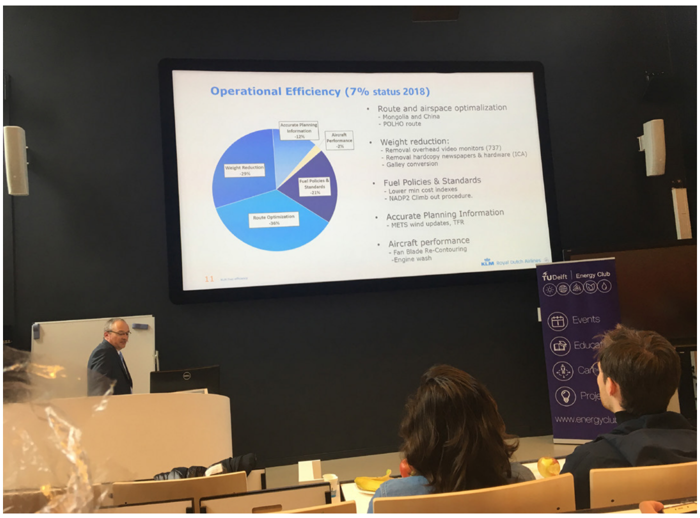

IATA: CO2 neutral growth from 2020
Air France-KLM supports the International Air Transport Association commitment to reduce CO2 emissions related to air transport:
1.5% average annual fuel efficiency improvement until 2020
Carbon neutral growth from 2020 onwards
A reduction in net aviation CO2 emissions of 50% by 2050, relative to 2005 levels
KLM's 2011 target
2% average annual fuel efficiency improvement until 2020
IATA

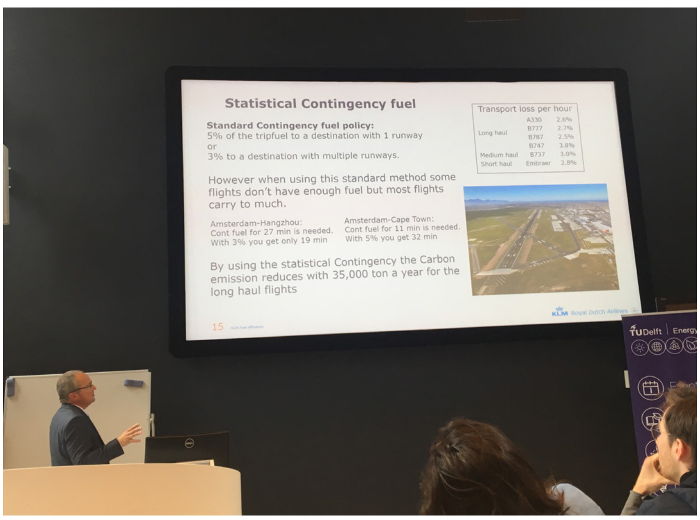

CORSIA is one of the measures to achieve ICAO's ambition of carbon neutral growth from 2020 onward and is a World wide system for Aviation.
CONTRIBUTION OF MEASURES FOR REDUCING INTERNATIONAL AVIATION NET CO2 EMISSIONS
Operational Improvements
Aircraft Technology
Carbon Neutral Growth from 2020
CORSIA: Carbon Offsetting and Reduction Scheme for International Aviation


Global CO2 emissions & KLM's part
More than 99% of the KLM/KLC CO2 emissions are caused by our flight operations.
Global
Air transport
KLM & KLC
Air transport 2%
KLM+KLC 1%
KLM-ICA 81%
KLC incl lease 7%
KLM-Europe 12%


KLM's Fuel & CO2 action plan 2011 - 2020 (status 2018)
Fleet Renewal
MD11 & B747 → B777-300ER & B787
F100/70 → E190/175
Sustainable biofuels (0.1%)
CO2 Offsetting & Emission Trading
Operational Efficiency
Aircraft Performance
Fuel Policies & Standards
Accurate Planning Information
Route Optimization
Weight Reduction
main subjects
Fleet Renewal 56%


Fleet renewal is #1 in fuel efficiency improvement (56%)
MD-11
2011-2014
A330-2/300
B772
747-400
-28% fuel per seat
B787-9/10
B777 2/300
F70/100
E175/190


Operational Efficiency (7% status 2018)
Route and airspace optimalization
Weight reduction:
Fuel Policies & Standards
Accurate Planning Information
Aircraft performance


Statistical Contingency fuel
Standard Contingency fuel policy:
5% of the tripfuel to a destination with 1 runway
or
3% to a destination with multiple runways.
However when using this standard method some flights don't have enough fuel but most flights carry to much.
By using the statistical Contingency fee the Carbon emission reduces with 35,000 ton a year for the long haul flights
Transport loss per hour

A.3.1

Expert **Interviews**

INTERVIEW GUIDE

The expert interviews were semi-structured. Interview guides were prepared that helped as a guidance throughout the interview. To cover the most important aspects during the interview DESTEP helped as an orientation. Prior to the interviews the interview guide was tested to avoid potential refinements throughout the interviews and to estimate the amount of time the interview might take.

Interview Guide

EXPERT INTERVIEWS

PROJECT:	**LOCATION:**
DATE/ TIME:	**INTERVIEWEE:**
CHECKLIST: - before the interview: handing generative design toolkit to the participant - Interview guide - Paper & pencil for note taking - Voice recording device - Phone for taking pictures	**INTERVIEWER:** **RESEARCH QUESTION:** Which role will sustainable mobility take in the Netherlands in 2035?

INTRODUCTORY SCRIPT

Before starting with the interview ask for a permission to record the interview.

Hello (name),
Thank you very much for taking time for this interview today.
The interview will be conducted for the Brazilian aircraft manufacturer Embraer. In particular, it is part of my master thesis in collaboration with Embraer and will be a valuable contribution to the project.
Embraer is currently looking into opportunities of sustainable mobility. With the term mobility all forms of mobility, that move a passenger from A to B, are included. The purpose of this study is to understand trends and the future development of the Netherlands towards 2035, and which role sustainable mobility will take in this environment. This interview will last approximately 1 hour.
I will now ask you some questions regarding this topic, please be aware that there are no wrong or right answers, just answer what you think about the topic.
At the end of every subtopic I will ask you to make a small collage with the images that I prepared regarding the subtopic to trigger further associations.
Let's start with the interview…

SUBTOPIC 1: Demography

OPENING QUESTION: How will the demographic composition of the population develop in the Netherlands towards 2035?

FOLLOW-UPS/ PROBES:

- How will different cultures, that the Netherlands gets in touch with, influence the country towards 2035?
- In which areas do you think will the most people live in?
- How will the density of the population develop in the next 15 years?
- What kind of sustainable transportation will be relevant for the population depending on the demographic information that you mentioned in 2035?

SUBTOPIC 2: Economy

OPENING QUESTION: What do you think will be the biggest market for sustainable transportation in 2035?

FOLLOW-UPS/ PROBES:

- What do you think will be the biggest challenges on the market for sustainable transportation in 2035?
- Which forms of sustainable transportation will be there on the market?
- For what reason will these forms of transportation be relevant?
- Which role do you think will aviation play in sustainable transportation?

SUBTOPIC 3: Society & Culture

OPENING QUESTION: Who might be a customer for sustainable transportation in 2035?

FOLLOW-UPS/ PROBES:

- How will the future society communicate in 2035?
- What will the future customer value in 2035? (e.g. hobbies, social events, family and friends importance)
- What kind of lifestyle will be significant for society in 2035?
- For what kind of reasons will it be truly necessary to travel in 2035?
- How often might people need sustainable transportation?

SUBTOPIC 4: Technology

OPENING QUESTION: What kind of technological breakthroughs will influence sustainable transportation in 2035?

FOLLOW-UPS/ PROBES:

- When can these types of technology be expected?
- Who will be able to implement this type of technology?
- Which kind of technical issues might this type technology have in 2035?
- What kind of need will this technology fulfill?
- Can you think of further needs of future generations in 2035?
- Can you think of future ways of transportation that don't exist currently?

SUBTOPIC 5: Ecology

OPENING QUESTION: Which aspects can you think of that will make transportation be sustainable in 2035?

FOLLOW-UPS/ PROBES:

- What are the current biggest challenges of mobility in terms of sustainability in the next 15 years?
- What kind of solutions for sustainable mobility will be relevant in the future?
- What kind of energy will be used for sustainable transportation in 2035 depending on the different forms of transportation?
- There are currently different types of energy for sustainable transportation. Can you tell me about the relevance of sustainable forms of energy on the market in 2035?

SUBTOPIC 6: Politics

OPENING QUESTION: How will the government and policies influence sustainable mobility towards 2035?

FOLLOW-UPS/ PROBES:

- Which kind of political parties will influence the political landscape?
- Can you tell me how politics may influence the way people live in the Netherlands in the next 15 years?
- How will politics shape the landscape of sustainability?
- What kind of taxes can you imagine that will influence sustainable mobility towards 2035?

CLOSURE

- Reflecting on the different aspects that you mentioned during the interview, which aspect/ aspects do you think are especially important for sustainable mobility in the next 15 years?
- I've asked everything I wanted to. Have we missed anything? Anything you care to add?
- To set your answers in a context, I would like to know some quick background information about you. Can you tell me your age/ nationality/ occupation?
- In case I have further questions, can I reach out to you again?
- Thank you very much for taking time.

LIST OF GENERIC PROBES

- What do you mean by that?
- Can you say more about that?
- Now we are moving to another subtopic.. (transition)
- What do you mean by that? (Specifying question)
- Do you have some examples of that?

A.3.2

Expert **Interviews**

SENSITIZING TOOLKIT

Before the interview a sensitizing toolkit was given to the expert. Sensitizing toolkits are part of generative design research by Sanders and Stappers (2012). Through generative design research latent knowledge is revealed which might remain hidden at a common interview. According to Sanders and Stappers participants also might need a time of immersion over night to reflect on the topic and to come up with better answers during the actual interview.

The sensitizing toolkit was structured the following way: a brainstorm about different forms of transportation aimed to support the participants to not only think about one specific mode of transport during the interview, but several ones. Through the section ‘my mobility journey’ the interviewee could reflect on personal experiences of the usage of a form of mobility. The reflection should help about thinking in more detail about the use phase of the product. Reflecting about personal experiences is part of emotional toolkits according to Sanders and Stappers (2012). Furthermore, the toolkit continued with a brainstorm about potential hazards and opportunities for sustainable mobility. These sheets helped the interviewees to define more what sustainable mobility might mean.

Sensitizing Toolkit

INTRODUCTION

Thank you very much for participating in this study! This study is part of a master thesis in collaboration the the Brazilian aircraft manufacturer Embraer.
The company is currently looking into opportunities of sustainable mobility. With the term mobility all forms of mobility, that move a passenger from A to B, are included.

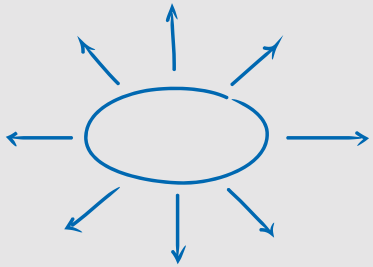
The following toolkit is meant to sensitize you regarding the topic prior to the interview. The next days please have a look from time to time in the workbook to answer the questions prior to the interview.
There are no wrong or right answers, and you are encouraged to write or draw anything down that comes to your mind. Every association is welcome. In case there is not enough space on the sheets, please feel free to use the additional papers, and mark to which kind of task they belong.

After completing all tasks, please, bring the toolkit to the interview session.

Best wishes,
Melanie

Types of Transportation

BRAINSTORM

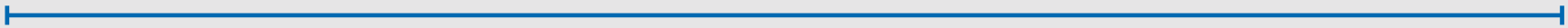


Please, brainstorm about the different types of transportation that you know. Feel free to write down your notes, but also draw the different types of mobility. You can directly draw on the paper or also use post-its additionally.

My Mobility Journey

TIMELINE

Pick one type of transportation and imagine how you used it throughout a day or a week. Who else was using this type of transportation? Where was it used? How was it used? Or maybe you have some other aspects that you would like to mention in here? Feel free to write down and draw whatever you like. Use the timeline to map the mobility journey of the type of transportation that you picked.



Hazards of Transportation

CURRENT ISSUES

Look back at the sheet ‘My Mobility Journey’.
What kind of negative impact has the type of transportation that you picked on the environment (e.g. in terms of resources, emissions, waste, social connection, ...)?
Map the current issues of transportation in terms of environmental and social sustainability by using rich drawings. Later you can add some explanatory words to the drawings.

Opportunities of Transportation

IN TERMS OF SUSTAINABILITY

Based on the hazards you found out: Which kind of opportunities and solutions for sustainable mobility can you think of? Feel free to use analogies or think about what could be an ideal situation. What kind of solution would make your wildest dreams come true?

A.3.3

Expert **Interviews**

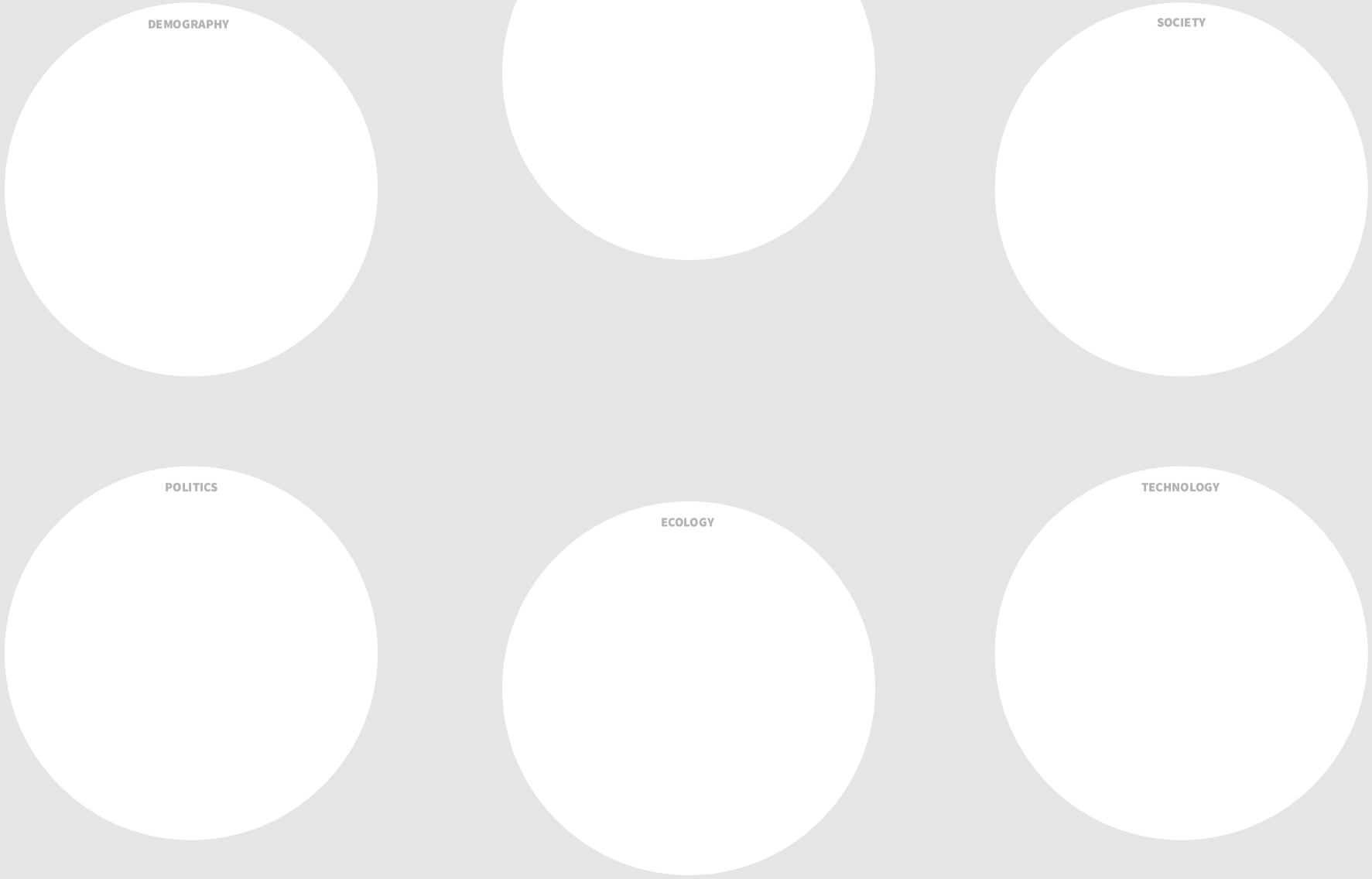
CONNECTION MAP

The connection map was used during the interview and also is part of generative design research by Sanders and Stappers (2012). The collage material below supported the participants in coming up with further associations and memories. Furthermore, the participants could see the topic more holistic and realize the relationship between different stakeholders, fields, and actions. According to Buzan and Buzan (1996) using apart from words also visualization stimulates brain activity to activate the full capacity of the interviewee.

Figure A1: Some of the collage material that could be used during the interview session

Connection Map

DESTEP



A.3.4

Expert **Interviews**

TRANSCRIPTS

All expert interviews were recorded and transcribed afterwards. The transcriptions can be found on the following pages. One interviewee preferred to stay anononymous. Therefore, his interview was marked as anonymous. Also, the company name, where the interviewee works was not written down.

INTERVIEW 1 - JAAP VLEUGEL - 26.04.2019

[P-JV] Okay. So, actually what we have, so, we have discussed the demographics, the grand demographics, indeed. We have these three or four developments. So, degreening, ageing of the population and inflow from other regions. So, in the end, probably a larger population. A larger population means a higher demand for mobility, but because more people are going to live in the cities that demand... the demand growth will be lot a bit lower than... maybe bit lower than in the past. But I don‘t know that... but then you have to study the people‘s need and the necessity, as they may also compensate by travelling more outside cities or taking more (short) vacation trips.
Then about the economics. Okay, but then the viability of, let‘s say, a sustainable transport system.

[I-MR] So my question that I asked so far were what will be the biggest opportunities for sustainable transportation in 2035? And the second question was, like, what do you think will be the biggest challenges for sustainable transportation?

[P-JV] Of course, the biggest contribution to let’s say air pollution and climate emissions related to emissions is first coming from the cars and the truck shows of the road vehicles let’s say. So that means what you... if you can have a big impact there, then you can have a big impact on the emissions. Public transport already is relatively green, the buses where the diesel buses will be phased out. So that means that we will have much greener public transport. But then it‘s up to the car industry to develop greener cars, less polluting cars. And of course, like I also mentioned actually try to reduce the fuel consumption by car because of course, you can say which we simply switch to electric vehicles. And we give everybody a Tesla race car, but then you also use a lot of electricity, but also say make the electric vehicles also as fuel efficient as possible. So then you can reduce energy consumption instead of just converting from one source to another. Because actually, and this would for me mean real sustainability… that you also reduce the primary energy consumption.

[I-MR] So, I think, right now, we talked a lot about the subtopic economy. So I just would finish this topic.

[P-JV] Of course, this is more about the autonomous vehicle that is not... that it‘s probably electric but I‘m not sure that can be a development. But in this department people are on this... and the battery,... and that is also fitting, I guess. In this department they are a lot studying on these autonomous cars. And some people say okay, it will happen soon and some experts also say, we have to wait until 2075 or something like that. So I‘m not an expert. It will be something in between....
And of course this is probably not a Tesla, looks a bit like a Ferrari of course, is of course an exception.
But of course, if our electric cars would be like this they still would use a lot of energy. So I wouldn’t favor that….
This one is about Indian car manufacturers or other manufacturers, of course, to sell in order to make a profit. So that means, if it is profitable to make electric cars, then they will offer them. That’s the economic side. But of course it takes large investments. Mostly large investments in battery capacity. You know, companies like Tesla, for instance, they‘re building these huge factories. In China they are also doing it. But still, then you have to talk about the primary resources to make the battery. And these are, of course, also limited. So you change from fossil fuels to let‘s say, sometimes very scarce earth materials.
And of course, these elements in technology, that you use less scarce materials, but still people talk about

scarcity and…
also the car manufacturer. It has changed a lot. That's a real challenge. But it can be done because also the car industry has a history has also a very long history of change. We had steam cars, we have these electric… I mean all kind of cars... even hydrogen... could also happen. So it shouldn't necessarily be electric, because some manufacturers also say "We don't do electric", "We are going to need hydrogen", or both.

[I-MR] And how realistic do you think will these forms of transportation be, like electric or hydrogen?

[P-JV] It depends on a few things. First, of course, the user side. How much does it cost? How.. what are the user characteristics? How easy is it to use? Do we have… so how fast do I have to charge? Can I go make a long trip? Can I go on vacation with it? What happens in winter? Does the capacity drop by 50%? There's a drop any news echo or another electric user system. I mean, these are relevant things. Of course charging... there is still no generalization of the clues. That is still an issue. There is also a discussion: Should we still charge with AC or should we go immediately to DC for instance description.
There is also discussion about it….. There is also the point that in some cities in the Netherlands we have a big charging system like in Amsterdam. In other cities there are hardly facilities. So there we also need charging systems. But also… let's say on a winter drive on a highway you also need charging facilities. So the public stations have to change also to offer that. The same.. the same we have also for instance with hydrogen. And I know that in Germany they are developing a hydrogen system slowly. In the Netherlands we are going a bit behind it because everybody talks about how to produce hydrogen, but when you produce it in a conventional way it is far too expensive and it takes.. it costs more energy than with fossil fuel. So I see… But when you make it locally or for instance with easy solar panels, then of course, if it becomes bio hydrogen, then the environmental impact is of course much better. So but it's also a question of technology, of downsizing the systems and I don't know. I am not an technical engineer, so I'm only repeating the things that I read in technical magazines. But there will be opportunities and I believe that it will happen. But of course, there should be support from the government. Two ways: first, regulation and secondly, subsidies, that's (historically seen) logical for new systems.

[I-MR] So you also already talked a bit about the user, and this would be like the next subtopic. And then I would like to ask you, who do you think might be a user for sustainable transportation?

[P-JV] So if there is no pressure from the government in the sense that fossil fuel vehicles will disappear then it will go gradually. Because what I see that, I see more electric vehicles for instances on parking spaces. Because there are more charging facilities offered, but it is going slowly. I guess that… and also…. if people have a good experience, they may talk with their friends or family or whatever and gradually… and they may also buy it. But then still the prize has to go down. And the car industry should also promote these vehicles more. Thus, like NS is also promoting that that they use let's say a green train for instance. In … for instance they are also promoting that. "We are driving 100% green.". That's what they say. So if the car industry would also promote it more, then, of course, people might be more interested in buying it. But still, it's a small market segment. And actually, what's also point is, and that's also the typical part of the car industry. The car dealers make a lot of money from repairing cars. And fossil fuel car, the engines have more parts. So they need more maintenance. So that means if you sell more electric cars, the dealers have less repair work.
And that's of course not so good for their business. So the car dealers may not be so willing to sell electric cars. And that's of course, a hurdle that also has to be overcome and it actually indicates a basic condition

for the introduction of these vehicles.

And for what kind of reasons do you think will it be truly necessary to travel? [I-MR]

So you are asking what is normal demand and what is excess demand let's say? [P-JV]

Yeah, maybe. Because sometimes it might be that you travel just for fun for example. But what might be… where can't you just avoid to travel? When do you think you really have the need to travel and you can't avoid it for example? [I-MR]

If I take my own occasion, that's the easiest. I don't... I've never owned a car, I only use it when I need it, I rent one. A lot of young people also think the same, they also like car sharing. But a lot of it is also related to your own choices. For example this morning when I have to go work… what I actually try I do try to schedule let's say the reading work in the morning. So the first few hours I work at home. In the afternoon I have the meetings. In this case of course it was different. But so I prepared yesterday… but… so in that way I completely avoid congestion. Because when I travel between 8 and 9 when cyclists are clogging the streets, it's incredible and I walk from my home. That's also really sustainable let's say. I can't be more sustainable than that. But a lot of other people… when they… the point is… the jobs in many cases are not where the people live. So you need commuting. Many people need to commute. Yeah, so that means if you want to reduce that you also have to redistribute the work and that's of course policy and we have a free market and it will only happen when some companies see the benefit of it. What they can do, they all cannot of course move their buildings to the same public transport site. That would be an option. As you can see it around station Amsterdam-Zuid. In other places that company invest in the green building, but also move to a green location. So then you have two benefits at the same time. But this should be policy. But some companies say "No, we don't want to be in a city center because that's more expensive.". You know, the soil costs much more than on the outside. It's usually difficult to drive inside so go to the edge of the city. But in the edge of the city that public transport is less. So that that's always a challenge. So there are options to do it. But there are also some things that prevent it. So it depends on individual decisions and whether it will be done or not and everybody makes a different trade-off. And the trade-off is not always completely economic. But also some social reasons. For instance reallocating a company might be quite challenging because some people need to move their household with social consequences as well. Are people willing to use public transport more? Or yeah we know that the, yeah, we know that the cross elasticity between the two systems is quite low that means that not so many people who use a car will use public transport… will shift to it. They will temporarily use it for example if there is excessive congestion but on the longer term it's quite difficult also because public transport is also crowded in the rush hours… really crowded. And even in the off-peak hours it's also crowded especially in the maintenance periods or whether there are sufficient trains? So I mean (quality and availability of) public transport is also a question mark.. is in change of things you have to do and the car is really easy. You simply.. you start from the home from door to door. It's much easier to organize, the travel time is also usually shorter. But of course you need time to find the parking space. And that's of course a more difficult challenge. And of course what takes the most travel time?. Is it for work? Is it for pleasure? Do you have some things that you want to carry for instance some big boxes or other stuff? Are there alternatives… in that case… can you also… can the vendor… Will they bring it to your home for free? Then you don't need the car for instance. For instance bought by Ikea as I let it deliver at my home. Then I don't need the car. Most people they have a car. They actually go to Ikea, they fill the car, and go home again. It's not necessary. But people do it because for [P-JV]

them it‘s more expensive logically because they only they only calculate with the fuel costs and not the total cost of the car but still of course the transport is more expensive. So it’s about individual trade-offs. How people perceive the costs and benefits of it and in the end in a free society everybody can still choose all you have to make it or you have to make sustainable transport cheaper. But of course we know subsidies cost money and government wants to cut down the subsidies.

[I-MR] Yeah, so then I would end this subtopic I think or maybe you also want to use some pictures maybe.

[P-JV] Ok. The pictures can be used in various ways.

[I-MR] Yeah, it should trigger some kind of other memories and might be helpful.

[P-JV] Of course this one… this will… we don‘t see this very much in the Netherlands. It’s more a picture of let’s say other countries in the world. But of course… Have you seen these mobility centres let’s say. It’s of course quite a different picture paired with this and it compares with this. This is more… this is gradually more becoming the Dutch city. It’s more like a Rotterdam style city…and this is more…. this is more a kind of city I could live in.

[I-MR] Yeah, I’m just looking at the battery…. ok..

[P-JV] This is of course an interesting picture. A bit similar like this. This is of course… for the climate it’s better because with more green… with drainage etc. it’s a bit of a problem.. this is more natural.. and eeh… yeah… This looks like Delft in some parts. But for the rest… it depends because you know you can actually develop and redevelop the city. In many cities you redevelop, which is in Delft. There the city centre is becoming more dense. You know these higher buildings whether I like it or not. But of course you put a lot of people in a small space, reduce mobility need. That’s positive. And of course for the economy because you attract more and more people and also more young workers and professionals. So that is positive. Eehm… yeah…

[I-MR] So I would go to the next sub topic which is technology and what do you think what kind of technological breakthroughs will influence sustainable mobility in 2035?

[P-JV] Okay. So we discussed the battery. That’s one thing. I guess also that the large scale production will also be needed. So we need to wrap up production of batteries and we need batteries with more charging power let’s say. That’s very important. And maybe also still hydrogen, hydrogen can still be an option, because it has the same range as fuel… as fossil fuel more or less… drive several kilometres on one charge. And actually if it can be produced by… like bio-hydrogen then it is quite positive. Could be quite positive. Because you can also use.. or use it in a similar way like fossil fuels. So I don’t need to change it. But of course you have to change the engine and in the tank you have to make it safer. And some companies like Toyota have developed the technique… they sell a hydrogen car. They have a second version already. And they‘re very positive about it. So, so in the end either electric or hydrogen is still interesting. And of course, the numbers are increasing. There will be more batteries of use, but they have to ramp up the production and sustain batteries enormously, because you have millions of cars so you also need millions of batteries. And these have a limited lifetime. So you have to make more make more of it for all the cars of the world. And also there is another point is also is also an economic factor that is the resale value of electric cars drops,

because of the uncertainty with the batteries and also if people… I have the battery is now half of the price of a new car. So at the moment you want to sell a car with a non functioning battery. You can forget it. That means the resale value of electric cars is very low. While we know that most of the cars sold nowadays are second hand. So in there is a very professional second hand market. So you also have to develop a second hand market where they can sell the cars. Because what happens now usually either they are scrapped or they are sold to some other areas. But… I don't know, but the resell market is really a problem. What could happen is for instance that the lease companies... because I know that private lease is growing. That lease companies may give it a lead. So they have bigger sales power.. or purchase power that means that the price for cars may drop. So then the consumer price for cars will also be lower and the private lease is cheaper than when you buy a car according to the Consumentenbond.

I need to look for my laptop I think the battery also will… [I-MR]

No problem. We have a also a few charging problems let's say. [P-JV]

Ok. Perfect. Now it is working again. [I-MR]

Um, yeah. You were just talking about different kinds of technologies. And for example, when do you think might hydrogen be relevant in the future? When do you think can this be expected for example?

Yeah, well of course there are a few things. First of course: How much hydrogen can we produce? Because and is it going to be produced on mass scale or … these are the questions. Then the cars should also be available on a larger scale. It means I don't believe that it will be available before 2050 or something. I don't believe it. They can come, but not faster. But you have to talk about completely different engine in fact. Okay. At least because it's not like a like a normal gas (lpg) engine but I am pretty sure about it. But definitely because for many people because now there's how many people driving a car on gas. It's quite an opportunity it's it's quite a bold number and it's also regulated by the taxes scheme, because you pay more income tax. And also how much space (in the boot) does it take for instance. I don't know that. So that can also be… because a lot of people say I don't want to lose space in the car. Because it takes.. it's quite a large tank it means that you can't travel with a lot of luggage. With certain packages or some other stuff. And that is also a point that will delay a large scale of hydrogen. Or there should be a way to make the car much more fuel efficient so that means that you need a much smaller tank. This can also be an option. [P-JV]

Yeah I think you already answered the following questions. Like which kind of technical issues might there be… just like the technology that you mentioned have. Yeah, I think I also would finish this subcategory and maybe you also can look at the different images. [I-MR]

This is also an important one. And something we also didn't mention maybe in future there will be discussion about should we simply ban cars in cities. We haven't discussed that, but I mean there have been [P-JV]

because of the uncertainty with the batteries and also if people… I have the battery is now half of the price of a new car. So at the moment you want to sell a car with a non functioning battery. You can forget it. That means the resale value of electric cars is very low. While we know that most of the cars sold nowadays are second hand. So in there is a very professional second hand market. So you also have to develop a second hand market where they can sell the cars. Because what happens now usually either they are scrapped or they are sold to some other areas. But… I don't know, but the resell market is really a problem. What could happen is for instance that the lease companies... because I know that private lease is growing. That lease companies may give it a lead. So they have bigger sales power.. or purchase power that means that the price for cars may drop. So then the consumer price for cars will also be lower and the private lease is cheaper than when you buy a car according to the Consumentenbond.

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[I-MR] Yeah I think you already answered the following questions. Like which kind of technical issues might there be… just like the technology that you mentioned have. Yeah, I think I also would finish this subcategory and maybe you also can look at the different images.

[P-JV] This is also an important one. And something we also didn't mention maybe in future there will be discussion about should we simply ban cars in cities. We haven't discussed that, but I mean there have been discussion in Amsterdam for instance to close the grachten, you know… these canals… for cars… and in Delft you also have some let's say Oude Delft places where you can't drive anymore. So, it could be an option that we would simply say: 'Ok we need more living space or green space we simply move some rocks'. I say it in a simply way, because there will be lot of discussion. But it could happen. But that means… but it depends on how much priority society will give the car or mobility in the future. And that's of course… because politics can't decide it, because then you can't get supported by the people. Because it (election

results) will simply fall differently next time and you lose the majority. … I'm really busy with pictures… you know…
And of course if maybe many more people will work at home and also employers trust that, because that's also what we discussed. Also a lot of people will like to work at home. But their employers will simply say "We can't do it.". There is, of course, what we didn't discuss is about the tele...about the electronic e-shopping let's say… the e-commerce or what you call. Nowadays, I buy most of my stuff from home and I am only going for daily products to the mall. And a lot of young people are doing the same. So the question is how many people buy CDs, DVDs or whatever stuff. You download it. So that means you get a, let's say reduction of let's say physical products and replace it by non-physical products. You may... if you don't have all the shops anymore. You will of course don't go to a shop anymore. But what are you going to do with your time? Are you travelling in a different way? So answer the question? I don't know. So they're always compensating developments in innovations. But also the most important is are people part of a group? Are we becoming more… are people because our society has become very individualistic. That means that the big families are disappearing, let's say people now live in small groups. How will the future develop? Will we... How will people connect to each other in the future? In work, but especially socially. I mean, if we do everything by electronic means, then we may not need any travel anymore. And also is… we have instant video. Do we need to travel? I don't know.

Regarding the questions, it is just like there is almost the one hour over. We still had like a bit more questions, but I'm not sure how it will be with your availability. Because I only said that the interview will take one hour. [I-MR]
But the most important thing would be right now a few things there was something really important if you would like to mention this.
Like, do you think is there something more... really important that wasn't mentioned so far?

We discussed a bit about autonomous cars, electric vehicles, we have…. Maybe the role of the government still? [P-JV]

Yeah, this would be the last subtopic. Yeah, the role of the government. [I-MR]

I mean, or maybe even governments.. and I mean because of course. Nowadays, more and more things are decided in Brussels. And for instance environmental policy for instance is more determined in Brussels. And the same goes for economic and financial decisions. So… but very important is not only what the government develops of policy, but how is it connected with how people feel, do, perceive, etc.. That's very important. How many people in society really want to become more sustainable? That's for me a very big question. Because.. what kind of stuff do people buy? Many people go for very… for let's say… with clothing. In the past when you bought something you bought a few things quite expensive. Nowadays, you buy shirt, 5, 10, or 15 € and this is normal. But where is it coming from? 6000 kilometres away. Is that sustainable? I guess not. You will throw it away, because we have fashion. There are other clothes. That doesn't matter. You can afford it. But that's not sustainable. I mean so there are many things.. also it has to be cheap, it has to be available etc.. And that's actually against the sustainability. Not to talk about repairability or other things. I mean, I have two right hands. I like to repair. But you can't repair anymore. Or replace the battery. In the past you could simply open and repair the battery. Now I have to unscrew it…. i mean it's complicated. Also, that's an assumption. So… are people willing to change? Do they have options to change? Who is going to give the options? Is the government a… actually a kind of in between [P-JV]

partner that actually regulates it? Is it really supportive... or not? Is the government…. It's the same with more healthy food. The government… now how it works sugar etc. everything contains sugar. We know it's not good for your health. The government simply says "Oh, we leave it on the market.". Yeah, but a bit less packaging… Do we need all the plastics? We don't need it. They say "Ok, we need packaging, because it needs to be protected.". But all the packaging is not needed. But the government simply says "We leave it on the market.". So there you have the tension. What does the government say? What is it asked from people? How much... Is it related to how the people feel, act, etc.? That is the biggest challenge. And that question is not answered in any way. And there's also enough philosophy about it. It's also the point is the real challenge, because you sustainable mobility is one thing… but you also have sustainable housing.. which costs billions of euros. Who is going to pay it? You know, we need funding. Nobody has reserved money for it. Maybe some people have reserved money for their pension, but certainly not reserved for climate change. I mean, so the question is, where does the money come from? Are we going to raise the taxes? Nowadays people don't want to have high taxes. How does it happen? Forbidding certain things might help. But still there is a free market. We have to convince manufacturers that they have to change their product. But it goes very very slowly. You also see it with toxic products for instance. Any kind of toxic product, toxic substances can gradually disappear in for example PC. Toxic substances are gradually disappearing, but it has taken decades before this happened. So why should it go faster with sustainability? Why should it? I mean…. and I mean we discussed the demand. If it costs more are they willing to buy it? So it's always chicken eggs. So that's why, of course, the society.. I can't give a definite answer. I can only give a few reasons. Because actually, what you're talking about is scenarios, the scenarios, they are about assumptions. It's about compositions of assumptions. And your scenarios can be different from mine. I mean, everybody has different biases in different fields. But I believe that it will happen. But the speed depends. Really.

[I-MR] I just wanted to say. the one hour is over and I just was asking for one hour. So I'm not sure how it is with your availability, but we can end the interview.

[P-JV] Yeah, how you like. I reserved until 4:30. So if there are still questions you would like to ask we can continue the interview.

[I-MR] There will still some kind of questions. There were also some questions that you've already answered. So, I don't know. I also skipped some questions. I think it would be interesting for me, still to ask, what kind of lifestyle might be significant for the society towards 2035 or in the next 15 year? Because this might be of course, also relevant for transportation… or sustainable transportation.

[P-JV] So what you see on the one hand. It looks like everybody tries to be individualistic. On the other hand you also have the social media, which I see… a lot of people feel forced to act in a certain way. Some kind of crowd behaviour let's say. I mean, there are different directions. People tend to be.. want to be individualistic, but also not too individualistic. Lifestyle changes. Many more people are going to live in cities. So they have to adapt. The space is more expensive. So that means probably more people in smaller houses also. Also, because families are small. So we need smaller houses and more higher apartments. Lifestyle changes. Travelling is very easy, the price is quite low. So that means that will also continue as long as enough people have money. But, of course, what will happen with incomes when automation really takes of? People… many people will lose their job. That's a very high risk factor. Because in the past all kinds of technical development lead to more jobs, but this can be the first time in history that the technical development leads to less jobs in total and that means a lot of people have much less money. And the city is very, very,

very expensive to live. Then you will see a kind of migration in that sense. And automation is not going to be inferior. Companies are investing an enormous amounts in automation. It really rises. Robots are becoming much more intelligent, much more capable, they can fulfill many tasks. So I really wonder what will be the economic base of society actually in the future. How is society going to look like? I don't…. because we have been really richly as a society in the past decades, but I don't believe that it can continue, because robots do not pay taxes for instance. That's a terrible discussion. So that means the income of governments will also decrease. Companies likely will have higher profits, but they have less employees, they pay quite low taxes and nowadays, because the taxes have been reduced by at least 50% in a few decades. So that made the tax wages are small, so that means that actually… yeah… the next generations, let's say there has been forecasted they will have less money. And that will actually… society as such will become poorer and on the other hand there be very few very rich people. So I also see the diversity of society between a the have and have nots. There will be more have nots than… and a few haves… and they… so the wealth of society will disappear in that sense. That's such a… I'm not a psychologist, but you can imagine what society will be. And that will actually slow down sustainability… sustainable mobility, because people cannot afford for this.

And how do you think might society communicate in the next 15 years? [I-MR]

Yeah, instant communication, of course. Especially when we have WiFi. Of course, WiFi nobody discusses the health issues with that. We already have a radiation problem. That's actually an underestimated risk. Because the… I guess the radiation will rise by 50% or something like that. Because the transmission system that has transmitters need 50% more power or something like that. So that is a health risk. That's… but most people won't care, because they want to do everything electronically. But of course, all the devices cost a lot of energy. And that energy should be produced in a sustainable way. Does it happen? We don't have many green servers, but investment in green server parks, that is happening. But all the devices they all charge from the wall. And usually not by not by solar panels, but by grey electricity. And let's say the internet etc. is one of the fastest growing users of electricity. So in a sense, it's not sustainable, but it will continue because people want it. But you also have more intelligent devices like clothes that are electronically connected. I don't know you probably know it better because you are from the industrial design department. That you have wearables let's say that are connected let's say. That you don't… [P-JV]

Internet of things… [I-MR]

Yeah. That the technology will become more embedded, let's say. That's for sure. And that will of course become much more mainstream. Yeah, instant connection, but then you have the point that we talked about lifestyle. A lot of people have, let's say… they are more or less overpowered. Or they have become addicted to technology. For your health that is actually not so good. So it can happen that… some people want to go back. So they.. we may have two kinds of developments. So on the one hand everything is available. But that doesn't mean that everybody will use it. Or maybe the devices might get certain functions like we already have for instance with the Apple computer. I know it counts the time that you are online. It gives you a notification when you exceed the time limit. Or you can simply stop it yourself. So if the technology will become more mainstream it can also happen that it will be more manageable. And that you can switch it off when you don't need it. And physically, because for whatever reason. So in that sense, it is… yeah… and maybe that can lead to less mobility. But I don't know, because instant mobility can also be that when your friend calls you or contacts you in another way. That you immediately want to [P-JV]

go somewhere, the two of you. That can also happen. Because you can on the fly, change your decisions. And one moment you are sitting and your friend call you and then you are going. So that means that the treshhold to move becomes lower on the one hand. So… but I don't know. So on the one hand you can have compensation that you go for holidays to a beach, but because you are connected you can instantly move. I don't know. On the other hand, if devices become more connected. You can immediately contact Uber that it comes immediately when you need it. I mean all kinds of things will happen at the same time. So more options. Of course, options cost more money. So people have to make choices. How are you going to make choices? That's also one of the things. We usually have too many options to chose.

[I-MR] And then maybe, like from the last sub topic, well, you already mentioned it a bit. Or like how would the government and policies influence sustainable mobility towards 2035? You mentioned already some aspects. Do you have more aspects to add in and in that area?

[P-JV] Oh yeah. So the most important is, of course, a consistent policy. Because in the past the environmental policies in the Netherlands have been a bit alternating let's say. Sometimes it's a bit more in this direction. Sometimes it's a bit less. I mean, the subsidy regime is also… if you stick with subsidies make it consistent. Because when you now see for sustainable housing for instance. There is a budget to make your house more sustainable. But there's only 74 million Euros available.It costs a few billion. How many years does it take in order to make everything sustainable? Decades. If you speed it up by spending.. by giving the budget to a few billion you can go faster and you reduce the climate impact now instead of in 10 or 20 years. That's a political decision. How do you allocate your budget? What does it take to find acceptance of society? I don't know. These are really relevant issues. And in the end governments need to make decisions as the so called will of the people. But what is the will of the people? I don't know. If I vote is there a relation between what I have voted and the people who will be in charge? That's very vague. But policy should be consistent and there should be sufficient support in terms of money. And actually it should also be consistent not only in one candidate period. But it should be sustainable over a few decades. Then something will really change. And also what I said maybe you ban car use in cities. Then you won't have fossil fuel cars, government buying more more electric vehicles for the employees for instance… we don't need fossil fuels anymore for government buildings. I don't know. There are all kinds of things you can imagine.

[I-MR] Yeah, right now reflecting on everything that was said, on all the aspects from the whole interview. What do you think are the most important aspects? Do you think that something is really important of the aspects you mentioned more than other things?

[P-JV] Yeah, the most important is about how much is individual behaviour changeable and influenceable? These are the most important things.

[I-MR] Um, yeah, I think right now I've asked everything I wanted to ask and do you have anything to add?

[P-JV] No.

[I-MR] To set all answers in a context I just would like to know maybe that you can just quickly tell about some background information about you like your age, nationality or occupation.

[P-JV] Age 58, nationality Dutch. I am actually a trained economist. Specialized in transport issues and I am wor-

king for nearly 20 years…. it's 18 years….

So I would like to use the interview for my master thesis. Would it be ok if I have the interview there? [I-MR]

Yeah.. yeah… I also supervise many masters students. [P-JV]

Maybe I would take a picture of you if that would be ok? Okay? [I-MR]

No. [P-JV]

No, ok you don't want a picture. I will note that down. …. And maybe if I have some small questions would it be ok to reach out to you again? [I-MR]

Yeah. What is normal. I also tell my students always simply send me the transcript of the interview. Then you have actually control. Then you can say yes or no. Then it will become a controlled experiment. That's the easiest way to do it. [P-JV]

Ok, I will do it. Okay, thank you very much. [I-MR]

INTERVIEW 2 - PAUL PEETERS - 06.05.2019

[I-MR] Maybe I should first also tell something in the beginning about me. I studied Strategic Product Design at TU Delft right now. So I'm on my master's thesis and do right now the collaboration with Embraer, a Brazilian aircraft manufacturer, and they want to look into sustainable mobility, not necessarily aircraft, but in general mobility. And I thought like it's really nice to interview you because of course you're an aircraft engineer and you know a lot about sustainable mobility. I thought that might be really interesting.

[P-PP] Yeah, well.

[I-MR] So I prepared several questions with several subtopics. So the interview should take approximately one hour.

[P-PP] Ok.

[I-MR] So we are used to participatory design. So that's also like, why I had this sensitizing toolkit and also of course, that we are really visual. So I will first just ask you the questions and maybe I also have here for example, some visual materials.

[P-PP] Okay, that saves some time for drawing.

[I-MR] It's just maybe that you can look through or that maybe these kind of pictures might trigger additional memories. So, that's the background of it and yeah, so this will, I will ask you just to look around there, maybe like after every each sub topic. And so I first would like to ask you about the sub topic of ecology, and there are I prepared a few questions. Which aspects can you think of that will make transportation be sustainable in 2035?

[P-PP] 2035? So really in the future?

[I-MR] So maybe I should just mention, so the project is also for sustainable mobility in the next 15 years. I need to create a roadmap for 2035 and how to get there, and it's basically about some kind of trend research, but of course also to understand a bit sustainable mobility. Yeah, and there the first question was…

[P-PP] Okay. Well, maybe I should start this study that looks a little bit like this one that I was leading in the time in 1985. So that's some time ago. One of my first projects and in that project we envisioned to design a transport system for the Netherlands. That would fulfill certain environmental requirements. Actually we didn't know the word sustainable at that time, but what you now would call sustainable. So we had requirements like 80%, less energy use, 90% less emissions, know people this more noise. That is actually in the law, but this is nowhere realized. Also, on safety, we had some, some goals. And then we started actually working from these goals, then looked at the different transport modes that are there at the time used in the Netherlands, and it is still the same more or less. Not so many new ones, only other variants of them. You didn't have electric cars, you have now a few. We didn't have electric bikes, we have not quite a lot of them. So that's that's really a change but doesn't change the whole picture that much. And from that study, we found that the the final year was aimed at 2010. So that's already in the past. So we had an

opportunity to look if we projected the trend scenario as we call it, the normal business as usual one, in the right way. So, everything we expected to happen if we would not change radically the policy and the policy didn‘t change, right? There were at the time it was quite discussed this, this scenario, but in the end, the big, yeah... the big, say stakeholders with their invested interest, or invested interest they want, as usual. Okay. So it didn‘t change. Well, it did change something. That was that one of the people involved in the study was also from Delft. But he was part time, professor and part time leading the innovation department of the Dutch railways. And they were at that time working on a new also kind of scenario for the railways. Because there would be in 2000, or in 1986, or seven, a new national plan for for Infrastructure and Transport. So they wanted to send that to the government as their bit, okay, we can do that. And then we were working with ours and that actually meant that we would ask for like, two or three times more investments in the rail then the Dutch railways were doing in their plan. And then at one moment the professor he said, “This is ridiculous. Of course”. That the environmental movement, the one who initiated my study comes with a plan that is far better than then we do ourselves. That doesn‘t look very well. So his proposals can we take your proposal in your study. One to one inserted in their own one. So, really a big update. But do you accept that we present that as our plan first? And they did. So we, of course, we accepted that and then actually 90% of those investments have been done. Okay, so that‘s quite a lot. So that‘s more than double what they proposed to do and they wouldn‘t have got anymore if they would have gone for the lower investment. So yeah, that‘s a side story, but it tells you a little bit about how things might run and what signs might help in policy making. But the basic outcome, of course, as you can imagine now is that there should be a big shift away from the car to public transport and cycling, of course. And actually we envisioned cycling and walking and public transport as one system. As opposed to using the car for everything, which is still not so much the cases in that time but still mainly it is. Most people that have a car do not think they take the car everywhere. Unless it‘s like impossible to park or ... And then they start to change somewhere or some do indeed or take trains.

And you think that this also will be relevant in the next 15 years? [I-MR]

Well, … Yeah, I think so because it makes things so much easier. The resource requirements of public transport are, by definition much lower... if it‘s used well. Sometimes you read, you could have better taken the car because it‘s less energy, but they compared this with an empty bus. Yes, then of course it‘s true. But if everyone takes a car and then you don‘t have the volume to keep the business going at a decent frequency, and that line pattern that there is a bus everywhere. And it‘s difficult to make that step. You have now a public transport that serves something like less than 10% of all transport in the Netherlands. And 70% is done by a car and then there are some mixes and of course, cycling and walking. But just imagine if you would have half of the car going to the public transport, then you would have four times more public transport. And that would in certainly in the center lines where the division the model split is even like 1 percent only for public transport. You could with that three buses per day you could improve that to 30 per day and then it‘s a decent alternative. So there is this a kind of turning point somewhere. And that will not happen out of it self. So you need something, some government or some investments, you stop investing in roads. And then, of course you see already that we have done too little there. So all the roads are congested, and that forces people into public transport. And to some extent so many people, if they are in public transport, they are happy with it as well. [P-PP]

And how do you think might for example flying vehicles be part of the sustainability in the next 15 years, for example? [I-MR]

[P-PP] Yeah, the flying cars, hey. I'm very skeptical about it. Firstly, the idea that it's actually a way of typical car driver thinking if you think that's the solution. Because then you if you look at adverts for cars, roads are always empty, always. And in reality they never are. So you see a car in a beautiful landscape driving as high speed and fully free which is not the case of course. So they think very much from their own perspective of being in the car and being fast and being etc.. And then you think okay, there is congestion. So if my car could just jump into the air and fly over the congestion, that would save me a lot of time. But of course it It won't save any time if everybody, if the whole congestion would go into the air, because aircraft always need much more space around them just for safety alone. Even if you make it automatic then you cannot drive or fly aircraft at one meter. That's, that's insane to think that we ever will reach that. And it will cost more energy, that's for sure. Yeah, so that makes things even more difficult. If it's more, it would be a faster system which is likely then it will also generate more volume of transport because people will think, okay, people don't think in kilometres they think in hours drive and they are prepared to drive half to one hour per day for their work, for commuting. So if you speed up by a factor 2, then you double the volume, people will live double the distance and double the distance means double the energy, double the everything.

[I-MR] So you prefer more of a public transport system, which is more on the ground?

[P-PP] Yeah, certainly. And that should be electric and in the end. Like the Dutch railways, they don't have emissions at the moment because they have their own wind park in the North Sea, it's literally their own. The Swiss do the same. But then with hydro. And they do it already for a century. So why are we trying to create electric cars, which is still difficult and expensive? And we have the solution already on the ground and it's working. You can daily do it if you want if you don't want emissions, get in the train.

[I-MR] And what might be the biggest challenges for sustainable mobility in terms of sustainability in the next 15 years?

[P-PP] Of course, the first one that comes to mind is climate change. But still, the solutions for climate change.. we are now looking for like the electric car will put another challenge in and that's the resource for the batteries and also how to get rid of them if they are... or if you can recycle them. It's possible but still costly. Or costing a lot of energy. So that's another challenge that's coming up. Still, the current system is using far too much space. And it's still dangerous. If you would start a new bus company with safety records of a normal car. It would be forbidden within a week. So but just look at the cycling or the cars for children for school children that were forbidden just because of one accident. That's another norm then for cars. Otherwise we already would get rid of them a long time ago. So there's a different way to look at which means that cars are inherently less safe than many other systems. So safety, is another one.. we've be made an enormous progress, of course. When I was a young boy, then we had almost 4000 deaths per year. And it's now less than 700. But it's now creeping up again. So yeah, it's not something that will really easily be solved. And still, there is a shift... there has been a shift from people that died to people that just survived and just surviving an accident it's not good. And the number of serious violence has not gone down very much.

[I-MR] So you also already just talked about sustainable energy. So like electric energy will be relevant or do you think only electric energy will be relevant or are there some more forms of energy?

So that's another thing. There is a parallel between the car and the aviation industry. It's very funny that… the car but certainly aviation is aiming now for electric aircraft and cars driven by batteries, because we know that the battery is a difficult thing, in many respects. Also, in human rights. I mean look at the mines, where they are. That is not what we call sustainable. And for aircraft it is even worse, because it's impossible to do it with the Lithium battery. I mean even see radically it is impossible, because you can improve theoretically the Lithium battery by a factor of 3 and even for short haul we would even need like for Embraer at least would need a factor 7 or 8, leighter batteries or you end up with a hybrid, but they are not half way. It will be much less, because you have then the normal engine, the electric engine. You have a generator. So you have a whole range of engines in the same aircraft and they might run all at the battery efficiency, because they can run more constantly, but still it's a lot of weight, it's a lot of space and these are all things that are not available in an aircraft. [P-PP]

…. and also not in the next 15 years? [I-MR]

No. Certainly not in the next 15 years. So it's a bit odd that everyone is… and actually Mr. Musk, of course Elon Musk is...often people say he's he's a big sustainable guru. But I doubt it. I think he has pointed the wrong way. Elon Musk with the Tesla. It was obvious that they are going for sustainable hydrogen, which we can make already make drive. So that's nothing new combined with fuel cells, and then electric. It's a far better solution. For aircraft you can do it, you can start tomorrow. But nobody is doing that. And that's something to think about.Why is that? [P-PP]

It would be interesting for me because I heard also that people were saying that hydrogen will be possible in 2050. And you right now say it would be possible tomorrow. [I-MR]

Well, in 2035, we could have a first aircraft on hydrogen. Not a very big one but certainly something with like 20, 30 seats. If we want. If we really would direct, all players in the same direction. And not all playing different pieces. [P-PP]

And this would be a sustainable solution.? [I-MR]

Yeah, in the end it would. [P-PP]

And what might be challenges for overcoming…. [I-MR]

Well, the big challenge, of course, and then you see that everywhere that's also in the car industry. Why is the electric car, this battery or whatever, but why is it not taking up by the big car companies? Because they have invested so much money in developing the wrong kind of car that they want to keep the wrong kind of car. That's their business model. As the same for aircraft. They've invested so much in improving the aircraft but also mainly the engines. And you are not going to throw that away you want as long as possible to build and sell those aircrafts with the wrong technology. That's the big problem. So somebody must buy them out or… and the someone that generally is the community, so the government. So that's the bigger obstacle. And I am certain, almost certain, that there is now a project by Rolls Royce, Airbus, and Siemens, I think. They are rebuilding an existing aircraft to make it a kind of hybrid aircraft. So one of the four engines will be electric. And there will be a system in the in the future with electricity generating fan engine still. Interesting project they spent a billion on it, so it's not a small one. And what is the purpose of this? Because [P-PP]

every conceptual aircraft designer can tell you there will be a very old aircraft and not a really useful one. So it's not for selling it. That's for sure. The main reason is that it will take 10 years that you can say to the politicians "We are working on it. We are spending even a billion." And for politicians that's a lot of money. For an aircraft manufacturer it's not that much. I mean, developing the 787.. or what was it? It was 30 billion. That's pretty much. But 1 billion is not so much. So they are spending this to delay decisions for a longer time and benefit from the investment they have already done. That must be the mechanism otherwise it's not sane. They should have gone for the… at least taken on board in the same aircraft also the hydrogen option. But as far as I know they don't. But maybe there are secrets things going on. That could be. Would be interesting if Embraer would consider such a thing. They have done more like that. Because as a very small company in the beginning they now capture quite a market and they are really making the big ones a bit nervous. So maybe that spirit is still there.

[I-MR] Yeah, I think I reached the end of the first subtopic and maybe can you just look at the pictures maybe it might trigger some further memories that might be interesting for the subtopic to tell.

[P-PP] Of course, we have here the lonesome car and here the other side of it….. That's more or less a symbol of the public transport. … and of course combined with cycling. Something like that?

[I-MR] Yeah, that's perfect.
So the next sub topic that would be interesting for me is technology. So what kind of technological breakthroughs do you think will influence sustainable transportation in the next 15 years?

[P-PP] Well, the electrification is going on already. So that will be a major thing. But yeah, we discussed part of it, of course already. The batteries will be… will stay a topic. That's the next kind of environmental and sustainable development. I mean, that's currently it's not a big, on the global scale, it's not a big problem because it's... there are so few electric cars, but if that really takes up, then we run into problems. ICT will be something that has a lot of impact on the other hand. There has been a lot of discussion. Also, the development of the automatic car. And if you look at those bigger companies, but also the scientists that were working and suggested about it, they are becoming less enthusiastic. Also, because of some incidents that happened. Well, again here, if you are a car driver, then you have a lower safety requirement than if you have an automatic car, and that makes sense, because then some operators that's responsible. So there is an issue of responsibility here. Who's responsible the one that was not looking after his car, because he thought it was automatic, or the one who somehow made an error in the in the software or made something that wasn't possible to make maybe either? So that's an issue that's coming up. But I said, yeah, I hope actually that the whole idea of the automatic car will not take up very much further. Because I don't believe it will help us to, to make that sustainable society that really is low on resources, it's actually adding resources to make the high resource using system even more attractive. And so that doesn't help. It brings us in the end, the rebound effect is quite big, if it would be successful. I mean, the big advantage, of course, of longer distances traveling by train is that you can work or read a book or do everything you like, almost. For the car that's a disadvantage, but if you make it automatic, then it's the same advantage. So that makes then the car even more attractive than it is now compared to the train. And that would be not helpful because, really, we need much less energy if we use a train system in the right way. Then if everyone has his own car and we have still the space use and everything. That's problematic.

[I-MR] So you were mentioning different types of technologies, and who do you think will be able to implement

these types of technologies? Like, for example, automation, that you were mentioning?

Yeah. Well, if you look at what Amsterdam… did you get that from the news that Amsterdam starts to forbid non electric vehicles in the city already in 2030? You cannot enter the city with diesel or petrol car anymore. That‘s their plan. And it‘s an official plan, the municipality. It‘s the first city that just takes the consequences of all the climate deals that have been made. And they say that this is going to happen. And now one city says okay that we make law. And now even the Dutch government is opposing this because they say that‘s too optimistic that cannot be done and then you only have a city where only rich people with a Tesla can enter.
Which of course is not true because they have a perfect public transport system. And you can cycle in the city and most people are much quicker with a bicycle than with a car. Certainly in the in the inner city of Amsterdam. It‘s impossible to do it in a different way. But anyway, that‘s that‘s an odd thing, of course that the Dutch government is responsible, they have signed pairs. They‘ve led all stakeholders sitting at tables that literally call it the climate tables. And they come up with plans... okay in 2025 those fence diesel fence should be forbidden in in bigger cities. And now there is a municipality that says ‘okay, we do that’ and then the say ‘Hey, what are you doing?’ And they try actually to find the law that they can forbid them, which is not there. I‘m sure. I wouldn‘t know. There are so many laws that tell city to do it. So but I didn’t answer your question I think. [P-PP]

It‘s okay. I think there were still like a lot of interesting aspects. [I-MR]

Okay. As long as it is useful. [P-PP]

Yes, it is. So I even also have some questions about politics. So that is even also a subtopic. [I-MR]

Okay. It’s always a mix. [P-PP]

Yeah, of course, of course [I-MR]

So that well... that‘s part of the... so governments can enforce things. And then changes can go very quick. Just take for example, the catalyzers for cars. It was a very, very simple system in the Netherlands and that goes within one year, every car that was sold got a catalyzer. And not a single one example. That was not by taxing something it was it was a combination of… Of course, the catalyzed car was like 1000 guilders more expensive than a normal or their normal. So what they inserted was a law that said, okay, you get a subsidy on the catalyzer, and it‘s paid by everyone who buys a car, without a catalyzer. So it was not costing the government anything, except maybe organizing it. And in no time, of course, non catalyzed cars became very, very expensive, as soon as more than half are catalyzed then, and we‘ve already paid more than that if you would pay for the catalizer directly. So within a year nobody was interested anymore in a non-catalyzed car. So that‘s the way to do it. You can do the same with electric cars [P-PP]

Because we are already there at this topic I think I just go on with these questions. So you were also already talking about several policies. So, the question that I have here also would be, how will the government and policies influence sustainable mobility towards 2035? You already mentioned something but, do you do you know about other movements, your developments in this area? [I-MR]

[P-PP] Most economists will say that, if you tax the wrong behavior, then you get the right behaviour. But unfortunately, if you look at the world as it is, that way of thinking generally fails for two reasons. The first one is that if there is a tax and it‘s issued by a government, that‘s a long way from the people who have to pay it, then you come in a kind of negative thinking about not driving a car, that people will do everything to avoid the tax or to keep driving the car or to avoid the cost by asking their employees to pay for it or whatever. But and that‘s what you see that generally such taxes, their effect is not very big. The second problem with it is the government‘s are because of these negative feelings are not prepared to implement the tax, that makes sense. And you can see that this with the ticket tax for for the Dutch. For the Dutch aviation sector, it‘s seven euros for every flight. So it‘s not effective for climate change because it taxes the biggest ones with the biggest emissions relatively very, very low. Actually, it makes long haul flight more attractive relative to short haul flight. Because the increase for short haul might be sensible like 10% for long haul it’s less than 1%. So from the same economic theory, we will see a stronger growth compared to the short haul over the long haul. And 80% of the emissions come from long haul, of course. Even though it‘s a minority. So it doesn‘t work at all. Well, add to this that there is also an element of lifestyle, of course, in changing behavior, and in what is common sense, and that‘s something we create together but there is no government... well, there are some governments that for enforce it, but that‘s generally not the place to where you want to live. Like Northern Korea. Yeah, that kind of government. So in general, in a democracy, that‘s not a government task. What we have seen the past year actually, it started in 2018. We had a big discussion, of course, about aviation and climate change. And before 2017, there was no discussion, discussion whatsoever. Well, almost not. It started a little bit in 2016. I remember a couple of moments. That there was in the news, some awareness that there might be a problem with aviation and the climate change. But since 2017, that has taken up very much and the NGOs have taken up the subject before they were not covering it, not at all. None of them, almost. And there was also a discussion about the could be an alternative in taking the train for international travel. Well, the international train hasn‘t changed, it‘s still the same six train pairs to Berlin and the same about 15 two pairs. Nothing changed. In 2018 excepted…. there was one...no two direct trains now from London to Amsterdam, but not back. So that‘s not really very good proposal. If you go back you have to change in Brussels for the customs. The prices are the same, the local scariest prices are the same, maybe even still lower and more frequent. Because that was quite a lot of growth in 2018. And still, we see 30% rise of international ticket sales in one year. It‘s a ridiculous amount. And even in China they cannot do that, they can just do that with the high speed railway system. So why? Why has that happened? Not just because of the public discussion about it and people thought ‘Hey, international train? I didn’t know that they were there. Let‘s try this. And the more adventurous once they tried it, and they discover, maybe it‘s not so expensive as rwe thought. It can be expensive. But if you look a bit better then, it can be very cheap as well. Maybe it‘s not taking the whole day to go to Brussels, but you can do it in a couple of hours. So, and that‘s, that‘s a form of developing a new lifestyle, because it‘s still continuing. Try to buy an international ticket, for instance, the train Rijst winkel as we go, and they are completely overwhelmed. They still cannot deliver very quick anymore. And it is used to be within a day. So they, they cannot cope with the enormous demand. So the demand is even bigger probably, than what‘s realized now because the system cannot cope with it. So that‘s… and what can you do as a policymaker to help this kind of developments, well, obviously, make it easier to book tickets. And there are many legal aspects that make it difficult. For instance, did that stop over in Brussels? If you go to London, it‘s only necessary because governments failed to organize it. There is a customs office in the Netherlands, that they have success there. So but the office is empty, just because of some agreements, they they didn‘t reach in. They are discussing it already for four years. And I don‘t see why that should take so long. There‘s no political will to it, but if there‘s political will, you have that within a month. Yeah, so that‘s also the

conditions in which things can develop, should be gentle as well.

So I also have the question which kind of political parties will influence the political landscape maybe in the next years. Also to think of how these kind of parties will influence sustainable mobility? [I-MR]

Yeah, it‘s difficult to say… If you look at the liberal parties, they generally are quite good if they have the idea that something needs to be done, then they are generally good to implement it. If you look at socialists, they have big visions, but they are unable to implement in the big thing. So, and then of course, you have the Green Parties, but they are hampered because they, they are so idealistic that they want to go for something only if everything is okay. And every solution has also its disadvantages, and then they start a big discussion about even improving the disadvantages. And the end of it, of course, is that the political opponents use those generally minor issues to try to get rid of the whole system, and successfully. So they they organized their own opposition. So that‘s a difficult interplay. But of course, the thinking about what could be done comes generally from the greener parties. And currently (?) is quite green in the Netherlands in terms of climate change, at least. They are very much convinced that there needs to be done a very much to change almost everything. So, yeah, those. But you see also that the people even negating climate change are coming up this out of the nothing out of the blue. And that’s a bit worrying. With so many politicians simply get a lot of folks because they do not tell the truth. [P-PP]

I think I‘m done with this subtropic. So maybe you can also look a bit on the pictures and tell me of it might trigger some some kind of memories. [I-MR]

Yeah. Well, this one is interesting because it‘s in the heart of the debate in Amsterdam. They say it‘s only the rich people. And that they are the only ones that can become sustainable because they can buy a Tesla. I feel it‘s it‘s a very simplistic way of thinking. Because first of all, they can also take the the electric tram and then they are sustainable as well. People that don‘t… that are able to buy a Tesla can also take the tram and be sustainable. So that‘s not a big deal. Of course, they will have difficulties to buy that second hand small car that they are used to. But on the other end, if that becomes more difficult than the system that‘s still available for them, the public transport system will become so much better. So that helps also to to have less problems with not having a car. So it‘s an argument I think it‘s a symbol for misguided kind of arguments. And in the end, do you have a choice? If we do not solve this problem, and we go to four degrees, they will survive probably, but not the poor people. Even with or without a car. They have a car then They will probably need to car to fly. Fly away somewhere else. Because in the Netherlands we will have serious problems just water management. So, yeah, what‘s the big deal? What‘s the choice? So that‘s an interesting one. Maybe this is another one, question mark. It‘s always easy, of course to ask questions if you try to change things, because what you used to, you know everything. But what you want to change always end up with questions. So there is a lot of resistance to change. Always whatever it is, yeah. Even if it‘s obvious that it‘s better for the people who have to change, for instance, when just from a mobility perspective, then everyone in the United States was still walking or using a horse. Then the T Ford came in. And nobody wanted to have it. Certainly not out of the cities in the cities, there were some people that saw the benefits but out of the cities, the farmers they said ‘I have my horse.’. And they have really forced those people to buy cars. And also in the cities they have… I don‘t know if you know that story. But in New York, the car companies, they bought the public transport system and closed it. More or less. Because they wanted to sell their cars and as long as people were taking the tram. So it‘s the change is difficult. It‘s not the other system that‘s difficult. If you are in the other system, you get used to it. Nobody will be unhappy because of [P-PP]

that. But of course, this is political used always to stop any change. ... Oh, maybe this one. That‘s a symbol for the vested interest. That‘s always against change, always. And it‘s very big.

[I-MR] And we were also talking about the sub topic of technology. So I changed because I just saw some correlation there. But of course, it might also be interesting if you find something else.. or I think one question that also was interesting to me that came up to my mind was you were also just saying, like, electricity as some kind of technology also for trains. And do these kind of… and does the electric energy always come from sustainable energy? Because there are, of course, also nuclear power plants. And I think this would also be interesting for me to know if you know something about this.

[P-PP] Yeah, that‘s a dilemma, I think. To some extent, it‘s certainly a dilemma in in countries like France that depend so much on nuclear electricity. On the other end, they have a low carbon footprint. So, yeah, those plants are there. So yeah, they use them but to build more of them, I don‘t think is the right way to go and in the end we really need to go for the triple… well the really sustainable forms, and that‘s wind, solar, hydrogen and maybe earth heat. Biofuels is also is a difficult one. It has so many disadvantages. And in an ideal world, it would be a perfect solution, but the world is so not at all ideal, certainly not the economic system. So it will turn out to be a disaster for many communities, places and kinds of

[I-MR] And which kind of disadvantages for biofuels can you think of?

[P-PP] Well, it‘s the competition with agriculture, with food production, with nature. It‘s actually chlorophyll is a very low efficiency solar energy converter. It‘s generally far less than 1%. Every solar panel does more than 10. So obviously you need much much more space to do the same. So why are we wanting this? And even the best ones the algae, which are changed genetically. So because the natural ones can do it but if you change them you can reach maybe 3% but that‘s that‘s really the bloody limit. And then you have created some creature that is of course in the big advantage over the natural ones. So I once asked somebody if they escaped to the sea. ‘Yeah, we have many precautions to prevent that.’ Well that goes wrong after some time. And there is nowhere if the whole world would be running on algae. There is no way to prevent it. At some moments the creature comes into the open sea. And then the second reply was, probably they are not able to survive because you can create them in that way, but you can make one error and then, you know, the rabbit is still there in New Zealand, and you get never rid of it. So, yeah, that are just a few of the examples that really worrying about biofuels. And it‘s not necessary... For aviation, I see actually two technologies that would potentially…. technically solve the problem. The first one is, we have this kerosene fueled aircraft fleet. And there are in the next 10 years, there will be more than 10,000 new ones added to it. So, of course, we could have the king that says, you have to stop with it, that‘s it. But that is not very likely to happen. So we have to create something that is as kerosine and biofuels is one route, but with all the disadvantages. So, you could go for the synthetic fuels, the e-fuels, based on power to liquids. That can be done now, I mean, we can do it, we know how to do it, we can use initially rich carbon dioxide sources to create the fuel from. And of course, that costs a lot of energy, it‘s like triple that you would use with just oil based kerosine. On the other hand, it‘s quite expensive, so it will make tickets about two times as expensive as they are now, so you will get rid of about half of the growth of the volume. So that saves a lot of energy compared to not doing this. And for a temporary solution until we have those hydrogen fuel cell aircraft, I think it‘s the best route to go and then, then you get can really fit aviation globally within the targets of Paris. I just made a new scenario for that, then I‘m not talking about 2035 but 2100. The assumption there is that in 2035, there starts to come those hydrogen planes. And the e-fuels will be by then be

more than half of the fuel. But that‘s doable, I mean also economically except that you, you have to forbid somehow kerosene based on fossil. And that can be gradually done every year 2% less. you have the (chor-sea?) system, we could insert it there. I stopped this silly idea that creating more forest or saving forest from being destroyed that that would really reduce emissions, of course, it doesn‘t. It does only stop even more increased emissions, but it doesn‘t stop the current emissions. So that would, I think for aviation be the route to go. But everyone is talking about too many things and then it doesn’t help.

Yeah, maybe just to close this topic, can you look at the pictures again, of technology? It might trigger some some memories. [I-MR]

Yeah, but still do it yourself. It’s undervalued…... Maybe we still need someone, who has some influence globally. At least we need some leaders, that could be a symbol for it. It doesn‘t mean that I say that democracy will never solve it. But pure democracy might not be able to do that….. Yeah, we need a scenario is this a symbol for the scenario? [P-PP]

This can be a symbol for it. [I-MR]

At the end a simple scenario, everyone goes for. [P-PP]

Um, so I think we were just also coming kind of the end of the interview. And so also reflecting on the different aspects that you‘ve mentioned, is there just some aspect that you think is especially important for sustainable mobility in the next 15 years? [I-MR]

Yeah, well it would be helpful, if the fake news kind of things somehow would be effectively opposed. And I don‘t know how to do that, because it‘s quite a lot. So it‘s difficult to... of course now Facebook and others are trying to do something, but not in this area. It‘s more the political part like that people say that some people have said something which they never said. Or even negating the Holocaust in that sort, things that … well, that’s not factual. And more a policy that’s again, more based on effects would be very helpful, of course. [P-PP]

Okay. And I‘ve asked a lot of questions. So have we missed anything or do you want... or do you care anything to add that was really important, but was still missing in this interview so far? [I-MR]

Not so many things. I’ve talked quite a lot about… yeah well, we talked a little bit about lifestyle but it‘s also, it includes also kind of mentality. So be happy with what you can do and do not think but if we had this or that we could have done in that way so I‘m very unhappy to be sustainable but not having the other things. You see that for instance with... if you go on international rail travel, I do it quite often. And I was once traveling back from London, with a colleague by Eurostar to Brussels, that‘s the easy part. And then you have to wait there generally for half an hour, quarters of an hour and the other one almost exploded, he said. This is so ridiculous. And then we go into the normal intercity. It takes all so much time, this is the reason why I will never do this again. And then I think that you are thinking I would have been at home already. But you could also say okay, it‘s a very lively place there Brussel you can have a nice dinner if you want and make something out of it. [P-PP]

And to set all these information in a context I would need to know maybe your age, nationality and maybe [I-MR]

that you say yourself like about your occupation.

[P-PP] Okay, well I'm 61, Dutch, I'm an associate professor. Well actually, in English, I should say professor in sustainable transport and tourism. And specifically, in… my object… sorry, my subjects are climate change, transportation, aviation. My background is, of course in aviation engineering, but just by doing other things, I've learned quite a lot about transport systems, model split, model shift, modeling transport systems, transport modeling, economic modeling, and the like.

[I-MR] Okay. And yeah, can I use of course, all this information for my master's thesis.

[P-PP] Sure.

INTERVIEW 3 - TIM VLEESHOUWER - 07.05.2019

How realistic do you think is it to have the technology like the Hyperloop in the coming years? [I-MR]

I think it's quite realistic. We have the technology already. And there are multiple companies and students teams. They are working on the technology of the Hyperloop. However, I think the biggest barrier in the Hyperloop is political and the regulations, he laws, because for example when you want to have a network in Europe you have a lot of different countries, a lot of different member states, European Union, that all have different opinions and want different things and regulations and legislations are I think the hardest part. But the technology… It's mostly just used by other for example modes of transport like (madlef?), there we have station trains. Actually, the Hyperloop is sort of some thing but then put into a large vacuum tube, for example the vacuum technology is there also quite ok , for example insert, engineer others, there is a big vacuum chamber. So the technology isn't the hardest part I think, but it's more legislation and also standardization and also socially. When people need to travel the Hyperloop, it can be fast, and claustrophobic. So they also need to want to travel the Hyperloop. But for the technology I think it can be done in a few years. [P-TV]

Okay. This would be my next question. When do you think can the Hyperloop be expected approximately? [I-MR]

I think in the first 10 to 15 years there will be the first operated trajectory, but it will not be in Europe I think. So I don't know what the scope of your project is, but I think that in India or China, United Arab Emirates that the first link will be over there and I think it will be in approximately 10 years and afterwards in Europe. [P-TV]

Okay, what makes these areas especially interesting for the Hyperloop? [I-MR]

That's more because it's easier to build a new system over there, because there is plenty of space and for example and there is only one country. So it's only one legislation. You don't have different countries that want different things. Furthermore, for example in the United Arab Emirates there is plenty of money and there are some people, they just want to do some cool projects and in my opinion the Hyperloop is quite a cool project. [P-TV]

And what kind of technological breakthroughs will influence the Hyperloop? What do you think? [I-MR]

The biggest breakthrough that will influence the Hyperloop is I think electric airplanes, because if we can travel by airplane… with electric airplanes I think the Hyperloop will not be a thing, because in the opinion of Delft Hyperloop and a lot of Hyperloop parties, we think that the Hyperloop is good to replace part of the aviation and mainly on the shorter medium haul distances, but when you can travel electric on these short distances, that's also a good alternative for the polluting industry as it is right now. So it's the Hyperloop or the electric vehicles or of course it can be both, but if there are electric vehicles there will be less interest in the Hyperloop I think. [P-TV]

And which kind of technical issues might the Hyperloop have? [I-MR]

It's something in the vacuum technology I think, because if there is for example a network throughout [P-TV]

Europe there will be one large vacuum chamber and… yeah… we don't know how it will be, how it will look like. And what will be the effect for example small haul in a tube if that are going to be really strong shock waves or just very small… yeah… things of air. We don't know that yet. So that can be technologically a challenge. But… yeah I think technology wise it will be ok, but one main point is that it needs to be tested thoroughly. So right now there is not a proper test track longer than 1 kilometre. The test track in Los Angeles from Elon Musk is where we have the competition in the end of the year. That's the longest test track in the world and it's only 1 kilometre. So noone is able to reach high speeds yet. So the Hyperloop concept needs to be validated for also high speeds and if the technology can reach those high speeds.

[I-MR] And what kind of need do you think will the Hyperloop fulfill?

[P-TV] I think taking over the passengers from the aircraft and mostly those short distances for example from Amsterdam to Paris it's very polluting and also airlines like KLM or Airbus in Schipol. They tell us they don't even want to travel on these short distances, because it is very polluting they just want to have more intercontinental flights and they also think the Hyperloop is a good alternative for the short distances, because it's way better for the environment. And furthermore, we also see a trend in the behaviour of people in the travel behaviour, because people want to travel further and they want to travel more. And I also think that this is a need that we can fulfill with the Hyperloop.

[I-MR] And which aspects can you think of that will make the Hyperloop be sustainable?

[P-TV] First of all, because it's all magnetic levitation. There is not that much resistance and furthermore, because it is in the vacuum tube and there is almost no air resistance, so less drag and therefore you don't need that much energy to sustain the high speeds that you are travelling at, for example when you reach the high speed, because of the less resistance compared to for example a train or airplanes, it's a really efficient mode of transport. And furthermore, when the tube is constructed above ground we can place solar panels on top of it to even generate more energy.

[I-MR] And what do you think are the current biggest challenges of the Hyperloop in terms of sustainability?

[P-TV] I don't think there are really much troubles for sustainability, because if constructed well it is more sustainable than for example aircrafts. However, I think for the construction that also costs a lot of energy I think. That's the main issue on sustainability for the Hyperloop. For example when the infrastructure is already there then it is very sustainable, but to build and construct a new infrastructure that will cost quite some energy. However, then the system can be build for 50 or 100 years and spread above all the years, then it's ok, but right now it can take a lot of energy to construct the Hyperloop.

[I-MR] And what kind of energy will be used for the Hyperloop? You said something like there are like magnetic fields of transportation. But will there be also other forms of energy that is used for the Hyperloop?

[P-TV] I don't know that for sure. We are currently not investigating that much. But with the solar panels we will generate as much energy as possible to use that for the Hyperloop system. And furthermore, we didn't investigate this that much into more detail.

[I-MR] And what are the biggest advantages of the Hyperloop compared to other forms of transportation?

First of all that it's more sustainable, because you use less energy. That is a very big advantage and secondly the speed. Right now when you want to travel for example from Amsterdam to Paris and you go by train that's quite a long time, but when you go by airplane the journey itself isn't that long, but when you want to go somewhere to the city center of Amsterdam or Paris you have the access of transport that costs quite some time and the idea for the Hyperloop is to have the stations in the city centres so that you arrive in the city centre so that you are close to your destination. So that you can on the one hand that can shorten the travel time from city to the city, on the other hand you can shorten the access. [P-TV]

So this might already a bit answered. I have the question: For what reason might the Hyperloop be relevant in the future? Or for what reasons might people truly need the Hyperloop to travel? [I-MR]

I think because to reach the climate goals, there needs to be done something in order to diminish the amount of aircrafts or the air passenger transport. Or the aircraft needs to be a lot more sustainable, but I don't see that happening in the coming years. We think that there needs to be done something to diminish the number of air travellers and I think that can be done by the Hyperloop. And furthermore, what I also said people want to travel more and further and that is also possible by the Hyperloop. [P-TV]

So I first have here also a question, which has nothing to do with the Hyperloop. But the follow-up question, which is relevant to the first question. So how do you think will the demographic landscape develop in the future? [I-MR]

I think there is a trend that the population is growing. There will be more… there is a trend of more people travelling. So in the future there will be more a need to travel. Furthermore, more and more people are living in the cities and not in the countryside. So, that's also something that we see, more people tend to move to the cities and the cities get bigger and bigger. There will be more transport between large cities and less transport between the smaller cities. [P-TV]

And how might the demographic composition influence the Hyperloop? [I-MR]

I also see it the other way around. That the Hyperloop can influence the demographics, for example when you build a new infrastructure and you connect for example some smaller cities with some other smaller cities, then people will change their behaviour and people might and people might want to live close to the Hyperloop station or something. So it can also be the other way around. But I think that when people are living more and more in the cities that more transport is needed between the larger cities and that can be done by the Hyperloop. [P-TV]

And how do you think will the government and policies influence the Hyperloop? [I-MR]

Yeah, that's a good question. We are also in contact with the ministry of infrastructure and water management as Delft Hyperloop and we are currently running a report for them mainly based on safety. So what are the main issues for the Hyperloop. And they are very interested in the Hyperloop, however, it's hard for them to finance something that isn't there yet. And it won't be there in the coming 5 years. So it's very hard to create the willingness of the people to invest in the Hyperloop. That's quite hard. But there are quite some government throughout Europe. They are very interested in the Hyperloop and there is also in the [P-TV]

European Commission. There have been a few meetings between Hyperloop parties, Hyperloop companies, and also multiple governments and how they see the future of the Hyperloop. So, I think the governments are interested in the Hyperloop. However, it's hard to spend a lot of money in something that isn't there yet. So I think there will research be done by the commercial companies, and then later that they will have a say on it.

[I-MR] And which companies do you think will build the Hyperloop?

[P-TV] That's a good question. I don't think there will be one company that can build the Hyperloop, because it's very.. there are a lot of different techniques, it's a large project and….

[I-MR] So it's more some kind of collaboration.

[P-TV] Yeah, I think there will be a public private partnership needed and for example right now there are some larger Hyperloop companies, for example Virgin Hyperloop 1, Hyperloop transportation technologies and they are with quite some resources and quite some people working on the Hyperloop and next to that there is Hard Hyperloop, which is also situated in Delft and they want to be sort of the integrator between all the different parties and companies that is needed to construct the Hyperloop. And they are also situated in Delft. We are also in collaboration with them .

[I-MR] What kind of companies are these? Are they only focussing on the Hyperloop or also on other modes of transportation?

[P-TV] They are only focussing on the Hyperloop.

[I-MR] Ok. Reflecting on the aspects mentioned during the interview, which aspect do you think is the most important one?

[P-TV] I think the most important one is the sustainability issues that there are right now and with the climate goals in order to reach that climate goals there need to be a lot need to be happened and also to the transportation industry. And I think the Hyperloop can be a big part in replacing the aircrafts, the short haul aircrafts, and therefore reducing their pollution that there is… produced by the airplanes.

[I-MR] Is there something you would like to add?

[P-TV] In my opinion the Hyperloop is a really good idea. However, more people need to be enthusiastic about it in order to realize the Hyperloop and also because it costs quite a lot. So in order to implement the Hyperloop it will need more momentum and need more enthusiastic people to work on it. To spread the word of the Hyperloop and also in order to get investments in the future to realize the Hyperloop I think there is a lot needed.

[I-MR] Ok you were talking about the people. Which kind of people would that be?

[P-TV] Government, and companies. For example right now we see that a lot of companies are interested in the work that we do and that's amazing, but it will be more amazing if there would be more companies

working on realizing the Hyperloop. But there are already a lot of companies working on the Hyperloop. I think that is already great.

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[I-MR] What do you thing will be the biggest market opportunity for sustainable transportation in 2035?

[P-LRM] Okay. I think it depends on several topics, but let's say we think a little bit… we do have already some regulations in terms of sustainability emissions and I think it's a huge trend although some goals are quite difficult to be achieved in the timeline they are suggesting. But anyway it's driving some technology development. So I think even though with all pros and contras, and we might move into more electric... So think about cars and aircrafts propulsion systems. I think we we will, we'll probably have this technology developments finished in the next decades, at least. And so I think, yeah, we will face a new possible transportation system with this technology. And yeah, and it will fit the regulations in regards to emissions. And yeah, and you create a more interesting market in that regards. Yeah. Yeah, I'm not sure. I think it's, depending on where we are looking for the mobility system. I think we might experience probably more.. a big change from autonomous driving. So I think maybe the car transformation will be higher than air vehicles, actually, but let's see.

[I-MR] Okay. Yeah, the next question would be, what do you think will be the biggest challenges on the market for sustainable transportation in the next 15 years?

[P-LRM] Yeah. So I think, first regulations and because, yeah, and it's linked to social acceptance. So, yeah, and infrastructure as well. So for, yeah, and considering that this kind of more efficient transportation system, they requires personal information about where you are and about your profile. I think also, this kind of share information will need to be also regulated. So because I think today it's still very interesting how things are treated in a different way, for example, and I'm sorry from going to other topics.

[I-MR] No, it's okay, it's okay, because the interview is also about other subtopics and they are often connected.

[P-LRM] Yeah. If you think about when you go to... we face a huge procedure, questionable but a huge procedure of regards to safety when you travel by aircraft. Yeah. But we go to a train, Metro, in any kind of bus and there is no safety procedure at all. So isn't it, at least, weird? Because somehow there is this mindset that the fly experience is seeing perceived completely different from other transportation system. So, yeah, so I think, again, when we are considering because of course, we will probably introduce new solutions, but we will probably keep having different kinds of transportation when you go from door to door. So, I think it will require a more homogeneous way of treating all transportation system, otherwise it's not the system integrated. So I think it's something that has to move, as well. So I think it's something that it's a challenge because I don't know exactly why, but it's not this way today. So it's something that has to change otherwise, we don't have the more efficient system. Yeah. And also, I think there are some things we, yeah, that I believe maybe it's not necessarily a trend, but maybe it's a possible solution, but I believe that because from my experience from an OEM, I think this high level regulations topics should be splitted into more feasible. So it could be a transition phase to change something and I think it could be interesting to happen. So maybe to come from more talks and having different players contributing to promote these more efficient mobility for society so I think it's maybe we will need to have more collaborations. Yeah, so sustainability, it's also interesting sustainability is still like you see companies in enterprise wherever. It should be more I think like there is no need to have a department of sustainability. We do have that because it's not

something that‘s really, a truly understanding about the topic. So it‘s something is to like, ‘Oh, yeah, I have to do something about it.’ But it‘s not internally people‘s mindset and culture. Yeah.

By people do you mean society. [I-MR]

I think everybody, I think in terms of society, we do see already, of course, people are more conscious about that. But you and, probably not enough people. I also I see like, it‘s turning a brand think also some like, and I can include myself in this brand thing. So like, let‘s say, it‘s nice, we feel good if you are doing a sustainable choice, but because we, the image we have about ourselves, maybe more than because we‘re really doing something good. So like, I‘m saying that, like, let‘s say cuz if we want to be really more sustainable, then by again in my case, I maybe I should reveal all things in my life and maybe try to really think about ‘Am I doing the best I can.’ And I‘m not there yet. So sometimes I‘m ‘Oh, I‘m doing this, I‘m doing this choice. It‘s nice, but still it‘s it‘s a brand thing’, you know, it’s not a problem. But I think it will turn in something more profound that people really need to, maybe now it‘s something we want to have, but it‘s not something we need to have. But I think it will turn probably something we need to have, unfortunately, because we are using our resources you can and polluting and so on. And in having more people living in the country. But yeah, but so in anyway I really believe that.. So it‘s a good thing that it‘s also.. it‘s a thing that people will not feel bad about, so it‘s a good thing. But still we need different contributions from different players from government, from society for companies, from regulations, agencies, and I think a lot of information, cultural thinking. So yeah, I think.. and also, whatever sustainability, project, topic in design we can think about. It‘s very important to have a very, very, very good marketing strategy together. Because I think it helps to create a culture. So we start thinking, ‘I don‘t care.’ In that OEM perspective. ‘It‘s not so important we are surviving up to now we are okay, we‘re fine.’ The suppliers the same. ‘Oh, we are doing well don‘t need to really introduce some things.’ But then it‘s ‘Okay people are complaining, regulations, there are these drivers, so the agenda. So, okay, let‘s try to do something so we are pretending or doing something or we‘re doing the minimum but ok there and then we are.. Yeah, we‘re doing something in now. It‘s it‘s expensive, but okay, and then I‘m proud, I‘m doing something. So, to see this, change, I think as the perspective of being.. it’s a business people…. We might have some exceptional, very good people that are really.. they care about the planet and so on, but most of businessmen they will look for profits. And so I think to... yeah, we need to have lots of things moving together, but for sure it has to turn something that will like having a car or not having car, it has to turn something that people will change their mindset about that. So, yeah. [P-LRM]

Okay, um, yeah, I think I would right now finish this subtopic. And maybe you just can... So I just said economics but of course, you also mentioned some other categories. So if you just.. maybe you can use the images also just write something or draw something. So that‘s like here, so it can be just some kind of collage. So I said like, maybe this might also trigger some other information. And yeah, also other memories. [I-MR]

Okay. [P-LRM]

Yeah, so you can use bit here but also just draw something maybe like, which stakeholders are important. What is really important about this subcategory? [I-MR]

Okay, yeah, I think like, yeah, like demography and society. It‘s I think it‘s very connected and also economics as well. But I think what I understand about. What we are going to, to solve, or to increase, yeah, so [P-LRM]

I think it‘s the congestion. So it‘s related to the demography and society and economics as well. Because like, why do we have... the thing starts with mega cities, so it can take a look in Sao Paulo, Los Angeles, Tokyo. Why it‘s related to economics, so people, they have an urbanization. People have to move to big cities and when they are supposed to have more opportunities and a better life. And because of that, and it‘s a cycle thing then it turns very expensive to live there and very crowded. And so we have seen some movements that people then they come back to other neighbor cities where they live but still they have to go to the center downtown to work and things like that. So, yeah, so the reason why people move and have to travel is because they have to work and they have to live somewhere and work somewhere. And so and... but it‘s also very dependent on the infrastructure of the city. For example here, I think we we do have a very good public transport. We do have already very good, good infrastructure. So the solutions they might, I think they might be considering that you can increase the current infrastructure. But if you go for instance to Sao Paulo, like, I don‘t see, maybe we should have trains there, but I don‘t see how it will happen in the future. So maybe, and also we see like in San Paolo, but for rich people, there is a a huge market for helicopters. So they‘re probably there is an interesting space to have more VTOLs and small air solutions flying. But maybe here, it might not be the best solution because here we do have already a good infrastructure and an economical situation. They avoid the country to increase the infrastructure to attend more people and made to do also some more creative restrictions in regards to not allow cars into specific areas or two in more space to have more electrically and autonomous driving and so on. So,

[I-MR] So you would say, VTOLs are more relevant for a city like Sao Paulo than for the Netherlands?

[P-LRM] I‘m not sure, but it seems to me. Because I‘ve been thinking, yeah, maybe sometimes it‘s not good also, because I come specifically from Sao Paulo from there, but like, I I don‘t have a very optimistic view about.. Yeah, I think it will be a mess. Because I really can think about how it will be in 10 years to live there. But unfortunately, I don‘t.. I can‘t see right now. Good solutions for society. I think it is still most of people there you will still face difficulties and maybe these new possibilities will come for a higher society you know that‘s there. It‘s very few people I don‘t know. Yeah, but although... Yeah, the things are changing we do have more bikes and let’s you yeah. And the technology is a means of.. a way of having this possibility.

[I-MR] Okay, I just would go on with the next sub topic. Maybe you can just write something down or just like use some pictures.

[P-LRM] Yeah, but like it‘s just a possible representation right here. Here it could be. Yeah. Thinking about. I think that the technology developments that will allow more autonomous car will be very close to what we allow any other transportation.

[I-MR] Or are there also other technological breakthroughs which will influence sustainable transportation in 2035?

[P-LRM] Yeah, I think we, yeah, then I think it turns out also very political. So, in my in my opinion, I can’t say precisely when we will have this electric solutions and also operational batteries really. Because also like, we still have a lot of restrictions in regards to recharging time. And also, even though I think it‘s still a very holistic idea, because even though we will have if we consider this flying cars for example, we do need to have infrastructure we do need to have takeoff and landing spots. And so, honestly speaking as we have... we are in the city, we have pedestrians, we are living here. So, because by the way the airports, they are

isolated for reasons very clear. So, it will probably happen the same way although we are considering Hyperloop that would be a solution. But, so, but so we I don‘t I think we will naturally face something that can be hybrid so you can introduce new things for specific spots, hubs. But we will still need to have other transportation. So, we and meanwhile, I think there is still place for more efficiency or more efficient transportation based on what we already have. So, for example, we do have aircrafts, conventional aircraft, maybe we will have more smaller aircrafts flying. And we could also use biofuel that is already ready to be flying, because it’s already certified and so on. The reason why we don‘t have biofuel operating nowadays is due to political issues and because we would need to, to change the infrastructure. But, but it‘s but it would already provide some benefits in regards to the emissions and this is the kind of example I mentioned it could be something in the middle. So, from what we do have now to we could have biofuels, smaller aircrafts introducing, small electrical something and then turning… depending on how will be the development of these aspects in life cycle batteries of battery so, and then we could have more.. increase the amount of vehicles using cars and air something and yeah, so.. But what dictates the choice is it‘s very political and also very related to like, yeah, it‘s like, we do have the manufacturers and they they are facing, struggling with what they can do right now. What are their availability, their intentions really to change what an example for, for car. We should have more... It‘s possible it would be possible to have car manufacturers in composites, for example, but then it would require a completely change in the infrastructure, the supply chain. So that‘s why it has not changed yet up to now. So the reason things sometimes don‘t move, it‘s not that it‘s not because it‘s not possible, but because of political issues as well.

And yeah, maybe I‘m moving over to other subtropics. But right now you were talking about political issues. And do you have something or that you know about the Netherlands of political issues that you know about the Netherlands that will influence sustainable mobility, or is it more that you know it from Brazil? [I-MR]

Yeah, here, I think it‘s much more evolved environment, of course. And also in regards to not, not only in economics, but also in politics, but also, I think, infrastructure as well. So, yeah, I think, maybe it’s more natural to evolve. Having already a very good public transportation system, maybe this is something that is a fact. So in places where you do have already have a good transportation public system, then I think it‘s a natural evolution and also because let‘s say, one thing, there is a direct effect on the order for example, if I live in Los Angeles, there is a terrible public transportation there and people use the car to go to work. So, if you... there is no public transportation system and if you do need to have your car you can consider using autonomous driving and so on. Okay, but you wouldn‘t you... Yeah, you, you necessarily.. we will necessarily need to have a car there. It‘s unless they start building an infrastructure to other kinds of public transportation. But it seems very unlikely to happen up to now. Because they are arriving already facing a huge congestion and big city and for many years and nothing has been done, and they don‘t seem to have economic issues. So it‘s very cultural, very mindset from US for example. Here you do have a wonderful public system, transportation system. So here we actually,... you can still have a car but you don‘t need to have a car, you can rent a car sometimes. So here it‘s much more natural to move to a more efficient transportation system. So you do have society conscious, you have economic, you have ecologic conscious as well. And the technology, everybody is available, so the technology will.. it‘s not an issue it’s economics of course feasibility, but again this kind of market is very global. So, the solutions they might be achieved depending on where you are. Yeah. But I think there is something may be that the know exactly if it comes from here, maybe it’s in here, it’s society, it’s cultural. This culture, but the culture is… yeah, it‘s.. it comes from, yeah, geographically speaking, it’s intrinsic. Here you can have the OEMs and society, I think, and so I think it will… it’s something very relevant in this possible change because, like, as I mentioned just a [P-LRM]

few minutes ago, you can consider not using something you have today to move to another, depending on the benefits you're having with that choice. Yeah, like Sao Paulo for example, people try to, again, the thing where you live, where you work, people try to live… and also also in Sao Paulo, I believe there are lot's of very big and expensive cities. If you are lucky to be able to live close to work. Then you can go by bike or walking. But in this mega cities, if some, it's usually it's very expensive to live. So you necessarily you live not so close and then you can spend several hours daily in the traffic jams. So I really don't know. I think it's very challenged to introduce something that will, yeah, just to solve the congestion in the future, unless, because, yeah, unless there is a, like in poor countries very complicated. Maybe in more developed countries, you end up using new transportation, maybe, or maybe it can be, yeah, you can try to introduce something that will be for all. But so again, but I think it's depending on where you are it will be very difficult to to avoid this, the increase of congestion. Yeah.

[I-MR] Yeah. We were talking also about technology. So there you mentioned several types of technologies like autonomous driving, but also electrification. And what kind of need do you think will these technologies fulfill?

[P-LRM] What kind of need?

[I-MR] Yeah, why do we need autonomous driving for example?

[P-LRM] Yeah. I think, yeah, first, it's very interesting. For me, it's it starts with a big movement. But not necessarily. It will be... it might be not the best thing, but the way so many players are focused and trying to develop this going into this direction. I think this is the kind of thing that will... so it's already a trend and I think that it is in a moment that it will not stop. It's more or less like... so let's see. The the main... it's very... the main actor is energy. So we have to generate energy in order to have the transportation system working. So the bad guy is the propulsion system and so on. It has been the bad guy since ever. So, like propulsion system companies have been trying to develop more efficient combustion sense and propulsion systems and also yeah in meanwhile there are alternative fuels that can be also performed in a better way and together especially in the aircraft industry, it has been having a huge effort in order to decrease the weight of the aircraft. So then we have an interesting space for structure materials and finished materials and so on. So, it's very much about the weight. You are transporting and the propulsion and the energy efficiency that it's in place. So that's why we have experienced this boom in electrification and in autonomous, is also autonomous, it comes from technology developments and digitalization and the way the information is connected and so and also it's very related to safe it. Yeah. So it's you lots of concerns about in regards to social acceptance and artificial intelligence in order to train something to avoid all possible situations that might happen. But still…. And again, it's a very interesting topic, because although car transportation, it's much more dangerous than aircraft transportation. The culture thing is so strong and always there that all focus are in aviation. Yeah. So it's a human thing.

[I-MR] So I would like to go to the next subtopic, which is ecology. And yeah, what kind of solutions for sustainable mobility do you think will be relevant in the future?

[P-LRM] Yeah, I think simply speaking, maybe we do have it already, but I think we should have a map… like a…. view, an understanding and about what is going on right now. And I know there are a lot of information, data but I... maybe it's not presented in a very clear way for everybody. So I think like so... I'm very fan

of trying to do something that is not the best one, but it‘s just simple but can be useful. So like, let‘s say, we do have information about, yeah, in the city for example, in Copenhagen, we… there is a… there are sensors, so, they count the number of bikes that are passing the sensor every time. So, this is an example of... So, doing that they encourage people to be aware that they are part of something they are in... and they have also information regards, what‘s the difference in driving a car and using a motor bike for example. So, this is just a way of turn something more concrete to for people to understand that you are contributing... you are part of something so, yeah, so I think maybe, if you are constantly exposed in with we know very often what was not very share with and obvious up to now, maybe we will start rethinking some options and maybe because, yeah, the question could be like, if I offered you a more sustainable option. Would you go for it independent of the price? I don‘t know. So I‘m not saying also that it will be more expensive. But I really believe that even if it‘s turns more expensive, somehow we have to start in somehow people might choose to pay a little more. But it requires time to be exposed to this information and get used to that. No, it‘s... Yeah, no I think I didn’t answer your question.

That‘s okay. So there you also were just already talking bit about the challenges of mobility because this is also a question that I have, and you brought up the current biggest problems of mobility in terms of sustainability. [I-MR]

Yeah. I think yeah. So I think we are… the focus is really in society in the planet. Yeah. So, again, also, any kind of transportation solution we do have, is just a way of moving, but actually, we want to save the planet. Yeah, so I think we really have to have like, you know, like when we ‘We know hear about but we‘ve pretend it‘s not happening’, but it‘s happening. So I think we really have to have a very fair honest moment. Yeah, and then let‘s say yeah, this is it. So for now on people let‘s try to do differently because we are killing the planet and the future generations will suffer and it‘s not nice. So yeah, but it would be like a very high level driver, but yeah, so and that‘s it. So for example, I know that in Amsterdam, they have a plan to avoid cars into the city area. Yeah. And I think it‘s something, it shows a very conscious intention and understanding about the topic. And I like very much also because it, again, we are live in the same planet, but it doesn‘t matter if your neighbor is… it doesn‘t for him it doesn‘t matter, because it‘s impossible to have everybody in the same page at the same time. So I think, yeah, so still, I think we will… it‘s not like it‘s not... the future might not be green for all. But I think individually, we will need to be more conscious and maybe I think maybe to have more voice also. And it happens when you have more information and yeah, and the government is more open, to talk and listen to people. Yeah. But still, some things will happen anyway. So coming back a little like, I don‘t know if our autonomous and electric is the best solution, but it seems that will it will happen anyway. And it‘s like nobody asked me about that. Yeah, it‘s just happening. So, yeah. [P-LRM]

Yeah, maybe we can also involve the connection map. So maybe just you can write down some topics or connect topics to each other or use images. [I-MR]

Yeah, I think this… And and I think technology is very... of course it‘s related to economics and... but I see technology like something more global. Yeah, and also… maybe it should if it is, it should be more regulated. And I don‘t know if it‘s necessarily politics maybe. And also to ecology. It‘s complicated because somehow everything‘s kind of linked. There is this movement for clean technology, green technology with regards to ecology, but also, yeah, and indirectly to fuel efficiency. That‘s... there is an impact in ecology. Yeah. Efficiency and regulations.... [P-LRM]

[I-MR] Thank you. And what kind of energy do you think will be used for sustainable transportation to 2035 depending like on the different modes of transportation?

[P-LRM] Yeah, I think it seems there to go more electric. Yeah, it seems to be a good approach but I really still think like it will be... I like to think about the Smart is the new green. It‘s not I‘m not the one who that said that first I heard it a lot. But this I think it‘s this Smart here then and it is also related a little bit with less is more to have. So I think it comes very much related to values and, yeah otherwise, yeah, it has to, it comes with society values and it‘s complicated to, to understand that how it evolves and how long it takes to, for us to see a change, but for... we do see a change in people‘s life. So it has to be also with education that I could refer to economics and society. Yeah, and here, I think there are cultural aspects and, yeah, like, for example, in Brazil, you see people that they don‘t have an apartment or a house, but they have expensive cars. You see? I don‘t see that this kind of people will easily avoid having cars. And yeah, because it‘s very cultural.

[I-MR] And who do you think might be a customer for sustainable transportation then because you were just like saying, like, who might not need it? Yeah, but like who might need it?

[P-LRM] Yeah, I think again, it depends on where you are. Again, if you if it‘s… Yeah, we probably will need to… it will be regulated somehow also and probably everywhere in future moment. We are not allowed to have more non electric cars for example then it will be happening naturally because it‘s regulated. Yeah. But what but I think it will be not enough because just it‘s a sizing thing we do have a limited planet with limited resource and people growing and yeah so more people in the planet, so we... everything is turning worse in regards to resource so... And yeah and let‘s say and we have a already a disturbed environment. So we cannot stop some physical phenomenons that are happening like ocean temperatures that are increasing every year and it will not stop. So I think, yeah, so regulations that play a very important role because it will somehow force some technology to be implemented and some constraints in the transportation system. So it comes from a sustainability perspective. I think it will somehow, yeah, literally regulate this system. But as we face economical, social and so on, so, of course, in an undeveloped countries and cities, it will take more time to change but it‘s still, I think it‘s not enough. So coming to more... to be more conscious like, let’s see, sometimes you could you go by car but you prefer to go by bike because you are aware that you‘re doing something that‘s good for yourself and for the planet. And sometimes it‘s raining and and so on, but still it‘s... you should just... it‘s very comfortable to have a car. Yeah, but when you do it, it‘s changing your mindset. Is like for me, it‘s like, for example, in Brazil it’s very common that you pay someone to clean your house. And it‘s very, and it‘s cheap. And it‘s a very… and it‘s a terrible job for people that they had to do it and usually they are. Who does it? People that they haven‘t studied and they do it and it’s so I was living there for many years. And for me it was something natural because I was there. When I was in Copenhagen, I had to clean my apartment. And it was very expensive to think about paying someone. And then I started thinking, ‘Wow, there we are kind of in a slave system. It‘s not nice. But then when you are there you think about ‘But ok, but there are millions of people doing it. And if everybody just decide ‘No, if I‘m not doing it they will die because they don‘t have other things to do in country as well.’’ So it‘s so complicated, but living abroad, I just thought wow, I don‘t have it anymore. Because it‘s it‘s not nice, you know, I can do it. So but this is some kind of cultural thing that‘s so strong. So I think but it has to be done. This kind of change can need to come from individuals, otherwise we will not be able to save the planet.

Yeah. Maybe just one last question: For what kind of reasons do you think will it be truly necessary to travel in the next 15 years? [I-MR]

Well, I think mainly... I think pretty much the same reason we travel today like, hopefully, maybe we travel more for business today than a vacation and so on. I think like in a good life quality way of thinking, considering people are living longer and we've hopefully.. life quality it is expected that people can have more time available to have more vacation travels. And yeah, and so I think actually, yeah, considering personal amount of travels, someone can do theoretically, everybody would travel more. We face the democratization of travels as well, especially by planes. So, which is something nice but also there is a bad impact on the planet. So yeah, actually, as much we travel it's worse. Yeah, and but yeah, I can say by myself, I want to travel as much as possible. So, in that regard, I'm not thinking about the planets, actually. Yeah. [P-LRM]

And so right now I'm coming to the end of the interview. And I would like to ask you, yeah, if you think something is really important Or have we missed anything that you would like to add right now. [I-MR]

No, I think it was really nice. The thing, I think that is really.. Yeah, I think you covered important topics, think about how is it today and how will it be possibly in the future? Yeah. But yeah, but again, I just think that it's whatever possible solutions. It needs to be related to a specific location. Yeah. [P-LRM]

Okay. Is there also something else? Usually I'm asking like, what is the most important or what is the essence or what you just would like to emphasize maybe? [I-MR]

Yeah, maybe emphasize that…. I don't know this specifically answer but I think it could be really nice if it was possible turn the transportation system really that would end up turning people's lives more interesting. And… but I don't know, if it's, it goes in the same direction to sustainability. Yeah. So this is something that has to be considered like... as I said, just theoretically, it could be really nice if people could travel more. But then if they can travel more, it's not good for emissions and so on. So, what could solve this if we could have everybody using transportation system that use green technology? Yeah, yeah. But I don't know if it's possible when? And when it will be possible. Yeah. [P-LRM]

……. (voice recorder turned off due to the end of the interview and turned on again, because relevant information were said after the official interview)

Even think about today, about airports. So the way, let's say, you know, in a travel experience, a flight travel experience, the wasting time in airports and connections it's like a huge part of your experience. And yeah and in the end, I think if all actors were together working like from the OEM, from the airline, for all kind of infrastructure and so on. So, yeah, it could, it maybe to would be more efficient way of turning the experience better in already reducing because here the congestion might not been perceived in a physically way when you look for a traffic jam but still you... there is…. what happens here you are you are losing your productive time and the same happens here and the difference is that you are… yeah people are more spreaded located but still it's very much about getting to your destination at least ina I would say in a predictable time. So like for example I go to from my city to Sao Paulo when the traffic is okay, I take one hour and a half, but when it's not okay, I can take four hours. So I think that could be human right to go from A to B and take the time that is required to go through this transportation to get there. This is something that I think could be a human right. Yeah. So like it's fair. Yeah, but it's not fair that you, yeah, you [P-LRM]

take much more time then the predictable initially because then it has a bad impact in in your life. Yeah. So here, I think everybody, yeah, like, yeah, they do surveys after your flight but you do you can just complain and nothing happens actually.

INTERVIEW 5 - ANONYMOUS INTERVIEWEE - 07.05.2019

And there I would start with ecology and which aspects can you think of that will make transportation be sustainable in the next 15 years? [I-MR]

So I see technology for example, on a technology point for example, what we do is that we do weight reduction a lot. So, we have the CO2 emission and minimized. What we have, we have biofuel, so, different forms of fuel in order to try to minimize the impact again also on the oil. I know that this is not particularly my subject but I know that (name of the company) is working on alternative forms of transportation, for example, they are working together with the Dutch government to see if there are better alternatives for the short connections. So for example, from Amsterdam to Brussels, we have a few flights nowadays while an alternative can also be the train, for example, but the thing is that by train to Brussels now still take quite some time and it's not as reliable and in terms of punctuality and stuff and difficult to use then also that you need to make the connection. What we do now we are a network carrier, so we try to connect everything very well to get a seamless. So you fly from Munich to Amsterdam, and then from Amsterdam to New York, but that connection time in Schiphol is minimal. So your total travel time is as less as possible. And the thing is if you want to do that with with trains as well, so that's quite a complex thing. But it can help in the future to see if it can make it more seamless. The train connection can be better, so then we may have possibilities where you fly and and then go further by train. So that's, that's a thing. But still, it's all about flying for us. So it's not that we invest a lot in all kinds of different alternatives for flying so it's basically flying and of course, we want to make money. So, you know, yeah, it's our goal to transport as as much as possible people in our planes. Of course, sustainability is an aspect of that, but it's not it's not the most, most important thing. [P-A]

And can you also like think in general of transportation or can you tell in general about sustainability aspects of transportation in the next 15 years? [I-MR]

So what I just explained is that we may combine, train and airplane into one single journey. Our core business is flying. And of course, we can think of sustainable innovations that may help the environment but also help the passenger to get from A to B. And then it can help to have a combination between between train and airplane. But then we have influence on our own schedule and our own...well, on flying and not on the full system of trains. So there's still quite some, some things to do to make it seamless But still, it's the train company and its (name of the company) and of course, we can work together. That's then the sustainability part. I think that our influence on sustainability is more on what I just discussed on minimizing the fuel, minimizing the weight, minimizing the plastics, minimizing whatever in order to… well, minimizing the plastics, by the way is not necessarily true because we look to the full footprint. So sometimes it can be better for example, on board to have plastics rather than cardboard or whatever material. But as long as you do the separate separation of the of the materials and stuff then in the end it can be more sustainable to use those plastics than cardboard. So yeah, so we look to the full chain. And besides cardboard or other materials can be heavier in weight. And of course, we have to transport the weight and weight is oil. Kerosine. So then it can also be more sustainable to have lightweight products plastic rather than cardboard. So, so we have all those alternatives and and we look at it from that perspective rather than from other of transportation. In the past I also did a study on virtual reality and augmented reality and other ways to connect people. But still, we believe that flying will be there for the next decades of years. So [P-A]

that‘s our focus. What we try to do is to, to optimize the time on board as well so that way, we look at other ways to connect passengers between each other but also connect passengers between air and ground with connectivity, with new technologies in order to optimize the time.

[I-MR] And what do you think are the currently or what are the biggest challenges of mobility in terms of sustainability in the next 15 years?

[P-A] Oil, kerosine, the number of people that are flying is growing. And it keeps on growing for the next years, for sure. We have a Asia coming up, we have Brazil coming up, we have all those countries call it the BRIC countries, Brazil, India, China. What else do we have... but doesn’t matter, but more people start flying. So, we have to transport more people and then the challenge is how can you make it more sustainable and what we can think of is minimizing the costs per unit, also means minimizing the CO2 per passenger. So if you have full planes the CO2 per passenger is less than you fly like Emirates with their half empty planes. So we have a very high density in our flights. So we cannot very much improve on that part. But what we can do is improve on new materials, new airplanes. So we have still a few old 747s in our fleet. Those are the most polluting airplanes we have. So we‘re phasing them out right now and then we get new planes in return which are more lightweight, and also less power is needed to get them in the air. So less kerosene is needed to, to fly with them.

[I-MR] And yeah, maybe you‘ve already answered this question a bit, but what do you think might (name of the company) expect from an aircraft manufacturer like Embraer, in terms of sustainability?

[P-A] Well, like they are doing at the moment with the E195 aircraft, that’s their newest aircraft, which is what they call it the… well, I think it‘s, it‘s the aircraft with the lowest kerosene needed per passenger. So that‘s a huge win for both the environment and the airline. And I think the most important thing for that one is, again, weight, weight reduction. So they start working with new materials, they have new technologies to make things less, having less weight. So keep on doing that. But on the other hand, it‘s not only about the environment and weight reduction, it‘s also about passenger comfort, which is very important for us as well, which is maybe even more important than the environment because we want passengers to choose for us as an airline and therefore it has to be comfortable. And I‘m not sure if you know what we did in the past, but we had those old seats, which were quite thick. And now we have those slim seats, which reduced weight with a few kilograms per seat. So that‘s a good thing. But on the other hand, what we did, so those seats were thinner, so we could fit more seats in a row, because if the seat becomes thinner, you can move the pitch a little bit. So the pitches is the space between seats. We minimize that. We could minimize that with keeping the same amount of legroom, so more passengers fit in. So is it then more environmental friendly? I don‘t know. I don‘t know. It depends how you calculate it if there are less planes needed to fly them around, it‘s more environmental friendly. If more weight is added to the aircraft and more passengers are seated in an aircraft, which is more weight, it‘s more polluting for the environment so you can calculate both ways.

[I-MR] Okay, so I would finish this subtopic and maybe you can already just start a bit with the collage or the connection and maybe just write some important points and just, yeah, exactly use this material. I also got a glue so...

[P-A] Well, this is also very interesting because we have an aging population, but we also have to millennials

coming up. And if you ask me there's a difference in what is most important for the aging population from... or maybe the current population is what we see nowadays, is that it's mostly about price price price. With the aging population, it's more about, they want to pay a little bit extra for a bit of extra comfort. And with the millennials, it's about price but it's also about the environment. So sustainability, vegetarian foods and all those kind of things. So this is more in depth. So, we have different types of customers with different thoughts and different profiles and backgrounds. Yeah, so we are working with not necessarily focus groups, but kind of focus groups. And our focus is on the business traveler and the frequent flyer, doing work at the plane, trying to rest a bit for their next appointment, recharge, recharge in the sky, and let them work so those are the most important for us. And that's a combination of millennials or the aging population or whatever…. (35.52) Politics we have the climates..

(27.66) Also curious what the electrical engines can do. (12.98) There was a discussion this morning on the radio also about … within the Dutch politic there was someone trying to stop the flights to London, Paris and Brussels from Amsterdam because of the distance and then there was the discussion. Is that really what we want? Because passengers want to have the short connection time. Now it's still to Brussels it will take you three hours by train, passengers are really price driven. They say they are not price driven, but it's price price price, we see it everywhere. If you want to have a train ticket to London, it will cost you more than a plane ticket to London. So the tour flying to London, you can fly for 100 euros. All the train can take up to….

You think also in the future it will be the same? [I-MR]

Well, it depends also on the politics. Because there's no tax at the moment on the kerosene. So if you will add tax on kerosene and all those kind of stuff flying has to be more expensive because you need to cover the cost. So then may then it may change in the future. But I don't.. from the economics point of view the oil price that one is very, very important. [P-A]

Okay, in which sense is it really important? [I-MR]

The oil prices is a third of the cost. So we have one, one third is labor cost one third is oil and one third is… What is the other one? I think it's more in loans and fabrics and hangers and all those kind of stuff. So it's one third, one third of cost. The oil price at the moment. So you have the politics also. So influence from politics on oil, so with Trump, with Iran, with Saudi Arabia. It all influences. [P-A]

I think it was what go on with the different sub topics and because it's really interesting that you were talking about the customer. So what do you think like what will be the future customer value in the next 15 years? [I-MR]

Of aircrafts? [P-A]

Of aircrafts or for (name of the company). Because who might be maybe the first question would be, who might be customer for (name of the company) maybe in the future? [I-MR]

Yeah. So we are focusing on the millennials. I think that's you? [P-A]

[I-MR] Yeah.

[P-A] Yeah, because those are the customers of the future. So millennials is very important for us now. And they have different values already. Like I said more aware of the environment, don‘t want to be polluting, sustainability. You see it in the well, almost everything. But on the other hand, there‘s also the price driven decisions that are made. So like myself I want to be sustainable if I‘m going to the supermarket and I was looking for... I needed eggs so there were two types of eggs. So we had the eggs in the plastic packaging and the paper packaging. And then there was eggs from, well, happy life, happy chicken eggs and then the normal eggs but the difference in pricing is huge. So which decision do you make? So I could not take the one with the plastics because it doesn‘t feel... doesn‘t felt good. But on the other hand, the difference then with the with the happy life chicken. Yeah, so it‘s a it‘s a trade off. And… I‘m not sure. It needs to be sustainable and it needs to be a good price. And of course, I want to pay a little extra but it needs to be affordable.

[I-MR] And for what kind of reasons do you think will people travel in the next 15 years?

[P-A] Yeah. It won‘t be much different. I think that people.. and we see that also in the numbers, people are traveling more and more. In the past it was for visiting friends and relatives or for a business trip or holiday once in a year. But now we do all those kind of city trips. It doesn‘t matter where you go everywhere you see those big groups of Asian people because it‘s now affordable for them to travel. Not only affordable, but the culture changed a bit that they are traveling now abroad. So it will be much.. it is nowadays much easier to fly and people will make use of that. Yeah. Yeah so it will increase. We are traveling more and more and for several reasons. Even for business trip it‘s more affordable and connections are way better than because you can fly now to Brazil in...What is it? 12 hours or 11 hours? I don‘t know exactly. While in the past it took you 24 hours. So you, if you had a meeting in Brazil, well, that must be a very good reason to go to that meeting. Now it‘s maybe you go faster. You go, you made quicker a decision to go to certain destination because the travel times are more and more affordable.

[I-MR] And how do you think might the lifestyle of society change in the next 15 years which might also have an influence on what people want?

[P-A] Yeah. Yeah, maybe, from… I believe that from a leisure point of view people want to explore. So they will go everywhere from a business point of view it may change in the future. Because we will have all those new kind of technologies with virtual reality, especially augmented reality where a face to face meeting can be, say it, it‘s hard to make a distinction between face to face meeting and a virtual meeting in the future. So business trips may… I‘m not sure. I‘m not sure because on the other hand people are.. it‘s so easy to do business and it‘s so easy to set up a new business it‘s so easy now to get stuff from China and then set up a new business or or to make connections all over in the world. So new techniques may minimize the impact of flying, buton the other hand, the fact that we can make connections through all the world and then I mean connections like, we can have a conversation together that also increase the needs for for for traveling. So I‘m not sure I think all in all there will be the, yeah, the number of flights will increase and the number of passengers will increase. It’s more like a commodity.

[I-MR] Here maybe you can also use a bit. Maybe here are some kind of visual material. Maybe this also might trigger some further information.

(22.15) Society,
(12.35) technology and more like this one. No this is not technology This is also society. [P-A]

Maybe you can say something about that? [I-MR]

Well, it's a new ways, new ways of making social connections all over the world. (42.65) So this one is numbers of travelers go up. (20.32) Asians… traveling… (19.90) [P-A]

Can you say something about that? [I-MR]

Or we call it the BRIC countries. And then those are the countries with most potential from people traveling point of view. So, yeah, upcoming markets. [P-A]

Thank you. So I would go to the topic of technology. I think you already just mentioned certain types of technology, but what kind of technological breakthroughs do you think will influence transportation in the next 15 years? [I-MR]

So I mentioned augmented reality and virtual reality already. I think it will not minimize the number of travel, it will change the way of working and communication. So, if you look from it from that point of view maybe less travel is needed than in the future but on the other hand you make it so easy again to communicate with other countries and other bad people and so you create new opportunities and new markets as well and in the end I think the the number of passengers flying are increasing rather than decreasing. Lightweight but a bit lightweight is already going on with the new materials, composites, structure of the aircraft from all the materials which are very strong and lightweight. New tooling so that you can make more lightweight products with the same material but you cut out all those…. So normally you had a plate of steel and what we do nowadays is to put out all kinds of rounds. So you still have the.. enough strength from the steel but in a less weight way. And maybe new engines, maybe electrical engines. [P-A]

And what do you think might be a technical issue or which kind of technical issues might this type of technology have? So technologies are like that everything will be lightweight,the structure of airplanes, new engines. Might there be some kind of technical issues? \ [I-MR]

It's more what's the balance, the balance of lightweight can also be that it goes… that the impacts the level of comfort, for example, so it's all about the balance. So that's another difficulty, technical difficulty or technical difficulty with the electrical engine is… I think it's not fully replacing the traditional engine but maybe it helps that certain.. well, the most of the fuel, burns during takeoff. And then I think you and you still need the power of that engine to get the plane on altitude. Maybe you learn an electrical engine can take over at cruising altitude, but I'm not sure if you win that much of... I don't know. I don't know. [P-A]

And I also would ask right now about another subtopic or go on this a subtopic to economy and there it's interesting for me to know what do you think will be the biggest markets for transportation or for (name of the company) in the future in the next 15 years for example? [I-MR]

We transport people all over the world via Schipol. This is the main hub...so we… yeah we are, but that's basically the answer. We are a network carrier, bringing people from all over the world to Amsterdam and [P-A]

then fly them to the destination they want. So we have a huge market of course we have focus groups. Yeah, but those are focus groups and does not mean... that we our market is.... is the complete world. Of course, those upcoming markets like India is very important, China is very important and that‘s why we have all those new collaborations now going on with Southwest and with Jet Airways. Maybe it’s not a good example because they went bankrupt, but we are looking for opportunities in China and India and in Brazil with… because our market so all over.

[I-MR] And which kind of challenges on the market do you see?

[P-A] Low Cost carriers that‘s the number one. And number two is the Gulf, the Gulf carriers. Number one because low cost carriers they put so much effort on getting the price as low as possible, which is very hard for us to compete with because we are quite a traditional airline with all the staff involved, with all the overhead of people. Also getting a certain reputation, of course, we are very punctual. We are very reliable and those kind of things with low cost carriers punctuality is always as good. By the way, Ryanair put a lot of effort on punctuality, so their focus will be on punctuality, with comfort in an aircraft is not that important for them. So they do all kinds of things that we won‘t do and cannot do because otherwise we have to change our complete organization into a low cost company. And I think with all the history we have it‘s impossible for us to do. So we need to be at this point of the market just a bit more… high level, high level type of airline. But it‘s very hard because people are price driven and price is important as well. So we have to reduce our prices as well. It needs to be a bit competitive. So, that‘s, that‘s a huge challenge for us because we have all the cost of labor, we have all the cost of... all the things that they don‘t have. So that‘s, that‘s a huge challenge and the other one is the Gulf carriers. So I‘m talking about Emirates, Qatar,... And like I said, one third of the cost is fuel. And they have a huge benefit there on the fuel markets. So, they can fly with empty aircrafts, because well, they have fuel like, like water. Our aircraft has to be completely full with passengers because the cost per unit, the cost per passenger needs to be as low as possible. And you can do that by having as much as passengers in your aircrafts. So those are the most two challenging topics from an economic point of view.

[I-MR] I also would like to ask more about politics, I think, yeah, I think all topics already were mentioned already somehow. But so I would like to know how do you think will the government and policies influence transportation towards 2035? Or in the next 15 years?

[P-A] Yeah, well, they have the climate plan from the European Union. So that will influence and we have another challenge here, by the way Schiphol. That‘s also a political thing. Schiphol is full, it’s completely full, full in a number of flights that can land and depart. So that‘s influencing the economics part as well because we cannot grow that much anymore. So that‘s that‘s a huge thing. And that‘s that‘s also politics because it‘s a restriction from the government. That we cannot grow anymore that not more slots are available. We cannot fly during nights, we cannot fly during certain times, we have all those kind of things. So that‘s a governmental thing. We have the influence from the politics on the oil, for example, what Trump now is doing together with Iran that will influence the oil price and Saudi Arabia and all those agreements going on. Tax, of course. So, the Dutch government is trying to implement a tax on flying to make to make other ways of transportation more attractive. Like, like the train. What else? Yeah, well, I think that we will get some restrictions from the climate plan. So that maybe they ask on a tax based on your CO2 pollution per company and those kind of things, but that’s also economics. Yeah.

And I think I would right now come to the end of the interview. But do you think is there something really important or something that you would like to stress or emphasize of one of the aspects that you have mentioned? [I-MR]

Yeah, I think, well, I think that the number of flights and the number of passengers that are flying won‘t be less, it will increase over time. And that‘s because of our own…. of what we want as people. We want to explore we want to do business, we want to visit friends and relatives, those are all over the world, we have the opportunities to do so. On the other hand, there will be, yeah, so there will also be a huge focus on sustainability. Because we cannot continue polluting the environment and not dealing with our next generation. Say it‘s a huge contradiction as well. So we want to fly but we don’t want to be polluting. So what do you want? So I think it‘s all about balanced sustainability. Balanced in a way we should use our brains and hat and we cannot stop flying. We don‘t... we cannot make flying green but think more think more green and find solutions, small solution, big solution whatever in order to deal with our next generation. [P-A]

Okay. I’ve asked everything I wanted to and have we missed anything?. Do you want to add something? Is there something that should be mentioned but was not mentioned so far? [I-MR]

No. [P-A]

INTERVIEW 6 - DERK-JAN VAN HEERDEN - 16.05.2019

[I-MR] And in terms of the resources, I think maybe you can tell more about this part. What might... Yeah, or have the question: What kind of environmental issues might we face in terms of resources for aviation because I thought you might know something about the resources.

[P-DJH] So the materials that aviation consumes are… we consume so little, because airplanes fly for 25 years, meaning that you know, the total amount of aluminum we consume in a manufactured aircraft is not even a percentage of the total aluminum consumption in the world. So, I don‘t think that aviation will be limited by availability of resources. I do see challenges in the possibility for recycling of the materials that are left when an aircraft stops flying. So in our day to day business where we try to recycle the aluminum and the other metals, that will be more challenging because you see more and more industries improving the, let‘s say the quality of the product they make and to make those quality they need a better quality control of the type of material they use. And to get that quality of material, it‘s harder and harder to make that from recycled material, because it‘s not a uniform feedstock, because it will be a balance between car engines and aircraft scramp and whatever also the aluminum mix and the more technology driven and the more quality demands there are for the quality of a car engine or whatever, it will be more challenging to make that quality of metal from a mix of metal. So and that I see as a potential issue in future

[I-MR] So which kind of materials would be recyclable or which kind of materials do you see in the future.. Which might be relevant for aviation to be recycled, for example?

[P-DJH] Because of the large time difference between when an aircraft is manufactured and when it is recycled, the world has changed significantly when that airplane was delivered to its end of life. So, scarcity, I don‘t think to be an issue. I do think that the demand for the material or the technologies available to create a purity that is required is a challenge. And the only solution for that is just to add more money to the process. But the question is, where does the money come from? How do you make sure that it happens? So you now get a certain price for a kilo aluminum. But that prize might needs to increase to make labour more possible, because it‘s more about sorting it and the sorting is machines have limitations.

[I-MR] And out of the recycled materials, what can you for example manufacture?

[P-DJH] Everything. If you have metal you can make whatever you like from the metal. So, there are no limitations.

[I-MR] So also another aircraft?

[P-DJH] Yes, in the theory.

[I-MR] What are the current biggest challenges of mobility in terms of sustainability in the next 15 years?

[P-DJH] I think the biggest challenge at the moment is the… that we all consider traveling as normal and a right as if I want to travel, I should be allowed to travel. So if you look at the bigger scheme of sustainability and debate about flying and yes, we‘re not flying, then that‘s the, I think the big hurdle. Flying is just a way to get from A to B as is taking a train, as taking a bike, as is taking the copper. And if you.. if we all think that it

is okay to go from A to B, saying that you should not fly is a stupid statement. Because it‘s not about if you fly it is about the fact that you choose the best means to get from A to B in the most sustainable way. And aviation has certain pluses that makes flying the best solution compared to for example, train, the car or whatever. However, one of the reasons why people fly is that it is relatively cheap and they want to go far and you know that we consider it normal that you fly to Thailand once a year and one times to Curacao in a year that sort of is the ridiculous thing that this is getting more and more normal. So I think we should if you‘d look about the sustainability of the total transport system it should not be about how you travel and yes every means of transport should do his best to be as sustainable as possible but sustainability in my opinion is wider than just CO2 production. It should be more about why do we travel and is there a need to travel.

And what do you think will be relevant in aviation terms of sustainability? [I-MR]

I think it will be the let‘s say the political end or the society pressure on traveling. Think that‘s that‘s the whole thing. That‘s the big question how that will develop. But at least here in the Netherlands, you see people complaining about airplanes taking off and we should have less aircrafts at Schipol, but that will not solve the environmental problem. Because if people want to fly, they will find a way to fly and yes, there maybe we will have less movements at Schiphol, but then those airplanes will still file the Netherlands and people will still go from A to B. So the discussion should not be about what means of transport. It should be about do we need to travel? Are there ways to avoid traveling and shoot we not allow people... should we not limit the amount of travel that a person is allowed to do. [P-DJH]

And what kind of solutions for system mobility do you think might be relevant in the future? [I-MR]

So I think technology can do a lot of... can can solve a lot of issues. However, whether or not a technology is a solution, and that people agree that it is a solution depends on where you draw the borders of your comparison. So electric cars might be a fantastic idea, but if you don‘t generate the electricity, you use in a sustainable way. You know, it‘s not sustainable. So it should be a system approach, where you combine everything and make sure that no, yes if we drive electricity we have the potential to be more sustainable. However, only it we generate electricity in a sustainable way. Otherwise, you‘re just relocating the problem instead of co2 emission. And on the highway, you have it in a electrics and electricity generating facility. And that that I see still an issue as in. I do, I do strongly believe in, let‘s say, the entrepreneurial side of the human being, they are creative and problem solving, and we‘ll find ways to get things sorted. But I do also think that the rules should be set by society, by the political community in such a way that it is a fair game and that the person that is over performing the other one gets to the reward that is related to the solution that he introduces. And that‘s the whole challenge. And that‘s a balancing act. That‘s very difficult. And I‘m not I my feeling is that we‘re not good at it because of the lack of technical knowledge in our political community, combined with a lot of influence of people that do not have the technical knowledge just to understand a life cycle analysis, for example. So I think it‘s time for engineers to take over the world. [P-DJH]

What kind of technological breakthroughs might influence transportation in terms of sustainability in the next 15 years? [I-MR]

Technology breakthroughs right so technology driven. I had a high expectation on drones. But that seems to not materialize. At least not as fast as expected. I do think that cars drive by themselves. If they can [P-DJH]

figure that out on the safe way, and efficient way, I think that will be an extreme game changer. But all of those are aimed at more traveling. And I think that there will be a requirement for less traveling. Then depending on how we put a lid on the travel demand of people and if we can figure out a political way or a societal way to let people travel less than way of communicating with people in a good efficient way without traveling will become more important. And and that is already getting easier and easier. Skype and whatever, you have FaceTime and… but it still doesn‘t feel as the same as seeing somebody in the eye. Question is, is there a technology solution that me be in a room and not traveling feels the same as being in a room with somebody when traveling.

[I-MR] Because you‘re an expert on recycling, maybe you can also just say about this part and some kind of developments.

[P-DJH] So more short term?

[I-MR] In the short term. Yeah, it‘s also. Alright. So in the transport industry, there is specific legislation for the recycling of cars or specific legislation for the recycling of ships. But there‘s nothing special for aviation

[P-DJH] I think that the end of pipe approach on you should focus on recycling is not the correct approach. I think you should approach it from a life cycle analysis approach. So if you can make the aircraft more recyclable meaning probably that you know, you know, if two alloys you need to make one alloy because it‘s easier to recycle. But then it would also mean that the weight of the aircraft will increase. So, I‘m hoping that big data and education and more knowledge with people on how lifecycle approach works that we‘re not going to look. And basically similar, as I said, on how society should look at transport, it‘s not a focus anymore on if something recyclable or what is the co2 consumption or what is the, what‘s the passenger comfort? It is more like that designing for sustainability becomes the main thing when developing new aircraft and new trains and new ships. And that... and I do strongly believe that big data or blockchain maybe as an as an example, to lock the data, is a solution of improving the way we use design and travel away, dispose off. Items that we use on a daily basis. So this is a very nice computer, but the person who designed it he probably didn‘t keep in mind that it needs to be used for five years or… that that‘s, I think, the challenge that we need to go through. And how you get the right incentives at the design phase, and even at the supply chain and all whole process to make sure that you optimize it over the whole life cycle?

[I-MR] So you talked a bit about the technology. And do you also know about other types of technology that might influence recycling?

[P-DJH] I have now been in this business for 12 years, and the same breakthrough technologies that were expected to break through 15 years ago are still waiting to break through. So I‘m on the recycling side of things I‘m not sure if it‘s a technology challenge. There are a few areas with specific materials. But again, I strongly believe it‘s more a economical challenge where the value of materials becomes more important and the cost of energy and the cost of labor. That balance is currently I think, the biggest challenge.

[I-MR] Okay, so we‘re talking a bit about the subtopic economy and, what do you think will be the biggest challenges on the market of transportation in terms of sustainability? In terms of recycling? And yeah, so you already mentioned the challenge, but do you also know about other kinds of challenges?

So, well, the world now, of these six economics is the driver of the day, right? If the stock market falls down, it gets news, way less than when the when an animal dies. I think that that should be changed. But I don't think it should be changed by saying we should not focus on economics we should focus on the ecology or we should focus on society if you like, I think we should change the rules. So that those other elements that we think are important, are also part of the economic equation. I strongly believe in that because I do think that if you look at let's say capitalism as a system and then not the extreme capitalism, but there is no such thing as 100% capitalism. And I think if we, if we could set the rules within the economical financial game, it's sort of Game of Thrones everybody plays, right. We want to be there. We want to earn the most money to be in a big game and what's his name? Bill Gates is on top of the mountain and below there are other millionaires and billionaires. So I strongly believe that for example, we should give technology an economical, we should make a ecology and economical player. I will tell you what how I look at that is that people are talking about co2 emission rights and all that sort of thing, right as a as a way of taxing or evaluating the fact that you're consuming o2 and creating co2. If I make a mug, I buy sand. I buy a machine that's created. And so you pay for everything. The only thing you don't pay for is the oxygen you use by burning something that creates your mug. That o2 is transported by air. So it's very hard to measure. And I think that's the reason why people never made it part of the equation. But I think that we should not work on co2 rights as in, we should create a co2 trading scheme or something like that. I think we should take it one step further. Where you say okay, somebody's using o2 that has a value for that company or that person, but somebody else is using the co2 and returns it to o2. And that is a tree or a grass or whatever. So, we want to we want that to be in balance, right we want to have it's okay to co2 in itself is not toxic, too much CO2 is. So, if we make everyone have a balance, what we should do is basically say to companies, organizations, people that own a machine to turn co2 into o2, we know to we should give them the right to sell that capacity. And in that way, you will give nature a economical value and you create a balance in the system that that we want to reach. And by giving a piece of rain boots, rain forest a value because that is turning co2, into o2, to all of a sudden you can make money with planting trees, instead of only chopping them and do nothing afterwards. And I think that that would be a solution to create a balance. And the reason why I like that is because the model that's now in play is that the political environment tells us there are now 3000 co2 rights, you get 200, you get 500, you get this and if you use less, you can sell it to them, but it becomes a political system. And I think politics are not good in managing systems. They are good in making sure that there are boundaries, they should be the referees to a game, but it should not be part of the team playing. So they should draw the lines and if you create economical value, or maybe that's not the correct word, if you create if you make nature with part of the part of the economical system because you give them the right to sell what they do, making o2 producing co2. That will be an interesting game changer. Because all of a sudden, then the growth nature funds, people will own a park or your garden all of a sudden you have, you have something that has an economical value. And that I think is part of the transport system. That should be part of the transport system as well. For me, it makes a lot of sense that if I own a tree, and I'm turning co2 in o2 and you're using the o2, you pay me for that, because there is a shortage of o2 and there is enough co2. [P-DJH]

Yeah, yeah, so maybe just you already mentioned about like several kind of topics and there were things about economics about ecology. Maybe you can already just write them kind of some kind of notes. [I-MR]

So I believe that everything should be eventually about economics. And, and I do think that, you know, ecology should…. go co2…. [P-DJH]

[I-MR] Yeah. I think it also would be interesting for me to know a bit about how do you think might politics influence recycling?

[P-DJH] A lot. And at the moment,.... and at least in Europe there is, I think... politics should be about politics and not about money. So, politics should be about setting the rules and not making sure that who is winning the game. And politics is too much busy with deciding who wins the game. Trump great example. He wants to win the game. He wants to make more money than somebody else.

...

[I-MR] Can you also tell a bit about the experience with companies that you had? For who you recycle?

[P-DJH] So I can give you a great example. If we offer somebody to recycle their airplane. Nobody and I mean absolutely nobody gives a ass about how well we recycled remains. They do want to know how much money I can get out of it. But if I tell them look, if you pay me 10,000 euros extra for recycling, I can increase the recycle rates from 90 to 95. And they will say 'Why?' They won't pay me for it. If an airline disposes of an aircraft, it's not about who will do the best environmental performance. It's more about where do I get the most money for my aircraft? Yes, they do say that you need to comply with the legislative minimum. So they won't sell you an aircraft if you drained the kerosine to the soar. So you need to be compliant. But showing doing an extra step is a voluntary thing that they don't want to pay for.

A.3.5

Expert **Interviews**

CONTEXT FACTORS

The transcripts of the expert interviews were coded and context and trend factors were derived. In the following tables the factors can be seen and its reference of the expert interview can be extracted. Furthermore, additional context factors from secondary data research were added to the table. All trends and context factors were organized based on whether it is a demographic, economic, societal/ cultural, technological, environmental, or a political factor. Furthermore, all context and trend factors were rated: first by their uncertainty to happen, and second by its impact on Embraer in case the company would not change its current product and service offers.

CATEGORY	TREND	SUBGROUP TREND	UNCERTAINTY	IMPACT ON EMBRAER	REFERENCE EXPERT INTERVIEW	PAGE	QUOTE	SECONDARY DATA REFERENCE
Demography	Urbanization		Low	High	JV	7	Many more people are going to live in cities.	
					TV	3	Furthermore, more and more people are living in the cities and not in the countryside.	
		urbanization of mega cities	Low	Moderate	LRM	3	the thing starts with mega cities, so it can take a look in Sao Paulo, Los Angeles, Tokyo. Why it's related to economics, so people, they have an urbanization.	
		Increasing density in city centres	Moderate	Moderate	JV	4	There the city centre is becoming more dense.	
		Higher buildings in cities	Low	Moderate	JV	4	You know these higher buildings whether I like it or not.	
		New structures in cities	Moderate	Moderate				CBS, 2018
		Difficulties of finding a parking slot	Low	Low				pwc, n.d.
		Declining population in rural areas	Low	Low				pwc, 2019.
		moving to cities to improve life quality	Low	Low	LRM	3	People have to move to big cities and when they are supposed to have more opportunities and a better life.	
	Growing population		High	High	JV	1	probably a larger population	TRENDONE, n.d.
					TV	3	I think there is a trend that the population is growing.	
					LRM	2	And in having more people living in the country.	
		In Amsterdam, Rotterdam, the Hague, Utrecht	Moderate	Low				CBS, 2018
		Immigration to the Netherlands	Moderate	Low	JV	1	inflow from other regions	CBS, 2018
	Degreening of cities		Moderate	Low	JV	1	degreening	
	Living in smaller houses		Low	Low	JV	7	So we need smaller houses and more higher apartments.	
	Aging population		Low	High	JV	1	invivo	CBS, 2018
					A	2	Well, this is also very interesting because we have an aging population,	
					LRM	7	considering people are living longer	
	Companies moving to green locations		Low	Low	JV	3	In other places that company invest in the green building, but also move to a green location.	
	Companies being located outside of cities		Low	Low	JV	3	But some companies say “No, we don’t want to be in a city center because that’s more expensive.”. You know, the soil costs much more than on the outside. It's usually difficult to drive inside so got in the edge of the city. But in the edge of the city that public transport is less.	
	Space being expensive in cities		Low	Low	JV	7	The space is more expensive.	
					LRM	3	And because of that, and it's a cycle thing then it turns very expensive to live there and very crowded.	
	Higher frequency of mobility between large cities		Moderate	Moderate	TV	3	There will be more transport between large cities and less transport between the smaller cities.	
	congestion		High	High	LRM	3	I think it's the congestion.	
	good train infrastructure in the Netherlands		Moderate	Low	LRM	3	And so and... but it's also very dependent on the infrastructure of the city. For example here, I think we we do have a very good public transport. We do have already very good, good infrastructure.	
	low train infrastucture in Brazil		Moderate	Moderate	LRM	3	But if you go for instance to Sao Paulo, like, I don't see, maybe we should have trains there, but I don't see how it will happen in the future.	
	insufficient public transport system in Los Angeles		moderate	low	LRM	4	Los Angeles, there is a terrible public transportation	
Economy	Higher demand for mobility		Moderate	High	JV	1	invivo	
		Growth in the number of train passengers	Moderate	Low				Rijksvorheid, 2018
		rising car traffic	Moderate	Low				Rijksvorheid, 2018
		rising demand of air travel	Moderate	High	A	2	the number of people that are flying is growing. And it keeps on growing for the next years, for sure.	
							We have Asia coming up, we have Brazil coming up, we have all those countries call it the BRIC countries, Brazil, India, China.	

	growing demand of flying in Brazil, India, China	Moderate	High	A	2	What else do we have... but doesn't matter, but more people start flying.	
Reduction of the mobility need in dense cities		Moderate	Low	JV	4	But of course you put a lot of people in a small space, reduce mobility need.	
Emirates, and Qatar owning a large amount of kerosine		Moderate	Moderate	A	5/1	So I'm talking about Emirates, Qatar,... And like I said, one third of the cost is fuel. And they have a huge benefit there on the fuel markets. So, they can fly with empty aircrafts, because well, they have fuel like, like water.	
Mobility-as-a-service		Moderate	Moderate				Capgemini, 2018
	Leasing of cars	Moderate	Low	JV	3	I don't... I've never owned a car, I only use it when I need it, I rent one. A lot of young people also think the same	
	Car sharing	Moderate	Low	JV	3	A lot of young people also think the same, they also like car sharing.	McKinsey & Company, 2019
Growing demand for batteries as electric cars get sold more		Moderate	Moderate	JV	4	There will be more batteries of use, but they have to ramp up the production and sustain batteries enormously, because you have millions of cars so you also need millions of batteries.	
	development of electric batteries	Moderate	Moderate	PP	5	The batteries will be… will stay a topic. That's the next kind of environmental and sustainable development.	
Diminishing of fossil fuels on the market		Moderate	High	JV	2	So if there is no pressure from the government in the sense that fossil fuel vehicles will disappear then it will go gradually.	
Aviation not being sustainable in the coming years		Moderate	High	TV	3	Or the aircraft needs to be a lot more sustainable, but I don't see that happening in the coming years.	
Schipol being full in number of flights		Moderate	Moderate	A	6	That's also a political thing. Schiphol is full, it's completely full, full in a number of flights that can land and depart.	
airlines trying to avoid short haul flights		Moderate	Moderate	A	1	I know that this is not particularly my subject but I know that (name of the company) is working on alternative forms of transportation, for example, they are working together with the Dutch government to see if there are better alternatives for the short connections.	
high safety standards in aviation		Moderate	Moderate	LRM	1	Yeah. If you think about when you go to... we face a huge procedure, questionable but a huge procedure of regards to safety when you travel by aircraft.	
car industry facing bigger change than aviation industry		Moderate	Moderate	LRM	1	So I think maybe the car transformation will be higher than air vehicles, actually, but let's see.	
Cusomter experience	seamless	Moderate	Moderate	LRM	1	So, I think it will require a more homogeneous way of treating all transportation system, otherwise it's not the system integrated.	Cerny, Rovati, & Janssen. (2019)
	personalized	Moderate	Moderate				
	interactive	Moderate	Moderate				
Companies investing in green buildings		Low	Low	JV	3	In other places that company invest in the green building	
Mass production		Moderate	Moderate	JV	4	I guess also that the large scale production will also be to achieve a path.	Capgemini, 2018; pwc, n.d.
Collaboration (companies, government, education, end user)		Moderate	Moderate				McKinsey & Company, 2019
				A	1	I know that this is not particularly my subject but I know that (name of the company) is working on alternative forms of transportation, for example, they are working together with the Dutch government to see if there are better alternatives for the short connections.	
	Collaboration with different players to improve the mobility system	High	High	LRM	1	So maybe to come from more talks and having different players contributing to promote these more efficient mobility for society so I think it's maybe we will need to have more collaborations	
	Collaboration to improve in terms of sustainability	High	High	LRM	2	But still we need different contributions from different players from government, from society for companies, from regulations, agencies, and I think a lot of information, cultural thinking.	
Companies need of thinki	sustainable business models	High	High				pwc, 2019.
	reducing dependence on raw material	High	Moderate				
E-commerce		Moderate	Moderate	JV	6	There is, of course, what we didn't discuss is about the tele...about the electronic e-shopping let's say… the e-commerce or what you call.	

	Replacing physical with non-physical products		Moderate	Moderate	JV	6	So that means you get a, let's say reduction of let's say physical products and replace it by non-physical products.	
	Products not being repairable		Moderate	Low	JV	6	Not to talk about repairability or other things. I mean, I have two right hands. I like to repair. But you can't repair anymore.	
	improvement in efficiency of transportation system		High	Moderate	LRM	1	So for, yeah, and considering that this kind of more efficient transportation system,	
	sharing information with companies		Moderate	Moderate	LRM	1	So for, yeah, and considering that this kind of more efficient transportation system, they require personal information about where you are and about your profile.	
	low safety requirements for trains		Low	Low	LRM	1	Yeah. But we go to a train, Metro, in any kind of bus and there is no safety procedure at all.	
	Being branded as sustainable vs. actually acting sustainably		Moderate	Moderate	LRM	1/2	It should be more I think like there is no need to have a department of sustainability. We do have that because it's not something that's really, a truly understanding about the topic. So it's something is to like, 'Oh, yeah, I have to do something about it.' But it's not internally people's mindset and culture.	
					LRM	2	Being more conscious in regards of sustainability	
		companies doing the minimum in terms of sustainability	High	High	LRM	2	So, okay, let's try to do something so we are pretending or doing something or we're doing the minimum but ok there and then we are.. Yeah, we're doing something in now.	
		Companies keeping on investing in unsustainable solutions due to rigid business models	High	High	PP	5	Because they have invested so much money in developing the wrong kind of car that they want to keep the wrong kind of car. That's their business model. As the same for aircraft.	
		companies valuing more profit than environmental performance	High	High	DJH	5	So I can give you a great example. If we offer somebody to recycle their airplane. Nobody and I mean absolutely nobody gives a ass about how well we recycled remains. They do want to know how much money I can get out of it. But if I tell them look, if you pay me 10,000 euros extra for recycling, I can increase the recycle rates from 90 to 95. And they will say 'Why?' They won't pay me for it.	
		Greenwashing of the aviation industry through investing minor amounts of money on sustainable innovation	High	High	PP	5	They are rebuilding an existing aircraft to make it a kind of hybrid aircraft. So one of the four engines will be electric. And there will be a system in the in the future with electricity generating fan engine still. Interesting project they spent a billion on it, so it's not a small one. And what is the purpose of this? Because every conceptual aircraft designer can tell you there will be a very old aircraft and not a really useful one. So it's not for selling it. That's for sure. The main reason is that it will take 10 years that you can say to the politicians "We are working on it. We are spending even a billion." And for politicians that's a lot of money. For an aircraft manufacturer it's not that much. I mean, developing the 787.. or what was it? It was 30 billion. That's pretty much. But 1 billion is not so much. So they are spending this to delay decisions for a longer time and benefit from the investment they have already done.	
	Demand for high quality material		Moderate	Low	DJH	1	I do see challenges in the possibility for recycling of the materials that are left when an aircraft stops flying. So in our day to day business where we try to recycle the aluminum and the other metals, that will be more challenging because you see more and more industries improving the, let's say the quality of the product they make and to make those quality they need a better quality control of the type of material they use. And to get that quality of material, it's harder and harder to make that from recycled material,	
Society & Culture	Healthy lifestyle		Low	Low				TRENDONE, n.d.
	millennials coming up		Moderate	High	A	2	but we also have millennials	
		importance of having a low price	High	high	A	3	And with the millennials, it's about price	
		valuing sustainability	High	Moderate	A	3	So sustainability, vegetarian foods and all those kind of things.	
		valuing vegetarian food	Low	Low	A	3	So sustainability, vegetarian foods and all those kind of things.	
	ageing population		Moderate	Moderate				
		paying more money for having more comfort	Moderate	Moderate	A	3	With the aging population, it's more about, they want to pay a little bit extra for a bit of extra comfort.	

	Premium class (aviation)	Moderate	Moderate				inmarsat aviation, 2018
business traveller in aviation		Moderate	Moderate	A	3	And our focus is on the business traveler and the frequent flyer	
frequent flyer in aviation		Moderate	High	A	3	And our focus is on the business traveler and the frequent flyer	
	frequent flyer being a combination of Millenials and the ageing population	Moderate	Moderate	A	3	And that's a combination of millennials or the aging population or whatever	
	value doing work in the plane	Moderate	Moderate	A	3	doing work at the plane	
	value resting for the next appointment	Moderate	Moderate	A	3	trying to rest a bit for their next appointment	
Making transportation quicker is most probably correlated with using more transportation for longer distances		High	High	PP	3	So if you speed up by a factor 2, then you double the volume, people will live double the distance and double the distance means double the energy, double the everything.	
Reasons for tavelling	Having the need to commute due to the job	Low	High	JV	3	But a lot of other people… when they… the point is… the jobs in many cases are not where the people live. So you need commuting.	
	leisure activity	Low	Moderate	JV	3	Is it for pleasure?	
	transporting goods	Low	Moderate	JV	3	Do you have some things that you want to carry for instance some big boxes or other stuff?	
aircraft passengers valuing having a low price		Moderate	High	A	3	or maybe the current population is what we see nowadays, is that it's mostly about price price price.	
				A	3	passengers are really price driven. They say they are not price driven, but it's price price price, we see it everywhere.	
passengers valuing short connection time		Moderate	Moderate	A	3	Because passengers want to have the short connection time.	
Travelling		Moderate	Moderate				CBS, 2018
	Need of travelling further	Moderate	Moderate	TV	1	And furthermore, we also see a trend in the behaviour of people in the travel behaviour, because people want to travel further and they want to travel more.	
	Need of travelling more	Moderate	Moderate	TV	2	And furthermore, we also see a trend in the behaviour of people in the travel behaviour, because people want to travel further and they want to travel more.	
				A	4	I think that people.. and we see that also in the numbers, people are traveling more and more.	
				LRM	7	someone can do theoretically, everybody would travel more.	
	Need of travelling more often between large cities	Moderate	Moderate	TV	3	But I think that when people are living more and more in the cities that more transport is needed between the larger cities and that can be done by the Hyperloop.	
	travelling by airplanes to make city trips	Moderate	Moderate	A	4	But now we do all those kind of city trips.	
Need to travel from suburban area to the centre of the city		Moderate	Low	LRM	3	And so we have seen some movements that people then they come back to other neighbor cities where they live but still they have to go to the center downtown to work and things like that.	
Need for instant mobility		Moderate	Moderate	JV	7/8	And one moment you are sitting and your friend call you and then you are going. So that means that trash holes to move becomes lower on the one hand. So… but I don't know. So on the one hand you can have compensation that you go for holidays to a beach, but because you are connected you can instantly move.	
need of visiting friends and relatives all over the world		Moderate	Moderate	A	7	we want to visit friends and relatives, those are all over the world,	
Brazilians valuing owning a car		Moderate	Low	LRM	6	for example, in Brazil, you see people that they don't have an apartment or a house, but they have expensive cars. Y	
Need of using a car in regions with low public transport infrastructure, e.g. Los Angeles		Moderate	Low	LRM	4	So, if you... there is no public transportation system and if you do need to have your car you can consider using autonomous driving and so on. Okay, but you wouldn't you... Yeah, you, you necessarily.. we will necessarily need to have a car there.	
Need of acting sustainably due to scarcity of resources		High	High	LRM	2	But I think it will turn in something more profound that people really need to, maybe now it's something we want to have, but it's not something we need to have. But I think it will turn probably something we need to have, unfortunately, because we are using our resources you can and polluting and so on.	

	Interest in alternative modes of transport, e.g. train		High	Moderate	PP	7	And there was also a discussion about the could be an alternative in taking the train for international travel.	van Schie, 2019; McKinsey & Company, 2019
	Environmental activism		High	High	LRM	2	I think everybody, I think in terms of society, we do see already, of course, people are more conscious about that.	
		demanding companies to act in a sustainable way	High	High	LRM	2	In that OEM perspective. 'It's not so important we are surviving up to now we are okay, we're fine.' The suppliers the same. 'Oh, we are doing well don't need to really introduce some things.' But then it's 'Okay people are complaining,	
	Awareness that aviation industry triggers climate change		High	High	PP	7	What we have seen the past year actually, it started in 2018. We had a big discussion, of course, about aviation and climate change. And before 2017, there was no discussion, discussion whatsoever. Well, almost not. It started a little bit in 2016. I remember a couple of moments. That there was in the news, some awareness that there might be a problem with aviation and the climate change. But since 2017, that has taken up very much and the NGOs have taken up the subject before they were not covering it, not at all.	
	Social software	messaging on social media - influencer marketing	Low	Low	JV	7	On the other hand you also have the social media, which I see…	pwc, 2019.; TRENDONE, n.d.
	Instant communication		Moderate	Low	JV	8	Yeah, instant communication, of course.	
	Electronic communication		Low	Low	JV	6	How will people connect to each other in the future? In work, but especially socially. I mean, if we do everything by electronic means,	
	Terrorism		Moderate	Moderate	LRM	2		
	Home office		Moderate	Moderate	JV	6	Also a lot of people will like to work at home.	McKinsey & Company, 2019
	Changing of jobs due to automation		Moderate	Moderate	JV	7	But, of course, what will happen with incomes when automation contains. People… many people will lose their job.	
	Working while commuting		Moderate	Moderate				TRENDONE, n.d.
	Need for green spaces in cities		Moderate	Low	JV	5	'Ok we need more living space or green space we simply move some rocks'. I say it in a simply way, because there will be lot of discussion. But it could happen.	
	Individualism		Low	Low	JV	6	Are we becoming more… are people because our society has become very individualistic. That means that there big families are disappearing, let's say people live in small groups.	
	Addiction to technology		Moderate	Low	JV	8	A lot of people have, let's say… they are more or less overpowered. Or they have become addicted to technology.	
	Having a vast amount of choices		Moderate	Low	JV	9	So people have to make choices. How are you going to make choices? That's also one of the things. We usually have too many options to chose.	
Technology	Artificial Intelligence		High	Moderate	LRM	5	invivo	
		Influencing mobility	Moderate	Moderate				Capgemini, 2018
		Pattern recognition	High	Moderate				Hensberger, 2018
		Voice technology	Moderate	Moderate				Pereira, 2019; TRENDONE, n.d.
		Prediction	High	High				Hensberger, 2018
		Smart assistant	High	High				inmarsat aviation, 2018
		Facial recognition	Moderate	Moderate				Pieters, 2019
	Robots		High	High	JV	7	Robots are becoming much more intelligent, much more capable, they can fulfill their first tasks.	
	Automation		High	High	JV	7	Companies are investing an enormous amount in automation. It really rises.	
	Connectivity		High	High	JV	9	On the other hand, if devices become more connected.	McKinsey & Company, 2019; Hensberger, 2018
		Connectivity of information	High	High	LRM	5	it comes from technology developments and digitalization and the way the information is connected and so and also it's very related to safe it	
		E-hailing	High	Moderate				McKinsey & Company, 2019

	Big data	High	Moderate	JV	1	Of course, this is more about the autonomous vehicle	Capgemini, 2018
	real-time, data driven navigation system	Moderate	Moderate				McKinsey & Company, 2019; Capgemini, 2018
	Assistive Adaptive Cruise Control	Moderate	Moderate				
	Sensors	Moderate	Moderate	LRM	6	invivo	McKinsey & Company, 2019; Hensberger, 2018
	Cyber Security	High	High				IATA, 2018
	Using connectivity to optimize time in an aircraft	High	High	A	2	connectivity, with new technologies in order to optimize the time.	
Internet of things		Moderate	Moderate	JV	8	invivo	
	smart wearables	Moderate	Low	JV	8	That you have wearables let's say that are connected let's say.	
Devices indicating amount of time spent with the device		Low	Low	JV	8	Or maybe the devices might get certain functions like we already have for instance with the Apple computer. I know it counts the time that you are online. It gives you a notification when you exceed the device.	
Digitalization		Moderate	Moderate	LRM	5	invivo	
Radiation		Moderate	Moderate	JV	8	We already have a radiation problem. That's actually an underestimated risk. Because the… I guess the radiation will rise by 50% or something like that	
Virtual/ Augmented Reality		Moderate	Moderate				IATA. (2018).
	Social experiences	Moderate	Moderate				TRENDONE, n.d.
	Workplace	High	High				TRENDONE, n.d.
	Potential influence of AR/VR on business trips/ replacing mobility	Moderate	High	A	4	Because we will have all those new kind of technologies with virtual reality, especially augmented reality where a face to face meeting can be, say it, it's hard to make a distinction between face to face meeting and a virtual meeting in the future. So business trips may… I'm not sure.	
	Entertainment	Moderate	Moderate				TRENDONE, n.d.
	VR in airplanes	Moderate	Moderate				inmarsat aviation, 2018
	VR/ AR investigation to connect people apart from transportation	Moderate	High	A	1	In the past I also did a study on virtual reality and augmented reality and other ways to connect people. But still, we believe that flying will be there for the next decades of years.	
	Communicating with other countries	Moderate	Moderate	A	4	So, if you look from it from that point of view maybe less travel is needed than in the future but on the other hand you make it so easy again to communicate with other countries	
3D printing		Moderate	Moderate				pwc, 2019.
Blockchain		Moderate	Moderate	DJH	3	And that... and I do strongly believe that big data or blockchain maybe as an as an example,	pwc, 2019.
				DJH	3	And that... and I do strongly believe that big data or blockchain maybe as an as an example,	
sorting machines to sort material for recycling have their limitations		Moderate	Moderate	DJH	1	But that prize might needs to increase to make labour more possible, because it's more about sorting it and the sorting is machines have limitations.	
Autonomous driving		Moderate	HIgh				
				PP	5	There has been a lot of discussion. Also, the development of the automatic car.	
				LRM	1	I think we might experience probably more.. a big change from autonomous driving.	
				DJH	2	I do think that cars drive by themselves	
	Drones/ transport person	Moderate	High				EASA, 2019
	Drones/ transport cargo	Moderate	Moderate				
	Cars	High	Low				McKinsey & Company, 2019
	Parking robots	Low	Low				Hensberger, 2018
	Autonomous trains	Moderate	Low				Capgemini, 2018
	Making mobility safer	Moderate	Moderate				Capgemini, 2018

	Hyperloop		High	High	LRM	4	So, it will probably happen the same way although we are considering Hyperloop that would be a solution. Capgemini, 2018
		Difficulty of introducing the Hyperloop in the EU due to politics	Moderate	Moderate	TV	1	They are working on the technology of the Hyperloop. However, I think the biggest barrier in the Hyperloop is political and the regulations, he laws, because for example when you want to have a network in Europe you have a lot of different countries, a lot of different member states, European Union, that all have different opinions and want different things and regulations and legislations are I think the hardest part.
		Feasibility of the Hyperloop	Low	High	TV	1	So the technology isn't the hardest part
		Social hurdle of introducing the Hyperloop	High	Low	TV	1	socially. When people need to travel the Hyperloop, it can be fast, and claustrophobic.
		the Hyperloop can be expected in the next 10 to 15 years	High	High	TV	1	I think in the first 10 to 15 years there will be the first operated trajectory
		the first Hyperloop might be in China, India, or the United Arab Emirates	High	Low	TV	1	So I don't know what the scope of your project is, but I think that in India or China, United Arab Emirates
		Hyperloop more viable in countries with one legislation and a lot of space	High	Moderate	TV	1	That's more because it's easier to build a new system over there, because there is plenty of space and for example and there is only one country. So it's only one legislation.
		Hyperloop might be a sustainable alternative to short haul flights	High	High	TV	1	Hyperloop is good to replace part of the aviation and mainly on the shorter medium haul distances, but when you can travel electric on these short distances, that's also a good alternative for the polluting industry as it is right now
		Hyperloop needs to be tested thoroughly, which is not possible now	High	Low	TV	2	But… yeah I think technology wise it will be ok, but one main point is that it needs to be tested thoroughly. So right now there is not a proper test track longer than 1 kilometre.
		Hyperloop being efficient mode of transport	Moderate	High	TV	2	compared to for example a train or airplanes, it's a really efficient mode of transport.
		Hyperloop not needing a lot of energy	Moderate	High	TV	2	First of all that it's more sustainable, because you use less energy.
		Hyperloop could be faster than trains	Moderate	High	TV	3	Amsterdam to Paris and you go by train that's quite a long time, but when you go by airplane the journey itself isn't that long,
		need to live close to the Hyperloop	Moderate	Moderate	TV	3	I also see it the other way around. That the Hyperloop can influence the demographics, for example when you build a new infrastructure and you connect for example some smaller cities with some other smaller cities, then people will change their behaviour and people might and people might want to live close to the Hyperloop station or something.
	Electrictrification		High	High	JV	1	that it's probably electric but I'm not sure that can be a development
					LRM	1	So I think even though with all pros and contras, and we might move into more electric... So think about cars and aircrafts propulsion systems. I think we we will, we'll probably have this technology developments finished in the next decades, at least. And so I think, yeah, we will face a new possible transportation system with this technology. And yeah, and it will fit the regulations in regards to emissions. And yeah, and you create a more interesting market in that regards.
		electric cars	Moderate	Low	JV	2	Because what I see that, I see more electric vehicles for instances on parking spaces.
					PP	1	You didn't have electric cars, you have now a few.
					LRM	1	So think about cars and aircrafts propulsion systems.
					DJH	2	So electric cars might be a fantastic idea,
		electric airplanes	High	High	PP	3	the car but certainly aviation is aiming now for electric aircraft
					LRM	1	So think about cars and aircrafts propulsion systems.
		hybrid electric aircrafts	High	High	PP	4	And I am certain, almost certain, that there is now a project by Rolls Royce, Airbus, and Siemens, I think. They are rebuilding an existing aircraft to make it a kind of hybrid aircraft. So one of the four engines will be electric.
		VTOLs	High	High	LRM	3	So they're probably there is an interesting space to have more VTOLs and small air solutions flying.
		potential demand of VTOLs from the prosperous part of society	High	Moderate	LRM	3	So maybe, and also we see like in Sao Paulo, but for rich people, there is a a huge market for helicopters. So they're probably there is an interesting space to have more VTOLs and small air solutions flying.

		prosperous part of society	High	Moderate	LRM	3	solutions flying.	
		demand for VTOLs might be higher in Brazil than in the Netherlands	High	Moderate	LRM	3	and also we see like in Sao Paulo, but for rich people, there is a a huge market for helicopters. So they're probably there is an interesting space to have more VTOLs and small air solutions flying. But maybe here, it might not be the best solution because here we do have already a good infrastructure and an economical situation.	
		issue of missing infrastructure for VTOLs	High	Moderate	LRM	3	And also, even though I think it's still a very holistic idea, because even though we will have if we consider this flying cars for example, we do need to have infrastructure we do need to have takeoff and landing spots.	
		electric bikes	Low	Low	PP	1	We didn't have electric bikes, we have not quite a lot of them.	
		Charging systems for electric vehicles	Moderate	Low	JV	2	There is also the point that in some cities in the Netherlands we have a big charging system like in Amsterdam.	
					JV	2	Because there are more charging facilities offered, but it is going slowly.	
		Producing batteries for electric vehicles	Moderate	Moderate	JV	1	You know, companies like Tesla, for instance, they're building these huge factories. In China they are also doing it.	
	Hydrogen vehicles		High	Moderate	JV	1	I mean all kind of cars... even hydrogen... could also happen.	
					JV	2	“We are going to need hydrogen”	
					JV	4	And some companies like Toyota have developed the technique… it’s a hydrogen car	
					PP	3	It was obvious that they are going for sustainable hydrogen, which we can make already make drive. So that's nothing new combined with fuel cells,	
		Hydrogen system in Germany	High	Moderate	JV	2	And I know that in Germany they are developing a hydrogen system slowly.	
	Mobility getting more safe, but still facing safety issues		Moderate	Moderate	PP	3	When I was a young boy, then we had almost 4000 deaths per year. And it's now less than 700. But it's now creeping up again. So yeah, it's not something that will really easily be solved. And still, there is a shift... there has been a shift from people that died to people that just survived and just surviving an accident it’s not good. And the number of serious violence has not gone down very much.	
Environment	Scarcity of resources		High	Moderate	LRM	2	But I think it will turn in something more profound that people really need to, maybe now it's something we want to have, but it's not something we need to have. But I think it will turn probably something we need to have, unfortunately, because we are using our resources you can and polluting and so on.	pwc, 2019.
		Scarcity of materials for batteries for electric vehicles	High	Moderate	JV	1	But still, then you have to talk about the primary resources to make the battery. And these are, of course, also limited. So you change from fossil fuels to let's say, sometimes very scarce earth materials.	
	Dealing with limited resources		Moderate	Moderate				pwc, 2019.
		Recycling	Moderate	Moderate				pwc, 2019.
		Reusing	Moderate	Moderate				TRENDONE, n.d.
		Zero waste	Moderate	Moderate				
	High resource using system		High	Moderate	PP	5	low on resources, it's actually adding resources to make the high resource using system even more attractive	
	Aviation not being limited on resources		Moderate	Moderate	DJH	1	So the materials that aviation consumes are… we consume so little, because airplanes fly for 25 years, meaning that you know, the total amount of aluminum we consume in a manufactured aircraft is not even a percentage of the total aluminum consumption in the world. So, I don't think that aviation will be limited by availability of resources.	
	treating the planet in an unsustainable way		High	High	LRM	6	So for now on people let's try to do differently because we are killing the planet and the future generations will suffer and it's not nice. So yeah, but it would be like a very high level driver, but yeah, so and that's it.	
		long haul flights being responsible for 80% of (aviation) emissions	High	High	PP	7	And 80% of the emissions come from long haul, of course.	
					LRM	7	So, which is something nice but also there is a bad impact on the planet. So yeah, actually, as much we travel it’s worse.	

	Rising energy demand for electronic devices		Moderate	Low	JV	8	But of course, all the devices cost a lot of energy.	
	Disappearing of toxic substances in products		Low	Low	JV	7	Toxic substances are gradually disappearing, but it has taken decades before this happened.	
	Climate change		High	High	PP	3	Of course, the first one that comes to mind is climate change. But still, the solutions for climate change.	
		Netherlands facing problems with water management due to climate change	High	Moderate	PP	8	Because in the Netherlands we will have serious problems just water management.	
	Increasing ocean temperatures		High	Low	LRM	7	ocean temperatures that are increasing every year	
	Reducing emissions		High	High				
		Using renewable energy	High	High				McKinsey & Company, 2019; Capgemini, 2018; Hensberger, 2018; Pereira, 2019; CBS, 2018
		Zero emissions	High	High				Capgemini, 2018
		Usage of materials with a low carbon footprint	Moderate	Moderate	A	1	But as long as you do the separate separation of the of the materials and stuff then in the end it can be more sustainable to use those plastics than cardboard. So yeah, so we look to the full chain.	
		weight reduction of aircrafts to reduce emissions	Moderate	Moderate	A	1	So I see technology for example, on a technology point for example, what we do is that we do weight reduction a lot.	
		using biofuel for aircrafts to reduce emissions	Moderate	High	A	1	What we have, we have biofuel, so, different forms of fuel in order to try to minimize the impact again also on the oil.	
		Phasing out diesel buses	Moderate	Low	JV	1	Public transport already is relatively green, the buses where the diesel buses will be phased out.	
		Phasing out polluting aircrafts	Moderate	High	A	2	So we have still a few old 747s in our fleet. Those are the most polluting airplanes we have. So we're phasing them out right now and then we get new planes in return which are more lightweight, and also less power is needed to get them in the air. So less kerosene is needed to, to fly with them.	
Politics	Government making citiy livable with limited resources		Moderate	Low				pwc, 2019.
	Political parties in favour of acting against climate change		High	High	PP	8	They are very much convinced that there needs to be done a very much to change almost everything.	
	Politicians negating climate change		High	Low	PP	8	But you see also that the people even negating climate change are coming up this out of the nothing out of the blue. And that's a bit worrying. With so many politicians simply get a lot of folks because they do not tell the truth.	
	Environmental regulations	CO2 penalties	Moderate	High				McKinsey & Company, 2019; Spierings, 2019
		Environmental subsidies	Moderate	Moderate				McKinsey & Company, 2019
		Regulation of noise pollution	Moderate	High				IATA, 2018
		regulations in terms of emissions	High	High	LRM	1	We do have already some regulations in terms of sustainability emissions and I think it's a huge trend although some goals are quite difficult to be achieved in the timeline they are suggesting.	
		taxes on aviation are currently quite low	Low	Moderate	PP	7	And you can see that this with the ticket tax for for the Dutch. For the Dutch aviation sector, it's seven euros for every flight. So it's not effective for climate change because it taxes the biggest ones with the biggest emissions relatively very, very low. Actually, it makes long haul flight more attractive relative to short haul flight. Because the increase for short haul might be sensible like 10% for long haul it's less than 1%.	
		impact of taxes to trigger sustainable behaviour might not be big	Low	Low	PP	7	But and that's what you see that generally such taxes, their effect is not very big.	
	Banning cars in cities		Moderate	Low	JV	5	And something we also didn't mention maybe in future there will be discussion about should we simply ban cars in cities.	
		Banning non-electric cars in cities	Moderate	Low	PP	6	did you get that from the news that Amsterdam starts to forbid non electric vehicles in the city already in 2030?	
		banning diesel vehicles in cities	Moderate	Low	PP	6	And they come up with plans... okay in 2025 those fence diesel fence should be forbidden in in bigger cities.	

European Union making decisions about environmental concerns		Moderate	Moderate	JV	6	Nowadays, more and more things are talked in Brussels. And for instance environmental policy for instance is more determined in Brussels.	
Government influencing towards sustainable mobility	Governmental investments in making bicycle routes	Moderate	Low				Rijksvorheid, 2018
	Government improving charging facilities to charge hydrogen or electricity	Moderate	Moderate				Rijksvorheid, 2018
	Government supporting development of biofuels in aviation	Moderate	Moderate				Rijksvorheid, n.d.
	Government supporting electric flying	Moderate	Moderate				Rijksvorheid, 2018
	Dutch government trying to make the train more attractive	Moderate	Low	A	6	So, the Dutch government is trying to implement a tax on flying to make to make other ways of transportation more attractive. Like, like the train.	
Policies for autonomous vehicles		Moderate	Moderate				Hensberger, 2018
Subsidies for sustainable housing		Moderate	Low	JV	9	Because when you now see for sustainable housing for instance. There is a budget to make your house more sustainable.	
Interest of politicians in the Hyperloop		High	High	TV	3/4	But there are quite some government throughout Europe. they are very interested in the Hyperloop and there is also in the European Commission. There have been a few meetings between Hyperloop parties, Hyperloop companies, and also multiple governments and how they see the future of the Hyperloop. So, I think the governments are interested in the Hyperloop. However, it's hard to spend a lot of money in something that isn't there yet.	
regulations of sharing personal information with companies		Moderate	Moderate	LRM	1	So for, yeah, and considering that this kind of more efficient transportation system, they require personal information about where you are and about your profile. I think also, this kind of share information will need to be also regulated.	

A.3.6

Expert **Interviews**

ADDITIONAL DATA

Apart from the trends further information was retrieved from the expert interviews and coded. The data can be found in the following table.
Also, this information was used for the report, e.g. the categories ‘airline as a stakeholder’, ‘change’, or ‘energy’.

CATEGORY	GROUP	SUBGROUP	CODE	EXPERT	PAGE	QUOTE
Modes of transport	Public transport	Advantages	public transport being environmentally friendly	JV	1	Public transport already is relatively green
			Trains being environmental friendly	JV	2	Thus, like public transport is also promoting that that they use let's say a green train for instance. In … for instance they are also promoting that. "We are driving 100% green.".
			Dutch railways fueled by sustainable electricity	PP	3	Like the Dutch railways, they don't have emissions at the moment because they have their own wind park in the North Sea, it's literally their own.
			Using public transport if there is congestion on roads	JV	3	They will temporarily use it for example if there is congestion
			Resource requirements for public transport lower than for other modes of transport	PP	2	The resource requirements of public transport are, by definition much lower... if it's used well.
			People using public transport due to congested roads	PP	2	So all the roads are congested, and that forces people into public transport.
		Disadvantages	Public transport being crowded during the rush hours	JV	3	They will temporarily use it for example if there is congestion but on the longer term it's quite difficult also because public transport is also crowded in the rush hours…
			Public transport being crowded due to maintenance work	JV	3	And even in the off-peak hours it's also crowded especially in the maintenance work
			Public transport being crowded due to insufficient amount of trains	JV	3	And even in the off-peak hours it's also crowded especially in the maintenance work or whether there are sufficient trains.
		Sustainable change barrier	Not being able to use the full capacity of a bus, because people are using cars	PP	2	But if everyone takes a car and then you don't have the volume to keep the business going at a decent frequency, and that line pattern that there is a bus everywhere.
		General information	expert preferring trains as sustainable form of transportation	PP	3	And we have the solution already on the ground and it's working. You can daily do it if you want if you don't want emissions, get in the train.
	Cars	Advantages	Seamless traveling	JV	3	is in change of things you have to do and the car is really easy. You simply.. you start from the home from door to door. It's much easier to organize,
			Having a shorter travel time than public transport	JV	3	the travel time is also usually shorter.
			comfort	LRM	7	it's very comfortable to have a car.
			autonomous driving creating a user advantage for cars in comparison to trains	PP	5	For the car that's a disadvantage, but if you make it automatic, then it's the same advantage. So that makes then the car even more attractive than it is now compared to the train. And that would be not helpful because, really, we need much less energy if we use a train system in the right way.
		Disadvantages	Finding a parking space	JV	3	But of course you have the time to find the parking space.
		Sustainable change barrier	Manufacturers selling cars in order to make profit	JV	1	it will happen soon and some experts also say, we have to wait until 2075 or something like that. So I'm not an expert. It will be something in between....
	eVTOLs	disadvantages	congestion in the air	PP	3	But of course it It won't save any time if everybody, if the whole congestion would go into the air,
			need of having enough space due to safety	PP	3	because aircraft always need much more space around them just for safety alone
			costing a lot of energy	PP	3	And it will cost more energy, that's for sure.
			Needing Lithium batteries for electric aircrafts	PP	3	And for aircraft it is even worse, because it's impossible to do it with the Lithium battery. I mean even see radically it is impossible, because you can improve theoretically the Lithium battery by a factor of 3 and even for short haul we would even need like for Embraer at least would need a factor 7 or 8,
			Difficulty to produce leightweighted batteries	PP	3	And for aircraft it is even worse, because it's impossible to do it with the Lithium battery. I mean even see radically it is impossible, because you can improve theoretically the Lithium battery by a factor of 3 and even for short haul we would even need like for Embraer at least would need a factor 7 or 8, leighter batteries
			Batteries needing a lot of space	PP	3	it's a lot of space and these are all things that are not available in an aircraft.
			Battery issue for aircrafts not being solved within the next 15 years	PP	3	No. Certainly not in the next 15 years.
		Creating a hybrid electrical aircraft to avoid battery issues		PP	3	or you end up with a hybrid, but they are not half way.
	Aircrafts	Advantages	being affordable	A	4	Even for business trip it's more affordable
			fast connections over long distances	A	4	Even for business trip it's more affordable and connections are way better than because you can fly now to Brazil in...What is it? 12 hours or 11 hours? I don't know exactly. While in the past it took you 24 hours. So you, if you had a meeting in Brazil, well, that must be a very good reason to go to that meeting. Now it's maybe you go faster.
			choosing to fly, because it's easy	A	4	So it will be much.. it is nowadays much easier to fly and people will make use of that.
		General information	More efficiency of aircrafts is possible	LRM	4	So, we and meanwhile, I think there is still place for more efficiency or more efficient transportation based on what we already have.
			Most fuel burns during takeoff	A	5	well, the most of the fuel, burns during takeoff.
			Price consitution of flights	A	3	The oil prices is a third of the cost. So we have one, one third is labor cost one third is oil and one third is… What is the other one? I think it's more in loans and fabrics and hangers and all those kind of stuff.
			airplanes being in operation for 25 years	PP	1	we consume so little, because airplanes fly for 25 years
	Walking and cycling	disadvantages	while it is raining	LRM	7	it's raining and and so on, but still it's... you should just...
Energy	Electric	Sustainable change barrier	Not having enough charging facilities for electric vehicles	JV	2	There is also the point that in some cities in the Netherlands we have a big charging system like in Amsterdam. Other cities there are hardly facilities. So there we also need charging systems. But also… let's say on a winter drive on a highway you also need charging facilities. So the public stations have to change also to offer that
			Batteries: Needing large investments in the battery for electric vehicles	JV	1	But of course it takes large investments.
			Batteries: need to improve the battery capacity	JV	1	Mostly large investments in battery capacity.
			Batteries: Limited resources of the battery capacity for electric vehicles	JV	1	But still, then you have to talk about the primary resources to make the battery. And these are, of course, also limited. So you change from fossil fuels to let's say, sometimes very scarce earth materials. And of course, these elements in technology, that you use less scarce materials, but still people talk about scarcity and…
			Batteries: Batteries of electric vehicles having a limited lifetime	JV	4	And these have a limited lifetime.
			Batteries: Issues of battery resources of electric vehicles	PP	3	we are now looking for like the electric car will put another challenge in and that's the resource for the batteries and also how to get rid of them if they are..

			Challenge of recycling batteries for electric vehicles	PP	3	or if you can recycle them. It's possible but still costly. Or costing a lot of energy. So that's another challenge that's coming up.
			Batteries for electric vehicles being an issue due to human rights	PP	3	because we know that the battery is a difficult thing, in many respects. Also, in human rights. I mean look at the mines, where they are. That is not what we call sustainable.
			Car dealers being against the development of electric vehicles	JV	2	The car dealers make a lot of money from repairing cars. And fossil fuel car, the engines have more parts. So they need more maintenance. So that means if you sell more electric cars, the dealers have less repair work. And that's of course not so good for their business. So the car dealers may not be so willing to sell electric cars.
			Difficulty to resell electric vehicles	JV	4/5	and also there is another point is also is also an economic factor that is the resale value of electric cars drops, because of the uncertainty with the batteries and also if people… I have the battery is now half of the price of a new car. So at the moment you want to sell a car.. we say a non functioning battery. You can forget it. That means the resale value of electric cars is very low.
		Development of electric cars being a problem		PP	5	there are so few electric cars, but if that really takes up, then we run into problems.
		Expert preferring electric fueled transportation in comparison to other types of fuels		PP	3	Yeah, certainly. And that should be electric and in the end.
		electricity of sustainable mobility should come from renewable energy		DJH	2	if we drive electricity we have the potential to be more sustainable. However, only it we generate electricity in a sustainable way.
		Using mobility from non-sustainable resources would reallocate the sustainability issues		DJH	2	Otherwise, you're just relocating the problem instead of co2 emission.
	Hydrogen	Sustainable change barrier	Hydrogen being expensive	JV	2	everybody talks about how to produce hydrogen, but when you produce it in a conventional way it is far too expensive and it takes..
			Changing technical aspects of the vehicle to be able to use hydrogen	JV	4	But of course you have to change the engine and in the tank you have to make it safer.
		Biohydrogen being more environmentally friendly than hydrogen		JV	2	But when you make it locally or for instance with easy panels, then of course, if it becomes bio hydrogen, and any environmental impact is of course much better.
		Hydrogen not being available before 2050		JV	5	How much hydrogen can we produce? Because and is it going to be produced on mass scale or … these are the questions. Then the cars should also be available on a larger scale. It means I don't believe that it will be available before 2050 or something. I don't believe it.
		Hydrogen being technically feasible now.		PP	4	It was obvious that they are going for sustainable hydrogen, which we can make already make drive. So that's nothing new combined with fuel cells, and then electric. It's a far better solution. For aircraft you can do it, you can start tomorrow. But nobody is doing tha
		Hydrogen airplanes being possible in 2035		PP	4	Well, in 2035, we could have a first aircraft on hydrogen. Not a very big one but certainly something with like 20, 30 seats. If we want. If we really would direct, all players in the same direction. And not all playing different pieces.
		Hydrogen airplanes being a sustainable solution		PP	4	And this would be a sustainable solution.? - Yeah, in the end it would.
		Hydrogen fueled aircrafts being a sustainable solution		PP	9	And for a temporary solution until we have those hydrogen fuel cell aircraft, I think it's the best route to go and then, then you get can really fit aviation globally within the targets of Paris.
		in scenario hydrogen fuels starting in 2035		PP	9	I just made a new scenario for that, then I'm not talking about 2035 but 2100. The assumption there is that in 2035, there starts to come those hydrogen planes.
	Biofuels					
		algae being low efficient producing sustainable energy and therefore need more space		PP	8	. It's actually chlorophyll is a very low efficiency solar energy converter. It's generally far less than 1%. Every solar panel does more than 10. So obviously you need much much more space to do the same. So why are we wanting this? And even the best ones the algae, which are changed genetically. So because the natural ones can do it but if you change them you can reach maybe 3%
		risk of algaes escaping in the sea		PP	8	So I once asked somebody if they escaped to the sea. 'Yeah, we have many precautions to prevent that.' Well that goes wrong after some time. And there is nowhere if the whole world would be running on algae. There is no way to prevent it.
		Disadvantages of biofuel				
			Missing infrastructure	LRM	4	And we could also use biofuel that is already ready to be flying, because it's already certified and so on. The reason why we don't have biofuel operating nowadays is due to political issues and because we would need to, to change the infrastructure.
			biofuels as a eco-efficiency strategy	LRM	4	But, but it's but it would already provide some benefits in regards to the emissions and this is the kind of example I mentioned it could be something in the middle.
	Power-to-liquid	One way of being sustainable in the aviation industry is using power-to-liquid energy		PP	9	So, you could go for the synthetic fuels, the e-fuels, based on power to liquids. That can be done now, I mean, we can do it, we know how to do it, we can use initially rich carbon dioxide sources to create the fuel from.
		Power-to-liquids needing triple the energy for production than kerosine		PP	9	And of course, that costs a lot of energy, it's like triple that you would use with just oil based kerosine.
		Power-to-liquids being expensive and raising ticket prices		PP	9	On the other hand, it's quite expensive, so it will make tickets about two times as expensive as they are now, so you will get rid of about half of the growth of the volume.
Sustainability strategy	Creating a strategy for sustainable transportation	1) Setting environmental requirements to design a transport system		JV	1	design a transport system for the Netherlands. That would fulfill certain environmental requirements.
		2) Looking into different modes of transportation		JV	1	And then we started actually working from these goals, then looked at the different transport modes that are there at the time used in the Netherlands, and it is still the same more or less.
	Eco-efficiency	Reducing fuel consumption to reduce energy independent of the type of fuel		JV	1	So then you can reduce energy instead of just converting from one source to another. Because actually, and this would for me mean real sustainability… that you also reduce the primary energy.
		weight reduction being important in the mobility industry to be sustainable		LRM	5	So, it's very much about the weight.
		Using the full passenger capacity of the mode of transport to be environmental friendly		PP	2	Sometimes you read, you could have better taken the car because it's less energy, but they compared this with an empty bus
	Needing investments to support environmental friendly mobility			PP	2	So you need something, some government or some investments, you stop investing in roads.
	Switching the mode of transport			JV	1	And of course, like I also mentioned actually try to reduce the fuel consumption by car because of course, you can say which we simply switch to electric vehicles.
		Difficulty to make people change from one mode of transport to another		PP	2	But if everyone takes a car and then you don't have the volume to keep the business going at a decent frequency, and that line pattern that there is a bus everywhere. And it's difficult to make that step.
	Needing the government to					

	government to support environmental friendly mobility		PP	2	So you need something, some government
		Governmental development towards sustainability through subsidies and regulations	JV	2	But of course, there should be support from the government. Two ways: first, regulation and secondly, subsidies, that's logical.
	Avoiding	Avoiding flying as a sustainability strategy	DJH	2	Are there ways to avoid traveling
		Redistributing companies to avoid commuting for employees	JV	3	Yeah, so that means if you want to reduce that you also have to redistribute the work
		moving to public transport side	JV	3	What they can do, they cannot of course move their buildings to the same public transport site.
	having ecology as a KPI instead of only financial values		DJH	4	So I strongly believe that for example, we should give technology an economical, we should make a ecology and economical player.
Deciding on a product/ behaviour change	Users considering the price in their decision		JV	2	How much does it cost?
		being cheap	JV	2	But then still the prize has to go down.
		price of sustainable products should only be a reasonable amount higher	A	4	I'm not sure. It needs to be sustainable and it needs to be a good price. And of course, I want to pay a little extra but it needs to be affordable.
		chosing flying as a mode of transport due to financial affordability	DJH	2	However, one of the reasons why people fly is that it is relatively cheap
		Making a trade-off	JV	3	So it depends on individual decisions and whether it will be done or not and everybody makes a different trade-off.
	Making it easy	Ease of use of the product	JV	2	How easy is it to use?
		making something easy to trigger sustainable behaviour	PP	7	So that's… and what can you do as a policymaker to help this kind of developments, well, obviously, make it easier to book tickets
		Quick charging time	JV	2	Do we have… so how fast do I have to charge?
	Avoiding barriers	Having the need to avoid congestion	JV	3	what I actually try I do try to schedule let's say the meeting activities in the morning. So the first few hours I work at home. In the afternoon I have the meetings. In this case of course it was different. But so I prepared yesterday… but… so in that way I completely avoid congestion.
	Situational suitability		JV	2	Can I go make a long trip? Can I go on vacation with it?
	Getting influenced by people you know		JV	2	I guess that… and also…. if people have a good experience, they may talk with their friends or family or whatever and gradly… and they may also buy it.
	raising awareness				
		being aware of being sustainable	LRM	6	So like, let's say, we do have information about, yeah, in the city for example, in Copenhagen, we… there is a… there are sensors, so, they count the number of bikes that are passing the sensor every time. So, this is an example of... So, doing that they encourage people to be aware that they are part of something they are in... and they have also information regards, what's the difference in driving a car and using a motor bike for example. So, this is just a way of turn something more concrete to for people to understand that you are contributing...
		Raising awareness through promotion	JV	2	So if the car industry would also promote it more, then, of course, people might be more interested in buying it.
		Not choosing unsustainable option´s due to a bad consciousness	A	4	So I could not take the one with the plastics because it doesn't feel... doesn't felt good.
	People evaluating mode of transport by hours to drive than in km		PP	3	people don't think in kilometres they think in hours drive and they are prepared to drive half to one hour per day for their work, for commuting.
Change	Change happening gradually without governmental interventions		JV	2	So if there is no pressure from the government in the sense that fossil fuel vehicles will disappear then it will go gradually.
	Change towards sustainability happening gradually/ slowly		JV	7	You also see it with toxic products for instance. Any kind of toxic product, toxic substances can gradually disappear in for example PC. Toxic substances are gradually disappearing, but it has taken decades before this happened.
	quick change is possible through govemmental enforcement		PP	6	So that well... that's part of the... so governments can enforce things. And then changes can go very quick.
Barriers for companies to act sustainable	Sustainable actions are often more expensive than non-sustainable actions		LRM	2	It's it's expensive, but okay, and then I'm proud, I'm doing something.
	difficulty to change the infrastructure of supply chains		LRM	4	It's possible it would be possible to have car manufacturers in composites, for example, but then it would require a completely change in the infrastructure, the supply chain. So that's why it has not changed yet up to now.
	politicians not supporting companies sufficient to act sustainable		LRM	4	So the reason things sometimes don't move, it's not that it's not because it's not possible, but because of political issues as well.
Recycling	Difficulty to get high quality material out of recyled aircraft materials		DJH	1	I do see challenges in the possibility for recycling of the materials that are left when an aircraft stops flying. So in our day to day business where we try to recycle the aluminum and the other metals, that will be more challenging because you see more and more industries improving the, let's say the quality of the product they make and to make those quality they need a better quality control of the type of material they use. And to get that quality of material, it's harder and harder to make that from recycled material,
	Difficulty to make high quality metal from a mix of recycled metal		DJH	1	it will be more challenging to make that quality of metal from a mix of metal.
	challenge of creating a technology that separates the types of metal and creates pure recycled metal		DJH	1	I do think that the demand for the material or the technologies available to create a purity that is required is a challenge.
	purifying metal costs more money		DJH	1	And the only solution for that is just to add more money to the process.
	sorting machines to sort material have their limitations		DJH	1	But that prize might needs to increase to make labour more possible, because it's more about sorting it and the sorting is machines have limitations.
	ease of creating new forms out of recycled metal		DJH	1	Everything. If you have metal you can make whatever you like from the metal. So, there are no limitations.
Airline as a stakeholder	Target group	focus on business traveller	A	3	And our focus is on the business traveler
		focus on frequent flyer	A	3	And our focus is on the business traveler and the frequent flyer
		Millenials being important as a target group	A	4	Yeah, because those are the customers of the future. So millennials is very important for us now.
	focussing on economical profit		A	1	and of course, we want to make money.
	goal of transporting as much people as possible		A	1	So, you know, yeah, it's our goal to transport as as much as possible people in our planes.
	consideration of sustainability as a side criteria		A	1	Of course, sustainability is an aspect of that, but it's not it's not the most, most important thing.
			A	2	it's not only about the environment and weight reduction, it's also about passenger comfort, which is very important for us as well, which is maybe even more important than the environment because we want passengers to choose for us as an airline and therefore it has to be comfortable.
	aiming to create a seamless mobility experience		A	1	What we do now we are a network carrier, so we try to connect everything very well to get a seamless.
		through considering train in user journey	A	1	So what I just explained is that we may combine, train and airplane into one single journey.

	through the interaction of touchpoints between train and aviation sector	A	1	But then we have influence on our own schedule and our own...well, on flying and not on the full system of trains.
	collaboration with train company	A	1	But still, it's the train company and its (name of the company) and of course, we can work together.
passenger comfort as an important criteria for airline		A	2	it's not only about the environment and weight reduction, it's also about passenger comfort, which is very important for us as well, which is maybe even more important than the environment because we want passengers to choose for us as an airline and therefore it has to be comfortable.
	optimization of board time	A	2	What we try to do is to, to optimize the time on board
Having Schipol as a main hub		A	5	We transport people all over the world via Schipol. This is the main hub...
Brand	Airline being reliable	A	5	We are very reliable and those kind of things with low cost carriers punctuality is always as good.
	Airline having problems with punctuality due to low cost carriers	A	5	We are very reliable and those kind of things with low cost carriers punctuality is always as good.
	... Being a high level airline	A	5	high level, high level type of airline.
Airline trying to offer low prices to be compeitive		A	5	But it's very hard because people are price driven and price is important as well. So we have to reduce our prices as well. It needs to be a bit competitive.
	High density in aircrafts to reduce the cost per unit	A	6	Our aircraft has to be completely full with passengers because the cost per unit, the cost per passenger needs to be as low as possible. And you can do that by having as much as passengers in your aircrafts.
		A	2	So we have a very high density in our flights.
	Weight reduction through slimmer seats	A	2	And I'm not sure if you know what we did in the past, but we had those old seats, which were quite thick. And now we have those slim seats, which reduced weight with a few kilograms per seat. So that's a good thing.
	Fitting more passengers into aircraft	A	2	But on the other hand, what we did, so those seats were thinner, so we could fit more seats in a row, because if the seat becomes thinner, you can move the pitch a little bit. So the pitches is the space between seats.
	Using leightweight material in an aircraft to save fuel	A	1	And besides cardboard or other materials can be heavier in weight. And of course, we have to transport the weight and weight is oil. Kerosine. So then it can also be more sustainable to have lightweight products plastic rather than cardboard.

A.4.1

Search Fields

CO-CREATION SESSION

To find search fields a co-creation brainstorm was set up. The co-creation was especially valuable for two reasons. First, research shows that groups outperform individuals (McMahon et al., 2016) during the idea generation. Second, through co-creation the company can learn from consumer needs, and the customer can design for its own needs (Prahalad & Ramaswamy, 2004).

At the following page photo impressions of the session can be seen.

Furthermore, A. 4.2 shows the planning of the session. For the session setup snacks were provided to create an atmosphere of well-being for the participants, an atmosphere in which they feel more comfortable to generate ideas. The session started with an introduction phase, in which the participants were introduced to the project context and the most important analysis results. The next two phases were divided into a problem definition and a phase of idea generation. The session plan was oriented on the book 'Creative Facilitation' by Tassoul. Also techniques like 'wishful thinking', 'How to's', 'dot selection' and 'roleplaying' were extracted from the same book. The technique

Figure A4_01

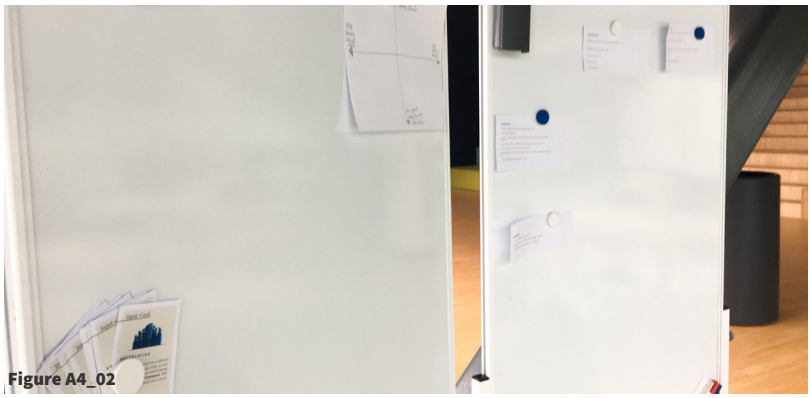


Figure A4_02

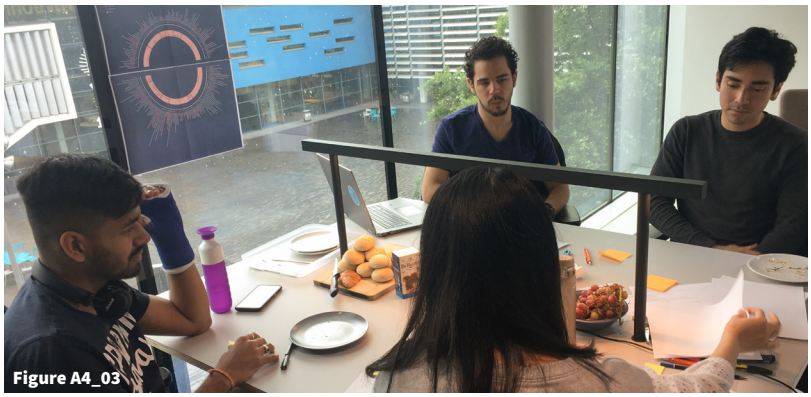


Figure A4_03


Figure A4_04

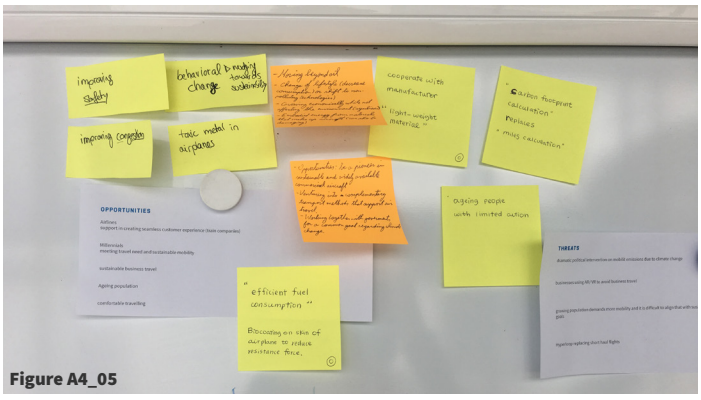


Figure A4_05

Figure A4_01: Session set-up: An inviting set up supported the participants well-being and motivation for the creative session
Figure A4_02: Session set-up: Cards for roleplaying, trend scenarios, and analysis results were map visible for the participants on a board
Figure A4_03: Session set-up: The context map helped the participants to get an overview about context factors of sustainable mobility
Figure A4_04: Participants brainstorming
Figure A4_05: Opportunity areas found out by the participants

Co-Creation

SEARCH FIELDS

PROJECT:	**LOCATION:**
DATE/ TIME:	**PARTICIPANTS:**
CHECKLIST PREPARATION: - prepare snacks - set up presentation - form to ask for background information of the participants (age, gender, nationality, occupation)	

INTRODUCTION

10:30 - 10:40
Arriving time

10:40 - 10:55
Welcome everyone and thank participants for coming. Participants need to be asked if it is ok if pictures during the session are taken. As an energizer the participants are asked to grab some breakfast. Furthermore, a form is provided in which participants should write down their background information.
Afterwards, the presentation is shown providing information about the project context, analysis results, and the trends scenarios. Some time is provided to ask questions about the project.

PROBLEM DEFINITION

10:55 - 11:15
A brainstorm is conducted about strategic strengths and weaknesses, as well as external opportunities and threats. A list of SWOT aspects will be additionally provided by the facilitator. The methodology wishful thinking helps to support the brainstorm and think about potential ideal situations or worst case scenarios.

IDEA GENERATION + SELECTION

11:15 - 11:50
5 minutes: Create H2s relating to the collected brainstormed SWOT aspects.
5 minutes: Select H2s that you would like to brainstorm on.
20 minutes: Write the H2s on different pieces of paper and start the brainstorm. Every 5 minutes give the pieces of paper around. After a few minutes give roleplaying cards around.
5 minutes: Select the best ideas through dot selection.
Afterwards, thank participants for their participation and close the session.

A.4.3

Search Fields

SESSION PRESENTATION

Brainstorm Introduction

Co-Creation Search Fields

MELANIE RUMPF

MAIN BUSINESS STREAMS

Commercial aviation (used to be Embraer's main revenue stream and is right now part of a joint venture with Boeing. Embraer keeps 20% of the joint venture)

Executive jets

Defense & security

Services & support

REVENUE STREAMS

Commercial aviation used to be 73% of the revenue

Defense & security: 23%

Executive jets: 4%

Embraer General Facts

MAJOR TRENDS

Urbanization
Being sustainable vs. high consumption
Smart technologies
Digitalization

CRITICAL UNCERTAINTIES

Politicans might need to intervene CO_2 emissions with dramatic interventions due to the risk of irreversible environmental effects in the next 10 years due to climate change

VR/ AR might decrease the amount of business travel

Trend Analysis

Co-Creation
Search Fields

Trend Scenario 1 & 2

THE POLITICAL INTERVENTION

- dramatic change demand towards sustainability through political interventions
- ticket prices for airplanes fueled by kerosine are rising enormously due to taxes, which result in a decrease of flying
- government forces the aviation industry to shift to biofuel/ electric/ hydrogen fueled aircrafts
- mobility need is decreasing through governmental interventions
- Embraer having difficulties to adapt its airplanes quickly and making them sustainable
- VR/ AR trend decreases the demand for executive airplanes and business travel

REPLACEMENT THROUGH ALTERNATIVES

- government creates plan to abandon kerosene over the next years
- funding and support by the government is given to sustainable transportation (e.g. trains, Hyperloop)
- Embraers business stream of eVTOLs is rising, but there are still issues with a missing infrastructure for VTOLs and the competitive landscape
- the mobility demand is rising due to the growing population

Co-Creation
Search Fields

Trend Scenario 3 & 4

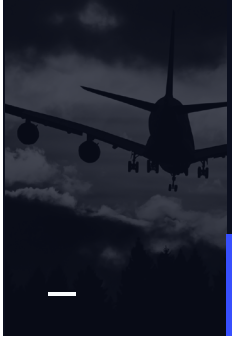
THE COMPETITVE LANDSCAPE

- Change towards sustainability in the aviation industry goes really slowly. Rising ticket prices caused by using alternative sustainable fuels like biofuels or hydrogen is avoided as much as possible in order to stay competitive on the market.
- The current core market characteristics don't really change. However, there is an increasing demand for mobility and air travel . The mobility market is booming.

ENDANGERED BUSINESS TRAVEL

- Change towards sustainability is going slowly and gradually towards sustainability.
- The mobility market is growing due to a growing population. There is a higher demand for travelling.
- Businesses are investing in VR/ AR meetings to avoid travel costs. Therfore, business travel is decreasing.

Co-Creation
Search Fields



GENERAL INSIGHTS

Sustainable mobility should focus on the core issue to avoid/ reduce greenhouse gas emissions. Further problems are more secondary.

Shift from ownership to mobility as a service is preferable.

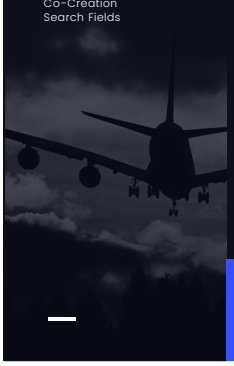
Using collaborations to increase influence might help Embraer to enable sustainable mobility.

Behavioral change might be a key regarding sustainable mobility.

It should be taken into account that the production of an aircraft takes up to 5 years. Its operation duration is approximately 25 years.

Sustainability Analysis

Co-Creation
Search Fields



FUELS

Large airplanes won't be completely emission free until 2035. With biofuels and weight reduction eco-efficiency will be achieved.

Electric forms of transportation are desirable. However, also here are limitations: battery capacity, resources of the battery are quite scarce. Research is required here.

Smaller air vehicles powered through electricity are possible and are more sustainable than electric vehicles if a certain amount of kilometres is reached.

Small zero emission hydrogen airplanes (up to 30 seats) might be feasible in 2035. However, the viability might be critical if the competition with kerosene fuels will remain.

Comparing all current modes of transport, trains seem to be the most sustainable. In the Netherlands they are fueled by sustainable electric wind energy.

Sustainability Analysis

Co-Creation
Search Fields

Competitor Analysis

COMMON SUSTAINABILITY STRATEGIES

Most competitors in the aviation industry focus on eco-efficiency strategies, e.g. through using biofuels or weight reduction. Furthermore, often companies look into eVTOLs. EVTOLs can be expected in the next 5 years. However, the infrastructure for eVTOLs is currently missing. (examples: Boeing, Airbus, Lulium)

STRENGTHS COMPETITORS

- Airbus and especially NASA stand out through really innovative concepts that Boeing and Embraer don't have. Concepts are even designes by students sometimes. Embraer can catch up on that with EmbraerX and its university partnerships.
- Bombardier sticks out with also creating trains.

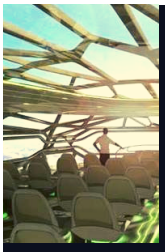
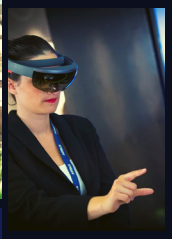
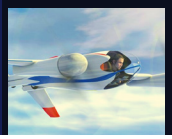


Figure above: Airbus future bionic cabin making airplanes leightweighted in 2050

Figure below: Airbus looking into AR & VR





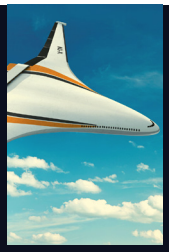


Figure above: Innovative aircraft shape by NASA. The aircraft reduces emissions and noise and is manufactured with composite material.
Figure left: Personal electric air vehicle by NASA.

COMPETITOR ANALYSIS

Innovation Concepts

Customer Insights

CO-CREATION SEARCH FIELDS

Importance of seamless travelling for customers.

Millenials often prefer a healthy and sustainable lifestyle, but also value travelling a lot.
A low price often seems to be relevant to them.

The ageing generation often prefers comfort and is also willing to pay extra for comfort.

AIRLINES

Trying to offer low prices for its customers in order to stay competitive. Sustainability is often a side criteria. While some airlines focus on low prices, other airlines try to also focus on customer comfort in airplanes. Also, a seamless customer experience is important. Therefore, airlines collaborate for example with train companies.

Further Information

Thank you for your attention!

SUSTAINABLE MOBILITY 2035

A.5

Vision Creation

CO-CREATION

It is a common approach in Roadmapping to involve stakeholders in the vision creation, who will further work on the project. This is usually done through a workshop. Because it was not possible to organize a workshop due to the availability of stakeholders a form was created. Peter Vink, who will be involved in the collaboration between the TU Delft and Embraer for the next two years, participated in the vision creation. Employees of Embraer were not able to participate, the company needs to keep confidentiality to external stakeholders due to the current negotiations with Boeing.

For the co-creation of the vision first the presentation, which can be found in A.4.3 was shown as well as an additional slide showing the search field. Afterwards, the procedure of the form that was created was followed. The stakeholder was asked to brainstorm for value opportunities. As a next step a preliminary vision was presented that could be evaluated based on criteria that are suggested by the book Design Roadmapping (Simonse, 2017): clearness, compelling benefits, and desirability. Furthermore, it was possible to adapt the vision and add additional comments if necessary.

Peter Vink adjusted the vision and pointed out the importance of the passenger experience, which is mentioned in the report as an opportunity field in chapter 5. Additionally, Mr. Vink revealed further strengths of Embraer in comparison to Embraer's competitors.

Embraer shared vision 2035

To Whom It May Concern,

Thank you for participating in creating a shared vision for Embraer for 2035.
Your participation is valuable for creating a relatable vision for multiple stakeholders to get a focus on what should be important for Embraer in 2035.
The vision will be created for a project in collaboration with Embraer on sustainable mobility in 2035.
The outcome of the project can be any kind of form of mobility and doesn't necessarily need to focus on airplanes.

Before starting the survey please go through the presentation that was send to you via email to get an overview of the most important analysis results of the project.
Afterwards, please, follow the survey that will lead you through the process.

Kind regards,
Melanie

1. **Please provide first some background information (staying anonymous if wanted is also a possible option). Let's begin. What is your name?**

2. **What is your age?**

3. **What is your profession?**

4. **What is your relation to the project?**

Brainstorm

5. **I would first like to ask you to brainstorm on ideas of strategic value opportunities for Embraer in the future.Take into consideration that a vision is mainly about value drivers and less about defining the product or what the product does. The values should respond to the context factors found in the sent presentation about the analysis results. Also, this link might help you coming up with values: https://uxmag.com/articles/creating-a-shared-vision-that-works . Please, fill in the brainstormed values in the field below and copy them, because you might need them later on. After your brainstorm please remove system quality attributes that evaluate a system (e.g. accessibility, usability, quickness). For the exercise take as much time as you wish.**

Vision evaluation & refinement

The following primarily vision was created for Embraer:

In 2035 Embraer moves you through sustainable impactful and zero-emission transportation to the place, where you need to be, in a way that supports you in mastering your day.

The vision includes
- the value to be empowered to move in a sustainable way, which is nowadays often difficult to achieve
- sustainability goals like ‘sustainable impactful and zero-emission’ transportation
- transporting people preferably, when they really ‘need it’ (e.g. having the need to go to work)
- the value of supporting the user mastering its day

6. **Please evaluate if the vision is clear and easily understandable.**
   Markieren Sie nur ein Oval.

	1	2	3	4	5	
not clear	◯	◯	◯	◯	◯	very clear

7. **Please evaluate if the vision has compelling benefits for users.**
   Markieren Sie nur ein Oval.

	1	2	3	4	5	
no compelling benefits	◯	◯	◯	◯	◯	very compelling benefits

8. **Please evaluate if the vision is desirable and attractive for stakeholders involved in the project to work towards it.**
   Markieren Sie nur ein Oval.

	1	2	3	4	5	
not desirable	◯	◯	◯	◯	◯	very desirable

9. **Now I would like to ask you to change or adapt the vision in case you think it needs refinement or complete changes. For improving the vision please use the brainstormed words from the beginning, the criteria that helped you evaluate the vision or even create new values or ideas that enhance the vision. Furthermore, you can also have a look at this list of words/ expressions to improve the vision: https://docs.google.com/document/d/1rKzt66oQXW3hAfloSmwlhcRr7l0wnWNLhJZ55qna2ml/edit?usp=sharing .**

_____

_____

_____

_____

_____

10. **Do you have any additional comments?**

_____

_____

_____

A.6.1

Embraer
Business Challenge

PROMOTION & ENGAGEMENT

The event Embraer Business Challenge was promoted in various ways. Posters were hung up at various faculties on the TU Delft Campus. Also, a banner was made to promote the event on the screens of the different TU Delft faculties. A Facebook event was created that was shared by 3 associations: LATITUD Delft, Delft Sustainable Energy Association, and the Green Office TU Delft. The Facebook event reached 3,300 people and received 40 responses. People engaged with the event, invited friends to the business challenge, and liked and commented on the event. After the event, one participant shared her engagement about the event on LinkedIn.

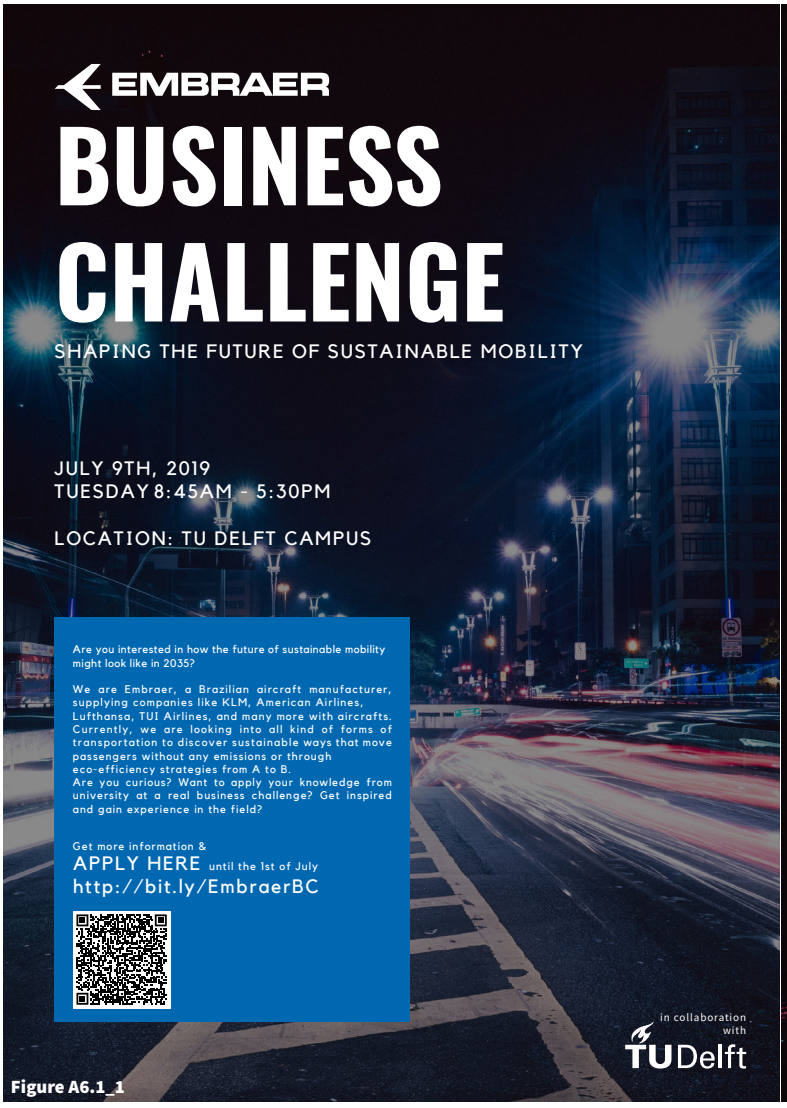


Figure A6.1_1

Figure A6.1_2

Figure A6.1_1: Poster was placed at the different faculties
Figure A6.1_2: Banner for the promotion on the screens of the different faculties

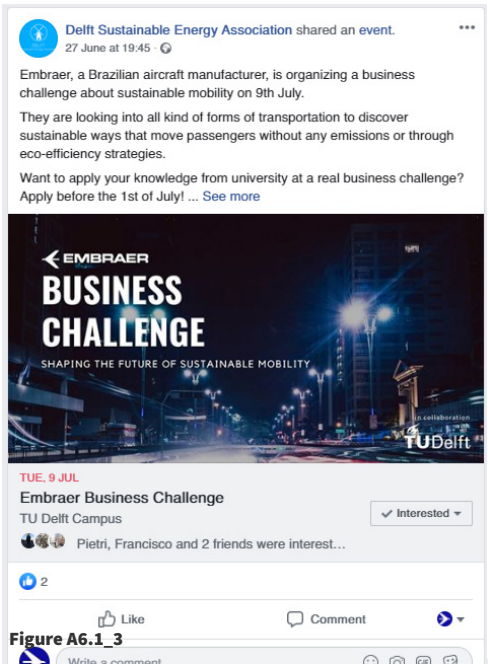


Figure A6.1_3

Figure A6.1_4

Figure A6.1_5

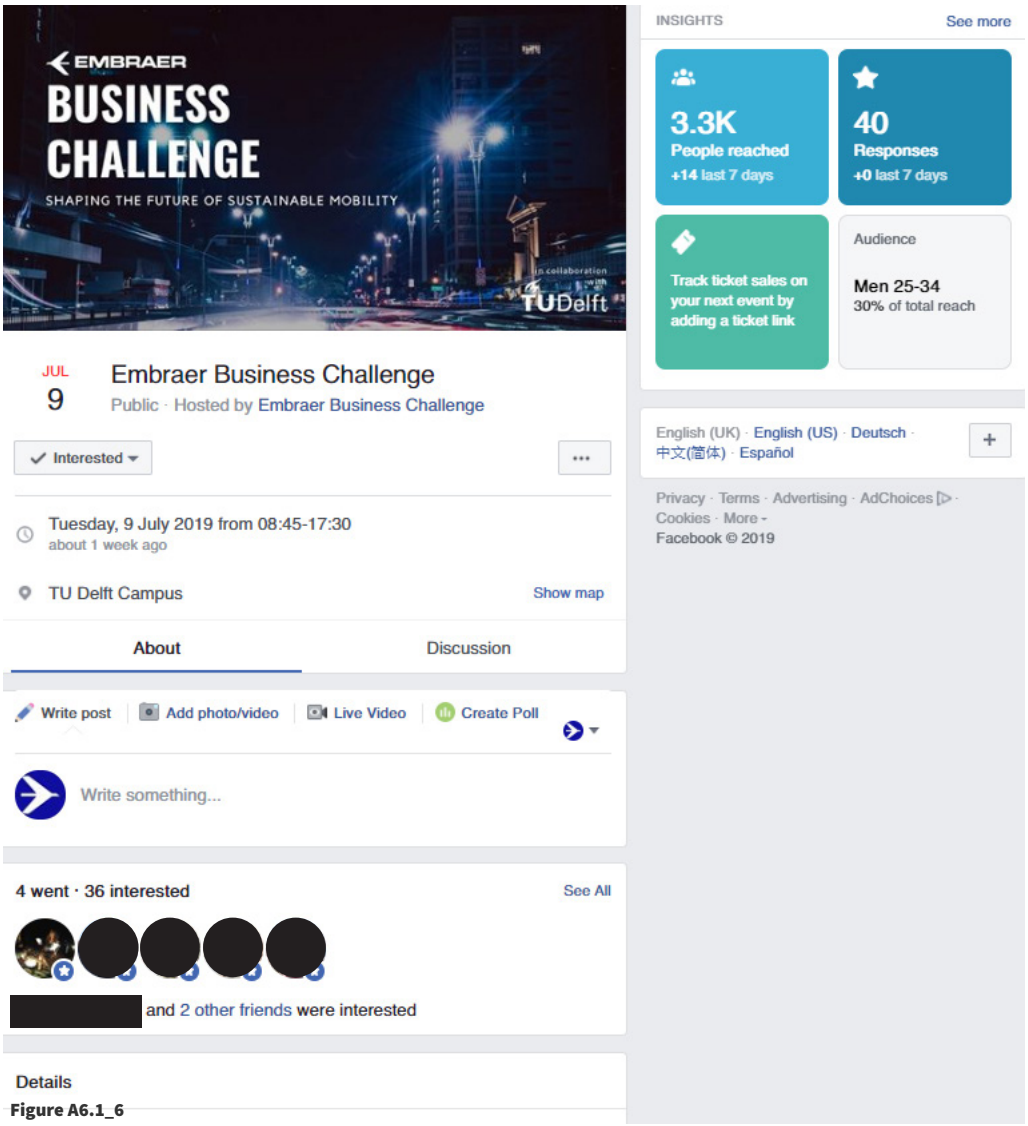


Figure A6.1_6

Figure A6.1_3-5: Delft Sustainable Energy Association, Green Office TU Delft, and LATITUD Delft posting about the event on Facebook
Figure A6.1_6: Facebook event

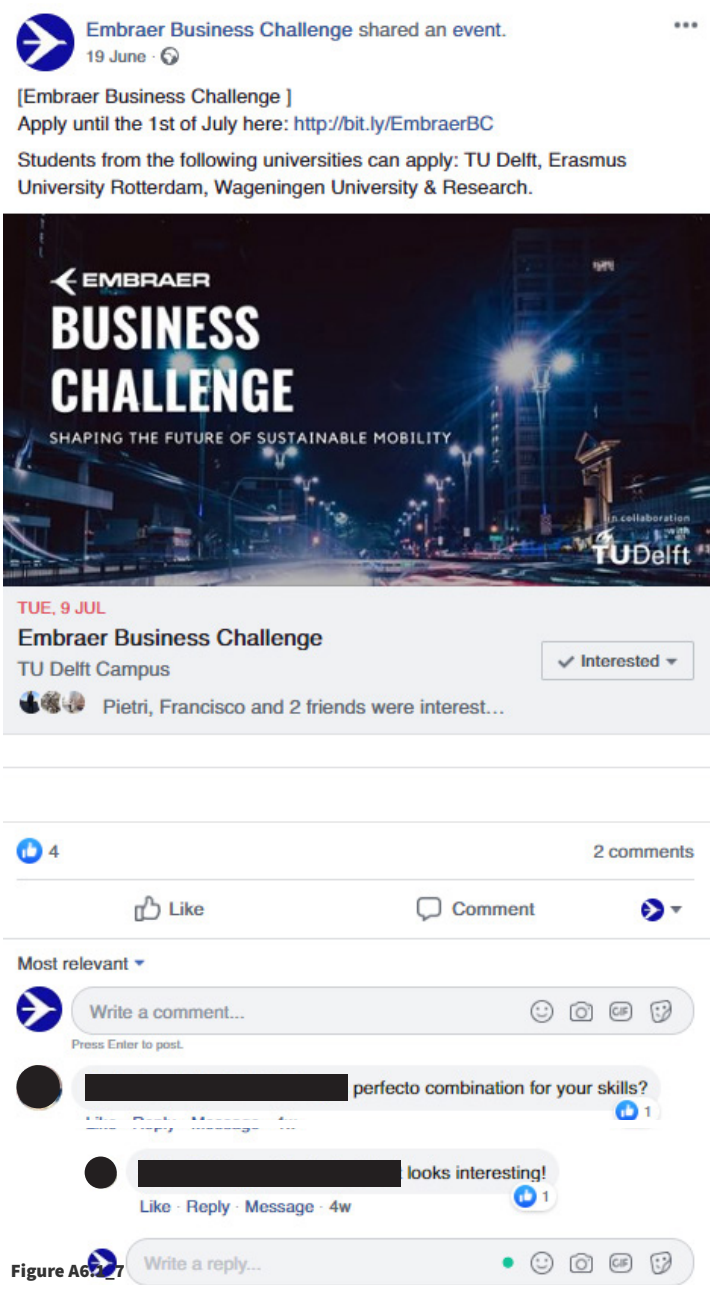


Figure A6.1_7

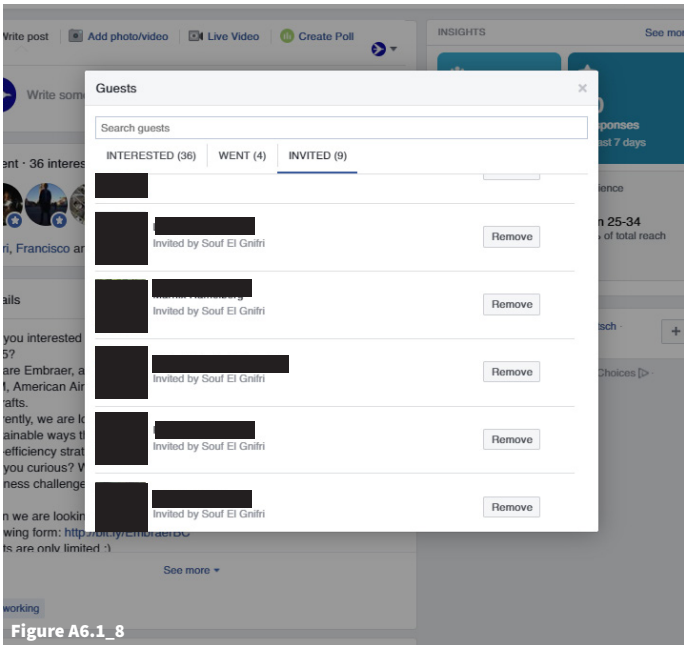


Figure A6.1_8

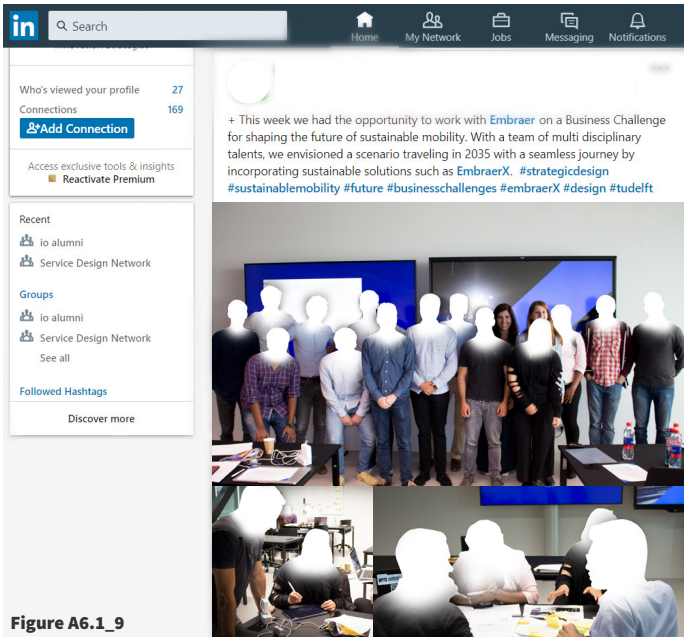


Figure A6.1_9

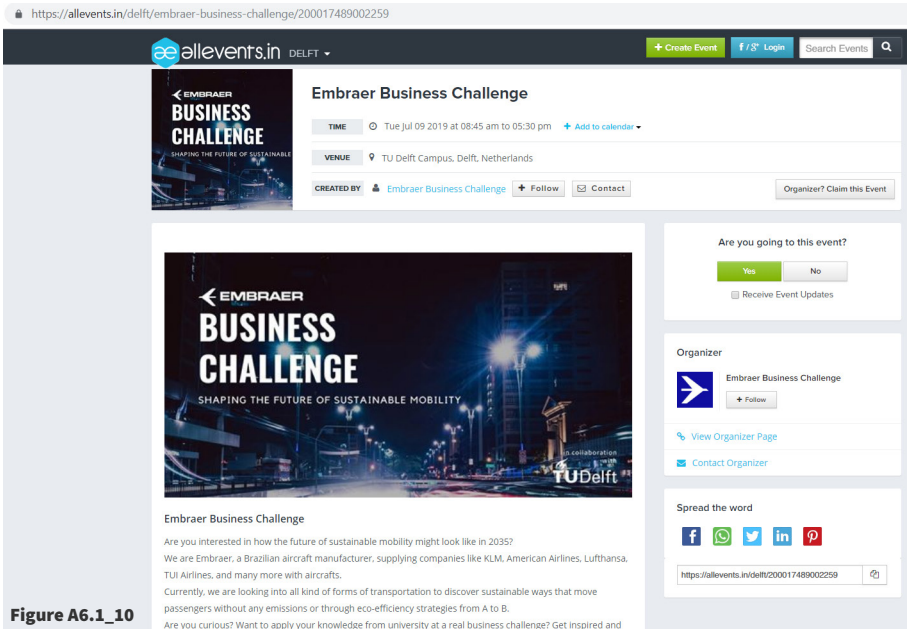


Figure A6.1_10

Figure A6.1_7: People engaging with the Facebook event
Figure A6.1_8: People inviting friends to the business challenge Facebook event
Figure A6.1_9: LinkedIn engagement after the business challenge
Figure A6.1_10: After some time promotion got easier: the event even got promoted on websites without asking for promotion, e.g. in the case of www.allevents.in

A.6.2

Embraer
Business Challenge

SESSION SET-UP

The event was promoted as a business challenge. For this reason, it was important to have a direct connection to the company at the business challenge. Luciana Ribeiro Monteiro took the whole day to accompany the business challenge. She presented the company, decided on the final winning teams, and was open to questions that the participants had about Embraer.

MORNING PREPARATION - 08:00 - 08:45

To make it easier for the participants to find the way to the room of the business challenge posters were positioned that indicated the way to the room. At the room a welcome poster greeted the participants.

The presentation had to be set-up. Drinks and snacks, such as fruits, cookies, and chocolate bars were provided from the beginning on of the challenge for the participants, and placed on different tables. Also, the assignment sheets were positioned on the table. A handout of the presentation slides should support that the participants keep the vision, sustainability criteria, or evaluation criteria in mind.

INTRODUCTION - 08:45 - 10:00

The participants were given 15 minutes to arrive. At 9 o'clock everyone was welcomed and a presentation was hold. An overview was given of the planning of the day and the project context was introduced followed by an introduction about what Embraer and EmbraerX is about. Furthermore, current issues of mobility were mentioned that might need to get addressed while creating a sustainable mobility strategy. The following technology roadmap informed about sustainable fuels that might be a key factor of sustainable mobility.
The mentioned vision gave a direction in which the strategy should go. Also, the complete assignment was explained. Selection criteria should support the participants in choosing for their ideas. Research shows that people come up with more creative ideas when they were told before to create really original ideas (Rietzschel, Nijstad, & Stroebe). Additionally, rules for idea generation were supposed to create an atmosphere in which participants felt comfortable and participate actively. These rules are based on the book 'Creative facilitation' by Tassoul (2012). Afterwards, participants got divided into different teams and were given handouts about the assignment and the presentation slides.

WORKING ON THE CASE - 10:00 - 13:00

During this time participants had to read the assignment carefully.
In the assignment the participants were consciously addressed as being the user themselves to imagine the described situation in a better way, to emphasize, and design for their own user needs. A concrete case (going from Delft to London) was given as well as a scenario of how 2035 might look like in order to design in a better way for this kind of scenario. The scenario was based on the context analysis conducted for this master thesis.
Besides, the sheets indicated with 'process guideline' should help the participants as an orientation to get through the process. In those guidelines doing a lifecycle analysis was suggested. The analysis of the lifecycle is a common approach for creating a cradle to cradle strategy (van der Grinten, 2018). A structure of the ideation process was

based on Tassoul (2012) .
During the idea generation of the participants Luciana Ribeiro Monteiro and Melanie Rumpf were available for questions. Additionally, photos of the participants were taken.

LUNCH - 13:00 - 14:00

The catering service arrived during this time and the participants had time to take a break. Sandwiches, fruits, and drinks were provided to the participants.

FINALIZING IDEA & PRESENTATION PREPARATION - 14:00 - 15:45

After the lunch, the participants had time to finalize their idea and prepare the presentation. Half an hour before the presentation submission the participants were made aware to start preparing the presentation now. Between 15:30 and 15:45 the presentations were collected.

PITCHING - 15:45 - 17:00

Each team had 5 to 10 minutes time to present their ideas. After the presentation the organizers had time to ask questions to the team regarding the presentation and the idea. When all teams presented, the organizers went outside the room to discuss the quality of the teams presentation. Finally, it was decided on two winning teams.

CLOSING - 17:00 - 17:30

At 17:00 the organizers came back inside the room to announce the two winning teams. It was decided on a winner and a runner-up. The winning teams got a box with chocolate and gift cards for ice cream. Also, certificates for the winner and the runner-up were handed out. Additionally, each participant received a certificate of attendance. All certfificates were signed by Luciana Ribeiro Monteiro in order to make them valid. The certificates also served as a value for the participants to have a proof for their participation in case they want to mention in their CV‘s that they participated in the event.
In the end, a group picture was taken of all participants and the organizers and the business challenge was closed.

A.6.3

Embraer
Business Challenge

PRESENTATION SLIDES

EMBRAER

BUSINESS CHALLENGE.

SHAPING THE FUTURE OF SUSTAINABLE MOBILITY

in collaboration with TUDelft

PLANNING OF THE DAY 02

A new, more accessible and more democratic way of getting around will change the world - for the better.

- Antonio Campello, CEO EmbraerX -

AGENDA.

- **09:00:** Introduction
- **10:00:** Working on the case
- **13:00:** Lunch
- **14:00:** Working on the case
- **15:30:** Presentation submission
- **15:45:** Pitching (5 - 10 minutes per group)
- **17:00:** Winner Announcement

Business Challenge 09.07.2019

PROJECT CONTEXT 03

WHO WE ARE.

Luciana Ribeiro Monteiro

R&D Analyst, Embraer

Peter Vink/ People in Transit

Professor of Environmental Ergonomics, Head of Design Engineering Department

Melanie Rumpf

Student Strategic Product Design

Business Challenge 09.07.2019

THE COMPANY 04

ABOUT EMBRAER.

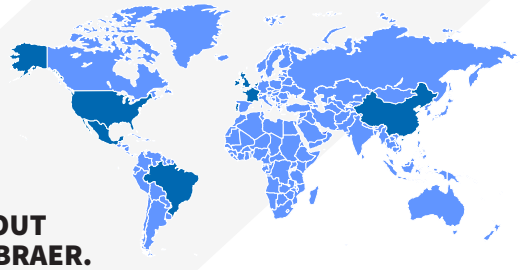
Founded in 1964 in Sao José dos Campos, Brazil

Commercial aviation, executive jets, defense & security, agricultural aviation

Operating worldwide

Business Challenge 09.07.2019

WORLDWIDE OPERATIONS 05



ABOUT EMBRAER.

Join us: https://embraer.com/global/en/join-us

Business Challenge 09.07.2019

INNOVATION WITHIN EMBRAER 06

EMBRAER X.

Disruptive innovation

Mobility for everybody

Internationality

Enhancing people's lives

Business Challenge 09.07.2019

SUSTAINABILITY ISSUES 07

Climate Change

Air Pollution

Environmental Issues

Noise

Safety & Security

Congestion

Physical Inactivity

Unsustainable Resource Usage

Land Usage

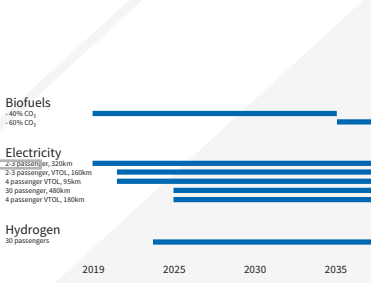
Social Inequality

Spread of Diseases

ISSUES OF MOBILITY.

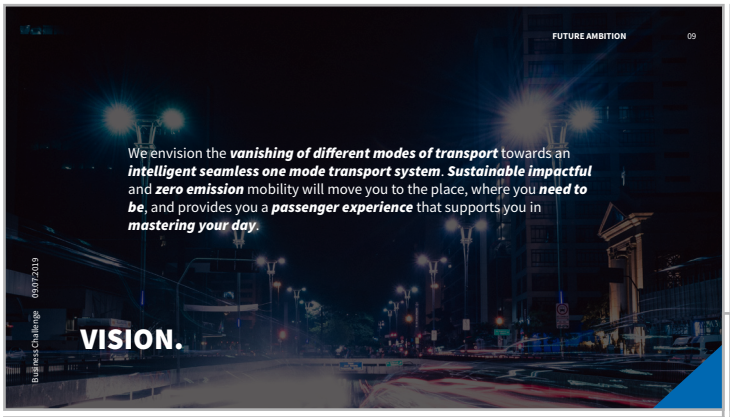
Business Challenge 09.07.2019

FUTURE SUSTAINABLE AIRCRAFTS 08

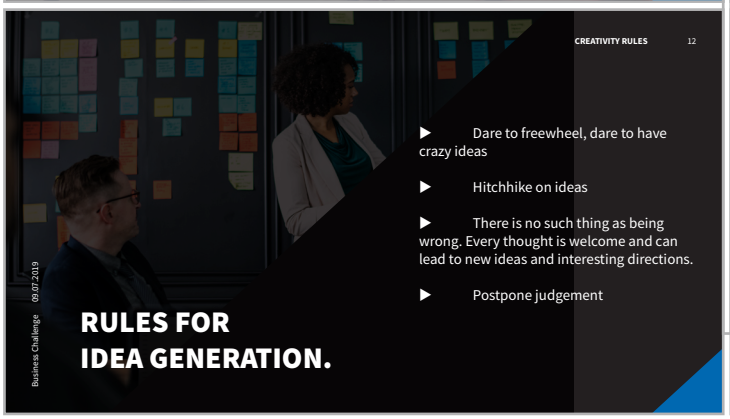


TECHNOLOGY ROADMAP.

Business Challenge 09.07.2019


FUTURE AMBITION 09
We envision the vanishing of different modes of transport towards an intelligent seamless one mode transport system. Sustainable impactful and zero emission mobility will move you to the place, where you need to be, and provides you a passenger experience that supports you in mastering your day.
VISION.
Business Challenge 09.07.2019


SUSTAINABLE MOBILITY EXPERIENCE 10
BUSINESS CASE.
Imagine it is the year 2035. You are living in Delft and would like to visit your best friend that moved a few years ago to London ..... To get to London you will fly in a 30 seater aircraft. To get from home to the aircraft, and from the aircraft to your friends place in London you will also depend on further types of transportation. How can you connect the transportation experiences? How can be the forms of transportation sustainable? And how can transportation fit in the described environment? What do you value during that journey? How can the experience be pleasuring for you?
Create with your team mates a mobility experience considering these aspects.
Business Challenge 09.07.2019


CREATIVITY RULES 12
▶ Dare to freewheel, dare to have crazy ideas
▶ Hitchhike on ideas
▶ There is no such thing as being wrong. Every thought is welcome and can lead to new ideas and interesting directions.
▶ Postpone judgement
RULES FOR IDEA GENERATION.
Business Challenge 09.07.2019


LET'S START.
SHAPING THE FUTURE OF SUSTAINABLE MOBILITY
EMBRAER
TU Delft

A.6.4

Embraer
Business Challenge

ASSIGNMENT

Business Case

SHAPING THE FUTURE OF
SUSTAINABLE MOBILITY

IMAGINE IT IS THE YEAR 2035...

You are living in Delft and would like to visit your best friend that moved a few years ago to London.
Throughout the years you experienced how cities like London, the Hague or Rotterdam got more crowded and bigger. Nowadays, autonomous vehicles drive on the streets, and everything seems more connected and smarter. Vehicles communicate with each other to avoid congestion. Because vehicles are autonomous you do not need to drive anymore yourself and can enjoy your time inside the vehicle through entertainment features like watching movies, listening to music, playing games, or simply relax and have a rest inside the vehicle. These experiences are personalized and know what you need to feel well and comfy. Through virtual reality the experiences even got a new 3D and immersive dimension. At work you also experienced virtual reality. It is now used to communicate with business partners all over the world. Therefore, travelling for work reasons is less necessary anymore.
While you like to see your best friend in London you are also aware of sustainability and your carbon footprint. You do like to travel and explore the world, but while doing so you and all global citizens need to be more careful. A few years ago, climate change almost caused irreversible effects on the environment, and citizens from countries close to the equator had to flee, because climate got too extreme: land areas got flooded, food and water supply got more difficult, and old and ill people collapsed due to the hot weather. The government is facing challenges to handle the growing amount of people and the growing consumption demand, while at the same time treating the planet in a sustainable way.
To avoid further climate change effects you will need to use a sustainable way of transport. To get to London you will fly in a 30 seater aircraft. To get from home to the aircraft, and from the aircraft to your friends place in London you will also depend on further types of transportation. What kind of further transportation is it? How can you connect the transportation experiences? How can the different forms of transportation be sustainable? And how can transportation fit in the described environment? What do you value during that journey? How can the experience be pleasuring for you?
Create with your team mates a mobility experience considering these aspects.

Process Guideline

SHAPING THE FUTURE OF SUSTAINABLE MOBILITY

TIME	ACTIVITY	EXPLANATION	OUTCOME
09:00 - 10:00	**Introduction**	Presentation	
10:00 - 10:30		Get together with your teammates and read the business case. If you have any questions always feel free to ask.	
10:30 - 10:50	**Problem Definition**	Think about the products that you are about to create. What is the lifecycle of an aircraft or a train for example? The life cycle might include the production of the transportation, its transport to the final destination, its use phase, end of life, and other stages. Draw the different stages of the life cycle with its context factors (e.g. energy used, material of the product, ecological impact, people involved). While having this overview you can find out what kind of issues the product causes on the environment and society. The process will make you more aware of the different issues of mobility throughout its lifecycle.	Brainstorm about the issues of mobility
10:50 - 11:00	**Problem Selection**	You collected different kinds of problems of mobility. Select now one issue that you would like to further brainstorm about.	Focus on one problem
11:00 - 11:45	**Idea Generation**	Generate several ideas regarding the selected issue. Using post-its will help with the brainstorm. Hitchhiking on ideas or combining ideas often can lead to better creativity. Think about how Superman might solve the issue. Dare to think crazy, every thought is welcome and can lead to new valuable ideas. Try to postpone judgement, it might inhibit creativity at this point.	Several ideas
11:45 - 12:00	**Clustering**	You may have come up with different kind of ideas including solutions focussing on different areas, e.g. technology, society, environment, etc. Cluster the ideas to get an overview about the generated ideas.	DIfferent clusters
12:00 - 12:10	**Cluster Selection**	One or two fields of clusters might call your attention. Select them via dot selection: everyone making two dots at the clusters that seem most interesting to him or her.	1 or 2 fields of inetrest to look further into

Process Guideline

SHAPING THE FUTURE OF SUSTAINABLE MOBILITY

12:10-13:00	**Idea Generation 2**	The clusters that you selected might have interesting elements that can be further developed or issues that still need to be developed further. Brainstorm further about the clusters, improve the current ideas, and generate more new ideas.	Several ideas
13:00-14:00	**Break**	Lunch will be provided for you.	
14:00-14:30	**Idea Selection & Development**	Select now the best ideas that you had from the previous brainstorms. Ideas from the first and the second phase of idea generation can be selected. A dot selection might help you to decide quickly on the best idea. Get your idea together and improve it if necessary.	Final idea
14:30-15:00	**Storyline**	2035 is still a long time to go. Imagine you are in the year 2035 now. Which stages did your idea go through? Technological development might not have been developed enough, people's attitude might have changed over time. Which products were introduced that finally let to your final idea? What kind of issues were faced and how did you handle with it? Create a storyline.	Storyline leading to the final idea
15:00-15:30	**Presentation Preparation**	Prepare a powerpoint presentation or a presentation via google slides. The presentation should include a short descriptive text explaining what your idea is about, graphics that help communicating the idea, interesting elements of the idea, and concerns. Also, include the storyline that you prepared in the presentation.	Presentation
15:30-15:45	**Presentation Submission**	Put the presentation on a USB flash drive and hand it in.	Presentation submission
15:45-16:45	**Presentation**	Every group gets 5 to 10 minutes to pitch their presentation.	Pitch
16:45-17:00	**Jury Consultation**	The jury will discuss the presentations and decide on a winner and a runner-up.	
17:00-17:30	**Winner Announcement & Closing**	The winner and runner-up will be announced. Prices will be given, and the certificate of attendance will be handed out.	

A.6.5

Embraer
Business Challenge

CERTIFICATES

Figure A6.5_1: Sample certificate of attendance

Figure A6.5_2

Figure A6.5_3

Figure A6.5_2: Sample winner certificate
Figure A6.5_3: Sample runner-up certificate

A.6.6

Embraer
Business Challenge

OUTCOME

GROUP 1

The group analyzed the tour from Delft to London: going from Delft to the train station, going by train to AMS airport, arriving at LTN airport, and having an in-city transfer in London. Issues that were identified were the long travelling time, transfer costs, high energy consumption, and an inconvenient transfer. The idea was to offer two modes of transport that you bring you to the 30-passenger aircraft that flies to London. A 4-6 passenger vehicle was supposed to collect passengers along the way and bring them to a bigger ground-effect vehicle that transports the passenger to the airport. Another solution was the Embraer Premium Taxi for financially sound passengers. In this solution the ground vehicle could be transformed into a flying drone and fly the passenger to the airport.

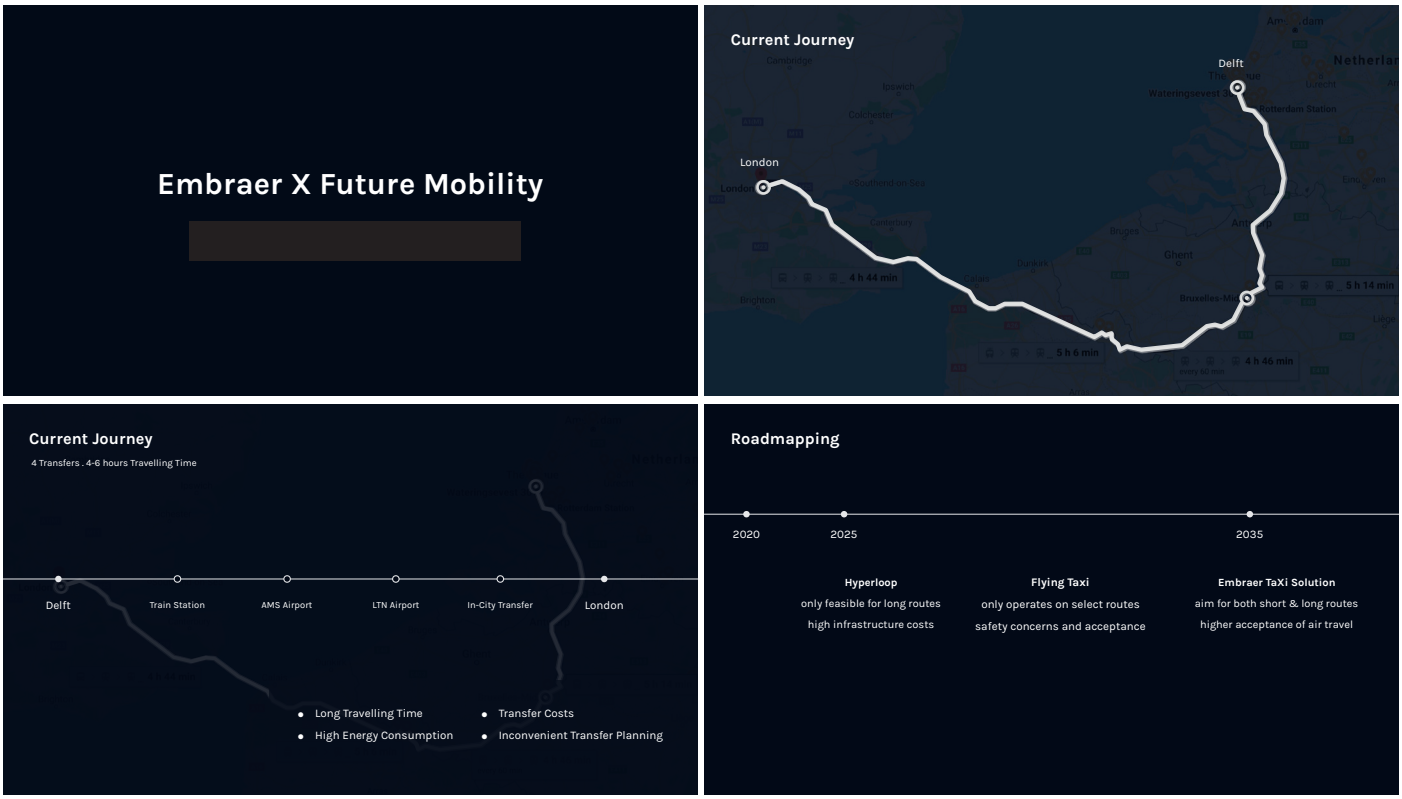
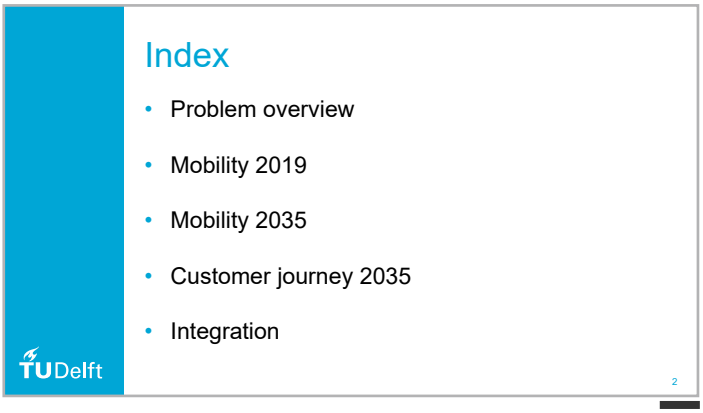


Figure A6.6_1: Presentation slides group 1

Figure A6.6_1: Presentation slides group 1

GROUP 2

Group 2 first phrased the following problem statement: “How can Embraer shape future mobility to accommodate for rising demand and frequency in international travel, without increasing carbon emissions? How does this future travel feel and benefit different customer types?”
The journey from Delft to London was mapped, and it currently takes around 6 hours. The following challenges might occur during the journey: transportation accessibility, time, carbon footprint, inconvenience, indirect emissions, economic accessibility, end of life recycling, safety/ security, prone to weather changes, digital infrastructure security.
The future in 2035 might look slightly different from now, eVTOLs might fly from Delft to the airport, and further alternatives might exist like autonomous vehicles, that take you to the train station. An alternate channel hop might fly you above the water over the channel to London.
Several assumptions were made about the future in 2035: there might be an increased population or less car ownership. The goal of the strategy to get away from car ownership to more ride sharing and trade the car for another value. Furthermore, in 2035 there is the possibility of autonomous vehicles, eVTOLs with 4-5 passengers, pedestrian friendly infrastructure, autonomous taxis, and hydrogen powered VTOL aircrafts. 15 years from now for the mobility industry is not that far away. Making the journey completely seamless probably will not be possible.
The team looked into different modes of transport and took a look of the preference of the mode of transport of different customer types: the young millennial and a representative of generation X. The mode of transport for the first mile was the bike, train, car, hub to hub transport can happen with an individual autonomous vehicle, car sharing, or an autonomous bus shuttle system, for the air to air transport a 30-seater aircraft, luggage transport facility, and an alternate channel hop can serve. Regarding the hub to hub transport the team suggested underground transport as currently Tesla is looking inside this direction, eVTOLs, public transport, autonomous shuttles, bus and car.
The idea is connect the different choices and optimize the system instead of only one mode of transport. End-to-end luggage transport and a door-to-door ticket can ease up the process. Optimizing the system can also support that everything works more fluently, is cheaper, and to save energy. Also, through system optimization waste is reduced.
The value of the solution is that it is a flexible solution that can serve different types of customers.



Problem statement

How can **Embraer *shape* future mobility** to ***accommodate*** for **rising demand** and **frequency** in international **travel**, ***without increasing*** **carbon emissions**?

How does this future travel feel and benefit different customer types?

TUDelft

Mobility 2019

Challenges

Transportation accessibility (disabled)	Time	Carbon Footprint	Inconvenience	Indirect emissions
Economic accessibility	End of life recycling	Safety/Security	Prone to weather changes	Digital infrastructure security

TUDelft

Mobility 2035

TUDelft

2035 eVTOL-Flight-eVTOL Issues

- Will eVTOL be ready at that scale?
- Is it energy efficient?
- Safety? ATC?
- There needs to be alternatives.

TUDelft

Delft 2035

- Increased population
- More Pedestrian/Biking areas
- Autonomous eShuttles/Trams
- Less car ownership?
- Students/Residents need access to long distance travel
- Schiphol is too busy, alternate airports needed

TUDelft

Solution Overview

- People want to travel
- But also hate to commute
- Remove the commute - VR, Video calls
- Integrated office/residential locations
- Increase pedestrian areas
- Urbanization can still increase, without traffic burden IF …
- Reduce car ownership, more sharing, more alternatives

TUDelft

Alternate Channel Hops

- Fly
- Boat/Ferry
- Chunnel
- Wing-in-ground-effect
- Long-range eVTOL

TUDelft

2035: Tech readiness

- Possibility of autonomous vehicles (e-vtols, cars, bus shuttles)
- E-VTOL aircraft, capable of 4-5 passengers' flights in a range of 300km
- VTOL landing pads
- Pedestrian friendly infrastructure
- Autonomous taxi – ride sharing options
- Hydrogen powered VTOL aircraft

TUDelft

Customer journey: Persona's

Name: Tom Boerse
Age: 21
Job title: MSc student at TU Delft
Residence: Student housing in Delft city centre
Travel pattern: 2-4x per year

Customer values:
- Price-efficiency
- Low impact on environment
- Physical & digital safety

Customer opinions:
- Optimistic towards automation
- Conscious of privacy/digital security
- Liberal stance against immigration and urbanization

TUDelft

Customer journey: Persona's

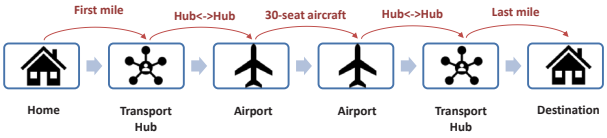
Name: Willem-Jan Ruyter
Age: 57
Job title: CEO ABN-AMRO
Residence: Luxury villa on outskirts of Delft
Travel pattern: Weekly

Customer values:
- Time-efficiency
- Comfort
- Convenience
- Ability to work uninterruptedly

Customer opinions:
- Skeptical towards automation
- Limited perception of privacy/digital security
- Conservative stance with regards to immigration and urbanization

TUDelft

2035: Customer journey



TUDelft

First mile (NL)

+ Zero emissions + EOL recycling + Economic accessibility - Travel time - Road safety	+ Economic accessibility + Travel time - Indirect emissions - Transportation accessibility	+ Travel time + Convenience - Indirect emissions - Economic accessbility
Tom: ✓ Willem: ✗	Tom: ✓ Willem: ✗	Tom: ✗ Willem: ✓

TUDelft

Hub to hub transport (NL)

+ Convenience + Travel time + Transportation accessibility - Safety - Economic accessibility	+ Economic accessibility - Safety - Incovenience	+ Safety + Convenience - Indirect emissions - No secondary activities possible	+ Safety + Convenience + Economic accessibility - Travel time
Tom: ✗ Willem: ✓	Tom: ✓ Willem: ✗	Tom: ✗ Willem: ✓	Tom: ✓ Willem: ✗

TUDelft

Air to Air transport

+ Cheap + Trusted - CO2 emissions - Waiting times - Crowded	+ Easier airport check-in + (Potentially) Cheaper feed - Planning	+ Less emissions + Simpler boarding process (marine vehicle) - Not yet developed - Coastal cities only
Tom: ✓ Willem: ✓	Tom: ✗ Willem: ✓	Tom: ✓ Willem: ✗

TUDelft

Hub to hub transport (UK)

+ Convenience + Travel time - Economic accessibility	+ Travel time + Carbon footprint - Economic accessibility - Prone to weather - Dependent on airspace congestion	+ Safety + Economic accessibility - Travel time - Incovenience - Security	+ Safety + Convenience + Economic accessibility - Travel time
Tom: ✗ Willem: ✓	Tom: ✗ Willem: ✓	Tom: ✓ Willem: ✗	Tom: ✓ Willem: ✗

TUDelft

Last mile (UK)

+ Cheap + Frequent - Crowded - Dirty - Limited stops	+ Autonomous shuttle - Limited routes - Trustworthiness ? On demand	+ On demand - More expensive + Privacy - More vehicles on road	+ High capacity + Cheap - Slow - No privacy - Not green
Tom: ✓ Willem: ✗	Tom: ✓ Willem: ✗	Tom: ✗ Willem: ✓	Tom: ✓ Willem: ✗

TUDelft

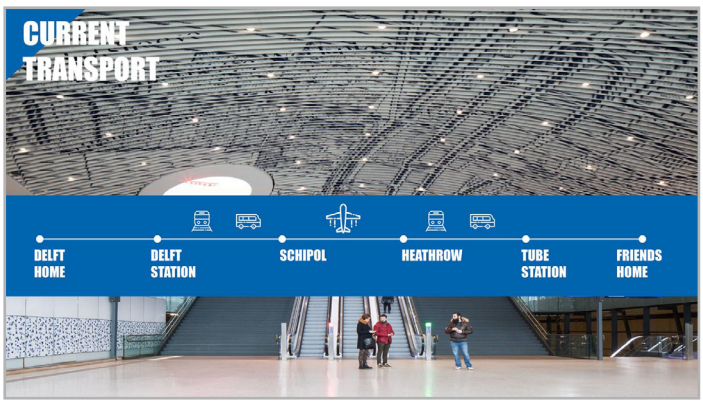
Connecting the choices

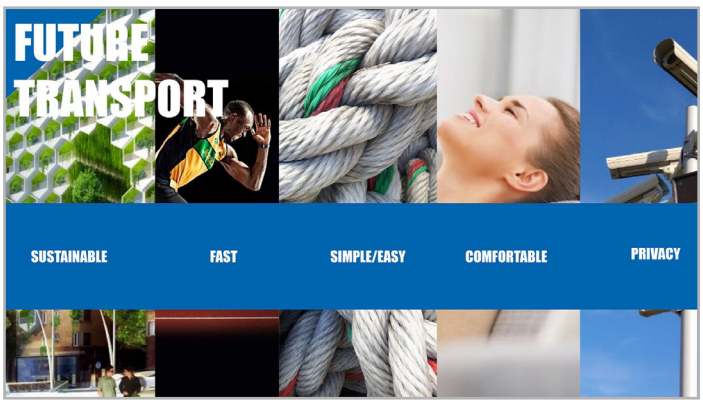
- Logistics for end-to-end luggage shipping
- Also door-to-door tickets
- Ticketing and Logistics service an offer optimized tickets for time, price
- Can account for overall system demand
- Manage trip and trip changes on the fly - always connected

TUDelft

GROUP 3

First, the journey was mapped from Delft to London. Main criterias for the solution were, that the solution should be sustainable, fast, simple/ easy, comfortable, and consider privacy.
As a solution the Embraer pod was introduced. Through a service provider, in this case Uber, a ticket could be booked for the whole journey. After booking the ticket the user just would need to get inside the pod and get outside at the arrival at its friends place, no further change of modes of transport would be necessary. The pod, the mode of transport, would have adaptable wheels for road and train routes. Also, the pod would contain a place for luggage. To make the journey seamless, the pod would enter the aircraft. The aircraft itself would not be a complete aircraft, the entering of the pod would make the aircraft appear as a whole. Both, the pod and the aircraft are electric fueled. To save weight during the journey, the battery of the pod would be removed when entering the aircraft and would get another battery in London to continue the journey as a pod. Additionally, extra services can be purchased such as luggage transport. Passenger advantages of the solution are comfort, privacy, the purchase of a complete journey ticket and the easy organization through an application.
A roadmap indicated when different features can be introduced: an AR function can be introduced in 2019, pods on rail in 2025, pods on road and a proper battery technology in 2030, and the pods on the flight in 2035.
As a conclusion it was mentioned that the solution is a sustainable design, secure, and easy and fast.





How it will work

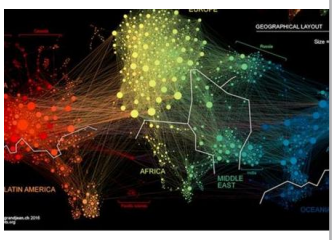
1. Book Trip
2. Get in Pod
3. Relax
4. Say hello to your friend

Pod specs

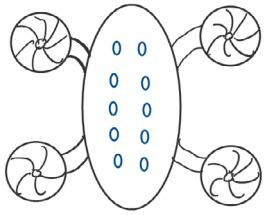
- Adaptable wheels for both rail tracks and roads
- Pod size are for 1 or 2 people. Potentially for family sizes
- Embedded connecting mechanism to the aircraft
- Passengers can check-in and do security check in the pod (facial recognition)
- Scan bags in a designated pod compartment
- Integrated scale to weigh luggage
- Communicates data in real-time to aircraft
- Removable batteries

Pod Network

- Pod deposit next to the airport
- Pods for all passenger arrive at the same time at the airport to minimize waiting time
- Once the pod leaves the passengers in the place, it goes to pick up someone else
- Points along the routes in case battery dies out



Airport & Aircraft



Society & Economy

Societal impact
- Acceptance of aircraft with pods flying overhead
- Universal design

Economy
- Ticket prices will represent the entire trip
- People will be able to buy products or services for the inflight part in pods
- Electrical battery technology already existing
- Using the existing roads, lanes and network
- Pods communication will optimize the network

Focus on passenger experience

- Comfort
  - Reclining seats
  - Climate control
- Privacy
  - Dim/ darken windows of the pod
  - Put windows down
  - Window projection (movies, places)
- Purchases
  - Partially known before flight from the pod
- The app:
  - VR capabilities similar to Google Pixel to locate pod
  - Compute arrival times

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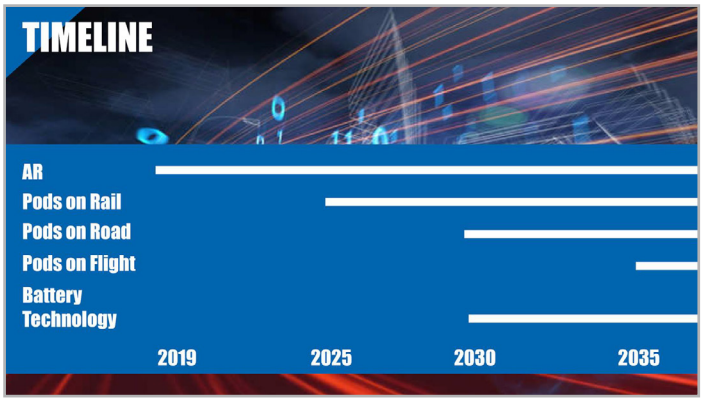
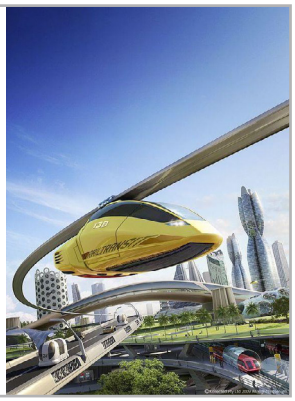


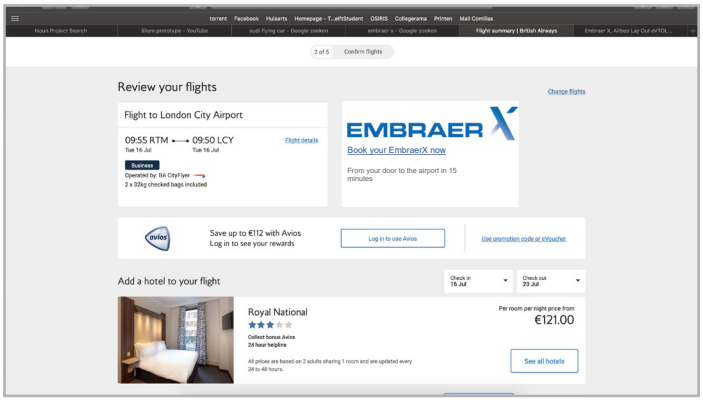
Conclusion

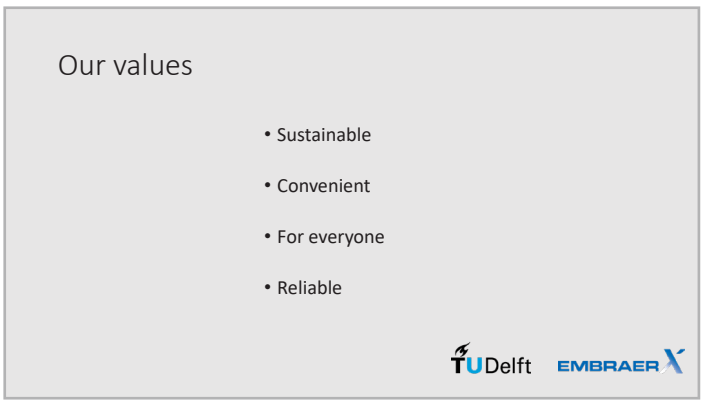
- Sustainable
- Security check done in pod
- Easy & Fast

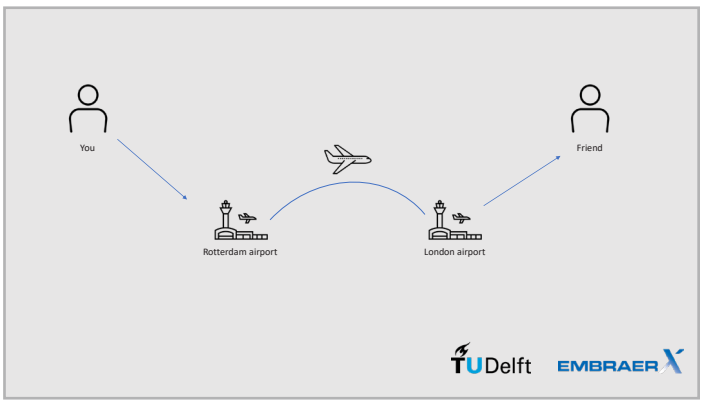


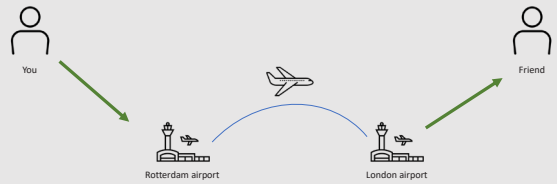
GROUP 4

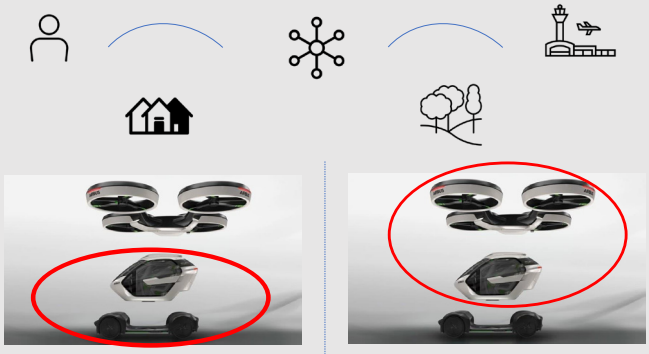
Group 4 presented an option to book a ticket online. Most likely the flight would be from Rotterdam airport as the aircraft is a small one with only 30 seats. While buying the flight ticket an additional option can be chosen of an autonomous vehicle that picks the passenger up from home. Passengers heading towards the same direction can join the vehicle. Values of the concept are sustainability, convenience, reliability, and that it is for everyone. An ideal scenario would be when one needs a mobility solution in 2035 the first option that comes up to the passengers mind is Embraer. At an Embraer pod a drone can be attached that allows transforming the vehicle into a VTOL. According to the planned roadmap, the first prototype of the VTOL can be realized in 2022. In 2027 a port is introduced at at the airport, this solution can be scaled over time.
The final solution achieves sustainability through electric flight, convenience through a modular solution, low costs through mass production, and feasibility and low risk through mature technology.









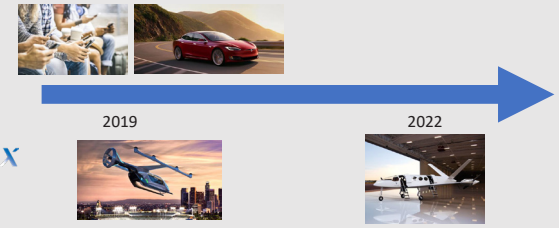


Packetized transportation

Sustainable Mobility Roadmap

1954

Timeline



What do we bring?

Sustainability?	→	Electric flight
Convenience?	→	Modular
Low Cost?	→	Mass production
Feasibility/Low Risks	→	Mature technology

A.7.1

People in **Transit** Meeting

PRESENTATIONS SLIDES

On the 11th of July, 2019 a workshop was held with stakeholders involved in the project to present the results of the master thesis and to develop the presented concept. Luciana Ribeiro Monteiro from Embraer; stakeholders from the department people in transit like Peter Vink, Suzanne Hiemstra-van Mastrigt, Yu Song; Erik-Jan Hultink as a supervisor of this master thesis, and Frederic Kindervater, who is involved with his master thesis in the collaboration between the faculty of Industrial Design Engineering and Embraer, were present at the workshop.

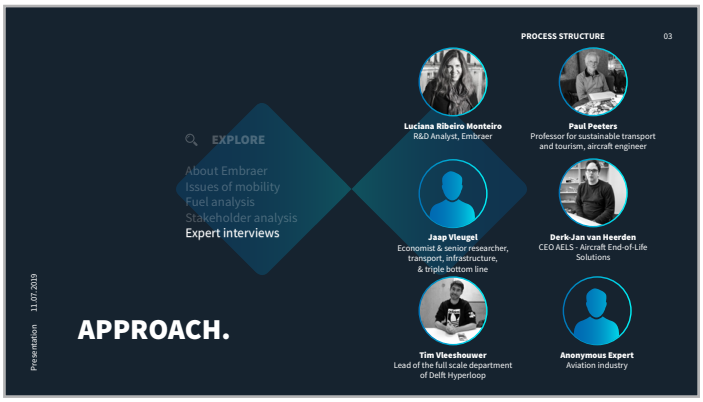
The following pages show the presentation slides, which were prepared for the meeting. First, the agenda was introduced. The goal was that the presentation was showed first and later within a workshop ideas were developed. Afterwards, Frederic Kindervater presented his master thesis results. Evaluation criteria were mentioned in the beginning of the presentation. The evaluation criteria supported recipients in evaluating the presented concept.
Furthermore, during the presentation an overview of the approach of the master thesis was given. Afterwards, the concept was introduced beginning with issues that the concept addresses. The vision should support the general idea of what the concept was about. Furthermore, a technology roadmap revealed which types of sustainable fuels will be possible in the future for the aviation industry. The final concept was mainly about going into the market of mobility-as-a-service (MaaS) and connecting the different mobility solutions with sustainable fueled airplanes. In the system of MaaS passengers shall get nudged towards sustainable forms of mobility. Additionally, the impact of travelling should be made more transparent to passengers. The last presentation slide shows the structure of the conducted workshop.

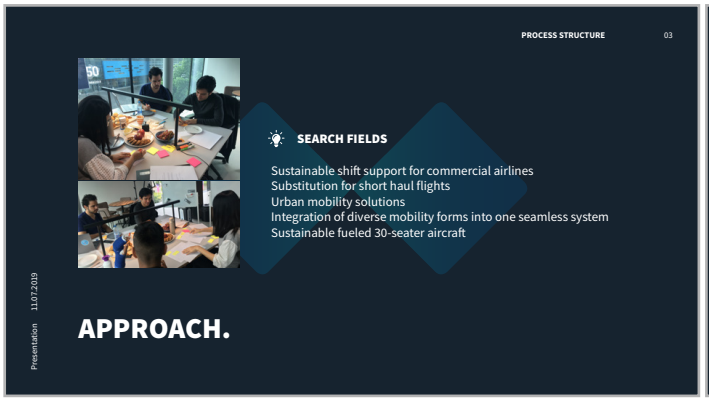
The generated ideas from the workshop can be found in A.7.2. Out of the generated ideas clusters were generated.

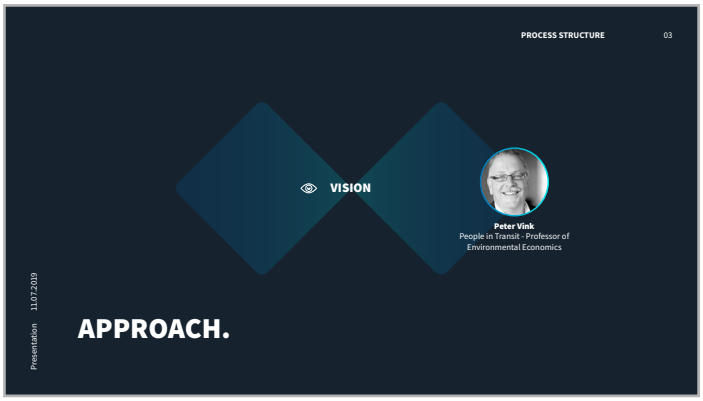

PLANNING 00
A new, more accessible and more democratic way of getting around will change the world - for the better.
- Antonio Campello, CEO EmbraerX -
AGENDA.
14:00: Arrival
14:10: Presentation Melanie
14:25: Workshop
15:00: Break
15:10: Presentation Frederic
15:25: Workshop
16:00: Closing
Presentation 11.07.2019


EMBRAER
SUSTAINABLE MOBILITY 2035.
AN INNOVATION APPROACH TOWARDS SUSTAINABLE MOBILITY
in collaboration with TUDelft


TAKING NOTES 02
Plus
Which aspects are good?
Improvable
Is there anything that needs to be improved? Are there any concerns?
Interesting
Are there any interesting elements?
EVALUATION CRITERIA.
Business Challenge 09.07.2019

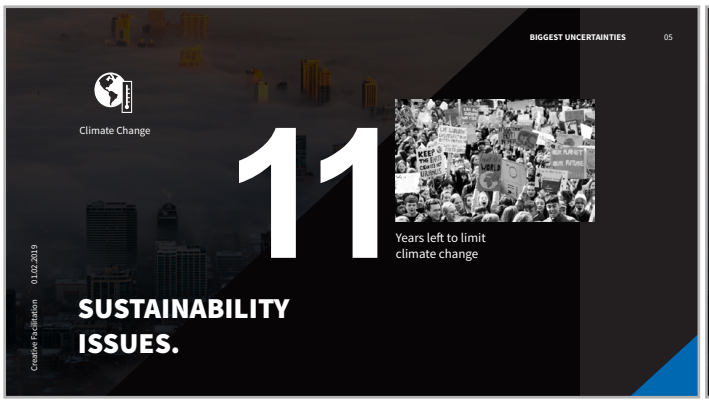

PROCESS STRUCTURE 03
EXPLORE
About Embraer
Issues of mobility
Fuel analysis
Stakeholder analysis
Expert interviews
Luciana Ribeiro Monteiro
R&D Analyst, Embraer
Paul Peeters
Professor for sustainable transport and tourism, aircraft engineer
Jaap Vleugel
Economist & senior researcher, transport, infrastructure, & triple bottom line
Derk-Jan van Heerden
CEO AELS - Aircraft End-of-Life Solutions
Tim Vleeshouwer
Lead of the full scale department of Delft Hyperloop
Anonymous Expert
Aviation industry
APPROACH.
Presentation 11.07.2019

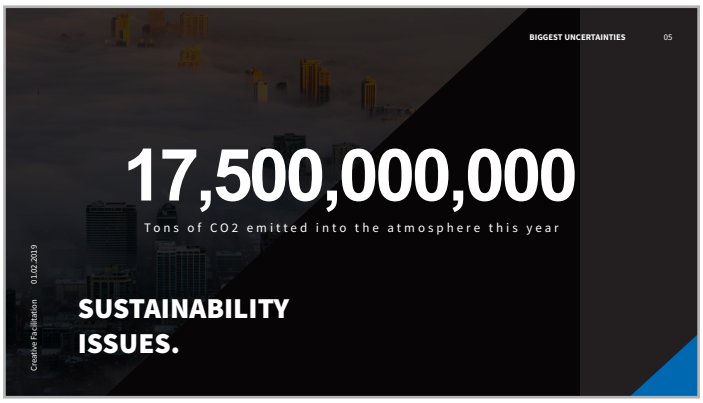

PROCESS STRUCTURE 03
SEARCH FIELDS
Sustainable shift support for commercial airlines
Substitution for short haul flights
Urban mobility solutions
Integration of diverse mobility forms into one seamless system
Sustainable fueled 30-seater aircraft
APPROACH.
Presentation 11.07.2019


PROCESS STRUCTURE 03
VISION
Peter Vink
People in Transit - Professor of Environmental Economics
APPROACH.
Presentation 11.07.2019


PROCESS STRUCTURE 03
CO-CREATION
14 students
6 different educational backgrounds
4 teams
1 day of ideation
APPROACH.
Presentation 11.07.2019


SUSTAINABILITY ISSUES 04
Climate Change
Air Pollution
Environmental Issues
Noise
Safety & Security
Congestion
Physical Inactivity
Unsustainable Resource Usage
Land Usage
Social Inequality
Spread of Diseases
ISSUES OF MOBILITY.
Creative Facilitation 01.02.2019


BIGGEST UNCERTAINTIES 05
Climate Change
11
Years left to limit climate change
SUSTAINABILITY ISSUES.
Creative Facilitation 01.02.2019


BIGGEST UNCERTAINTIES 05
17,500,000,000
Tons of CO2 emitted into the atmosphere this year
SUSTAINABILITY ISSUES.
Creative Facilitation 01.02.2019

452,138

Deaths from air pollution in cities this year

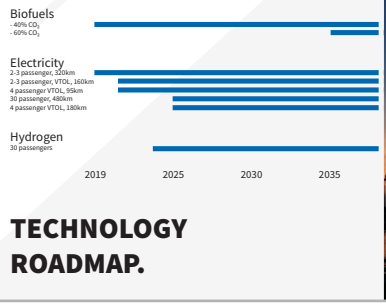
Creative Facilitation 01.02.2019

SUSTAINABILITY ISSUES.

We envision the ***vanishing of different modes of transport*** towards an ***intelligent seamless one mode transport system***. ***Sustainable impactful*** and ***emission limiting*** mobility will move you to the place, where you ***need to be***, and provides you a ***passenger experience*** that supports you in ***mastering your day***.

Business Challenge 09.07.2019

VISION.



Business Challenge 09.07.2019

TECHNOLOGY ROADMAP.

Missing Experience
Sustainable Fuel: Electric - Hydrogen

Missing Infrastructure
Sustainable Fuel: Electric - Hydrogen

Collaboration
Sustainable Fuel: Electric - Hydrogen

Business Challenge 09.07.2019

SUSTAINABLE CHANGE.

9,200

billion dollar in 2030 (MaaS) growing market

Presentation 11.07.2019

SYSTEM SOLUTION.

BEHAVIOUR CHANGE

Nudging towards sustainable forms of transport

Displaying sustainable impact

Presentation 11.07.2019

SYSTEM SOLUTION.

- **14:25:** Creating H2's
- **14:30:** Ideating on H2's
- **14:45:** Discussion/ Deciding
- **15:00:** Break

Presentation 11.07.2019

WORKSHOP STRUCTURE.

A.7.2

People in **Transit** Meeting

WORKSHOP IDEAS

BEHAVIOUR CHANGE

- How to stimulate travelling in a sustainable way?
- Help end users make the best choice (systems for the complete journey)
- How to stimulate self-satisfaction?
- How to nudge more sustainable behaviour?
- Nudge people towards „better choice“

RAISING AWARENESS

- How to make people aware of consequences of their behaviour?
- videos
- displays
- advertisement
- Make aware hoe much burden your planned travel is for the world.

INCENTIVES

- How to motivate us?
- financial incentives
- personal incentives --> related to family/ friends
- give people a sustainability budget; max. number of flights/ travels per year
- collect bonus points for cleaner travel options
- use gamification to nudge cleaner travel

PUNISHMENT

- How to punish?
- additional costs for less sustainable options

CHOOSING A CONCEPT/ MOBILITY MODE

- H2 compare alternative modes of transport?
- How to establish measurable criteria?
- How to know what the major direction of mobility development is
- price/ time/ sustainability
- personal preferences: what you find most important: personalized advice
- ‚dashboard' with ratings for each criterium
- provide info on carbon footprint for each option per km/ overall
- set a concrete „target" and optimize based on collected „data"
- make differences between different concepts explicit
- biofuels vs. electricity vs. hydrogen: how to choose?
- choosing mobility: economics/ speed - sustainability - price - comfort
- from cradle-to-cradle --> analyze the whole cycle
- e.g. CO_2 emissions
- How many people can be reached
- journey as a whole
- what: to make a tangible footprint for transport users
- why: there is a lack of info between many actions and my environmental footprint implications
- show the profit of a turboprop vs. a jet

COLLABORATION

- How to achieve collaboration: electric <--> hydrogen
- Forming a consortium group around a common objective
- Collaboration is unequal to actions/ municipality, cars, trains, metro, ... newtech suppliers)
- With companies that are working in that field
- Government (getting subsidies - enforce laws + regulations)
- Aviation industry --> problem: aviation industry is not acting due to competitors

SEAMLESS SYSTEM

- How to reduce walking distances to a minimum
- How to seamlessly go from one to another mobility mode
- How is this related to a seamless travel experience?
- to improve before and after the flight
- can we think about „better experience" of the system by „controlling" „Crucial" nodes of the system
- recognize people and automatically have next modality available (át the platform)
- a travel advisor which is able to „intelligently" predict
- because bad experiences have an impact on the whole journey
- by bicycle to/ from a sustainable airplane

FURTHER ADVICES/ TIPS

- Be sustainable now and not only in the future (create the positive sustainability sensation now)
- Make use of current infrastructure and fiind a balance with new developments (consider the movement into autonomous electric vehicles)
- Have a concrete case (start with an example A-->B and show where it can be made more sustainable and then make the infrastructure)
- Create a better brand experience (How to enhance and create a better brand experience)
- Segment different travellers (how to segment different travellers e.g. business travel, tourism)
- Iterate quickly
- Roadmap: identify the main aspects that will influence mobility in the future, considering the benefits for poeple (society)
- vision A to B: as a solution is linked to a case
- value proposition --> your statement
- --> concept solutions from idea generation --> technical validation in regards to TRL
- Dow we want the journey or the plane to be sustainable?
- from cradle-to-cradle --> analyze the whole cycle
- Consider is unequal to customers needs
- connect airline to airplane manufacturer to end user and engine manufacturer
- How to deal with complexity e.g. dynamics in the system
- How to integrate new mdalities sucj as the Hyperloop (modular transport system)
- why: there is a lack of info between many actions and my environmental footprint implications

A.8.1

Initital Idea

ROADMAP SOLUTION

An initial idea and roadmap was developed that will be presented here. Later experts evolved the idea. The learnings of the idea development can be useful for Embraer for future projects and to avoid mistakes.

THE IDEA

MaaS is a growing future market estimated to be 9,500 billion dollar worth in 2035. Instead of getting product orders from MaaS providers and being passive, Embraer actively goes into this market and determines its future direction itself.

When travelling a route, e.g. from Delft to London, often different modes of transport need to be used: car, train, aircraft, tram system in London, bus, and further modes of transport. Through MaaS the change of different modes of transports can get better connected and create a smoother passenger experience. MaaS considers the whole journey instead of one mode of transport and creates therefore a smoother passenger experience. Connecting the experience of different modes of transport means also having a competitive advantage towards aircraft manufacturers like Airbus, Bombardier, Boeing, who don't seek to go actively in this field.
Through the mobility service the passenger receives a door-to-door ticket, which eases up its journey. Furthermore, through a mobility system solution passengers can get nudged to more sustainable forms of transport and act in a sustainable way. Currently, passengers are open towards sustainable behaviour, but face difficulties in acting sustainably

Through the MaaS subscription the passenger gets nudged towards sustainable mobility solutions and away from car ownership. This happens for example through the following strategies
financial incentives, making sustainable mobility options financially more attractive
sustainable mobility options are shown to the user first, and then further mobility options appear
range of mobility combinations shall appear more attractive than car ownership
the service supports you in avoiding congestion and in getting a more seamless experience

The more a user makes use of the system the cheaper it gets for him/ her in total.

As an aircraft manufacturer, Embraer will continue using its expertise in manufacturing airplanes, and also uses its strength in commercial aviation in the segment of 30-seats (or less) aircrafts in the MaaS system, which only benefits Embraer and not Boeing to establish a new and stable revenue stream. New technologies of sustainable fuels create new market opportunities for Embraer that support Embraer in avoiding the risk of potential political interventions such as taxes on kerosene fueled aircrafts. Also, Embraer can act against the image damage of the aviation industry of not being sustainable. The image damage is a high risk for Embraer, the frequent flyer nation Sweden even introduced the neologism 'Flygskam' to shame people, who fly, and create a habit of avoiding the aviation industry (Banis, 2019).

As kerosene flights are currently substituted as much as possible (e.g. through high speed trains), sustainable fuels can be used for sustainable short haul distances. Throughout the years a wider flight range can be achieved and the sustainable impact can be increased.

Furthermore, Embraer can use its strength in stakeholder management and add value as an aircraft manufacturer in MaaS in managing different stakeholders such as mobility providers, governmental collaboration, or support in improving the infrastructure for a more seamless experience.

Financial governmental support for achieving the goal of a sustainable mobility system is possible since it is a goal of the government to enable a better and more sustainable mobility infrastructure and behaviour.

The whole strategy is divided into 3 horizons and uses examples of the European market as a possibility of market introduction. The horizons serve to increase the sustainable flight range over time and to support consumers in creating a habit to achieve an impactful mobility system solution.

HORIZON 0 (NOW)

Acting now & Preparing for a Future of Sustainable Mobility

The horizon begins in 2025 for the reason that it takes 5 years to manufacture an aircraft according to the expert interviews. However, already now a sustainable impact can be achieved.

Embraer can make use of social and environmental suppliers and sustainable materials to build their aircrafts. The sustainability impact of the materials can be measured through a life cycle analysis (LCA), and later be used to communicate the sustainability y impact towards customers. Through sustainable materials, the risks of scarcity of resources and harmful emissions through low environmental impact materials can be avoided.
Also, recyclability should be considered. It is possible to recycle at least 90% of an aircraft (Delgado Gozalvez et al., 2018). Recommendable companies that recycle are for example AELS (Aircraft End-of-Life Solutions) and the Rotterdam based company VerdraaidGoed.

Collaborations with universities and research institutions should be further pursued to develop technologies such as electric and hydrogen propulsion to prepare for the coming horizons and a sustainable future.

HORIZON 1

A More Relaxed & Seamless Experience

Figure A.7_1: VTOL distance range

In the first horizon the customer gets introduced towards the MaaS service. Embraer can use its connection to Uber to be part of a MaaS system.

The passenger gets a ticket from door to door including the modes of transports, that he/ she needs. In case, the passenger stays for some time at the final destination he/ she can pay additionally for the mode of transportation he/ she would like to use for a limited or unlimited period of time. It is always possible to upgrade the MaaS subscription.

Since Embraer aims to launch its eVTOL around 2025, the company should also start with this sustainable product. A value enhancement of the eVTOL is established in integrating it into the MaaS system. As the eVTOL is established into the system the passenger gets aware also through further products about the eVTOL offer. Furthermore, Embraer will be able through the eVTOL to gain experience in the field of electric propulsion and prepare for the next horizon.

Through the eVTOL sustainable mobility up to a distance of 195 km is possible (Holden & Goel, 2016). Distance like from Amsterdam to Brussel (Belgium) will be possible within this flight range.
In the journey from Amsterdam to Brussels, the passenger would need to switch the train connection several times to arrive to its final destination. Through the eVTOL the experience would get more seamless and be quicker.

Inside the VTOL a display indicates how much fossil fuel could already be saved in comparison to other modes of transportation through flying with the VTOL. This display supports in raising awareness and making passengers more conscious about sustainable forms of mobility

HORIZON 2

Nudging Towards a Sustainable MaaS System with Electric Flight

Figure A.7_2: 30-seater electric aircraft distance range

Embraer continues with mobility as a service. From the eVTOL Embraer expands to a 30-seater aircraft for short haul flights, and increases to a sustainable flight distance range of 485 km (Misra, 2017), e.g. connecting the distance Amsterdam to London and replacing kerosene flights on this distance. Currently, electric flight is a growing market (P&S Intelligence, 2019), and the demand for it is getting higher. Norway for example aims to cover its flight demand through electric airplanes (Dowling, 2018). Additionally, the British low-cost airliner EasyJet plans to have electric flight already in 2030 (Kolirin, 2018). On top of that, in case Embraer does not go into the direction of electric flight, the aircraft manufacturer might lose customers. The airliner JetSuite, who is a client of Embraer, bought 100 electric planes from Zunum, a startup that is supported by Boeing. Embraer might lose customers like JetSuite through this development if not going into the direction of electric propulsion systems (Goldstein, 2018).

Because the flight duration is longer than the one of eVTOLs, Embraer can establish screens inside the aircraft and provide an entertainment programme to create a more pleasurable passenger experience. Social trends like watching films on Netflix even can get integrated into the experience or even the use of Snapchat filters for taking pictures. A collaboration with Netflix could lead to the development of series that only can be seen when using Embraer's mobility service.
As the passenger used a subscription in the first horizon in the second horizon the user data from the first horizon can be used to reveal to the passenger, how much sustainable forms of transport he/ she used. Through sustainable milestones the passenger gets rewarded and new entertainment features, e.g. a new series get opened up to the passenger, which otherwise would cost additional money. Screens with the same entertainment feature also will be provided at further modes of transport e.g. trains to nudge passengers to the MaaS system.

For customers, who prefer a higher comfort level premium seats in the aircraft are offered.

Through a more pleasing and a more comfortable experience passengers are getting nudged towards the MaaS system instead of car ownership.

To achieve sustainability passengers should be aware of their travel behaviour and rather travel when it is rather necessary. For this reason, promotional campaigns are addressed mainly to the target group of people, who travel to visit relatives or friends.

HORIZON 3

A Smart Autonomous System

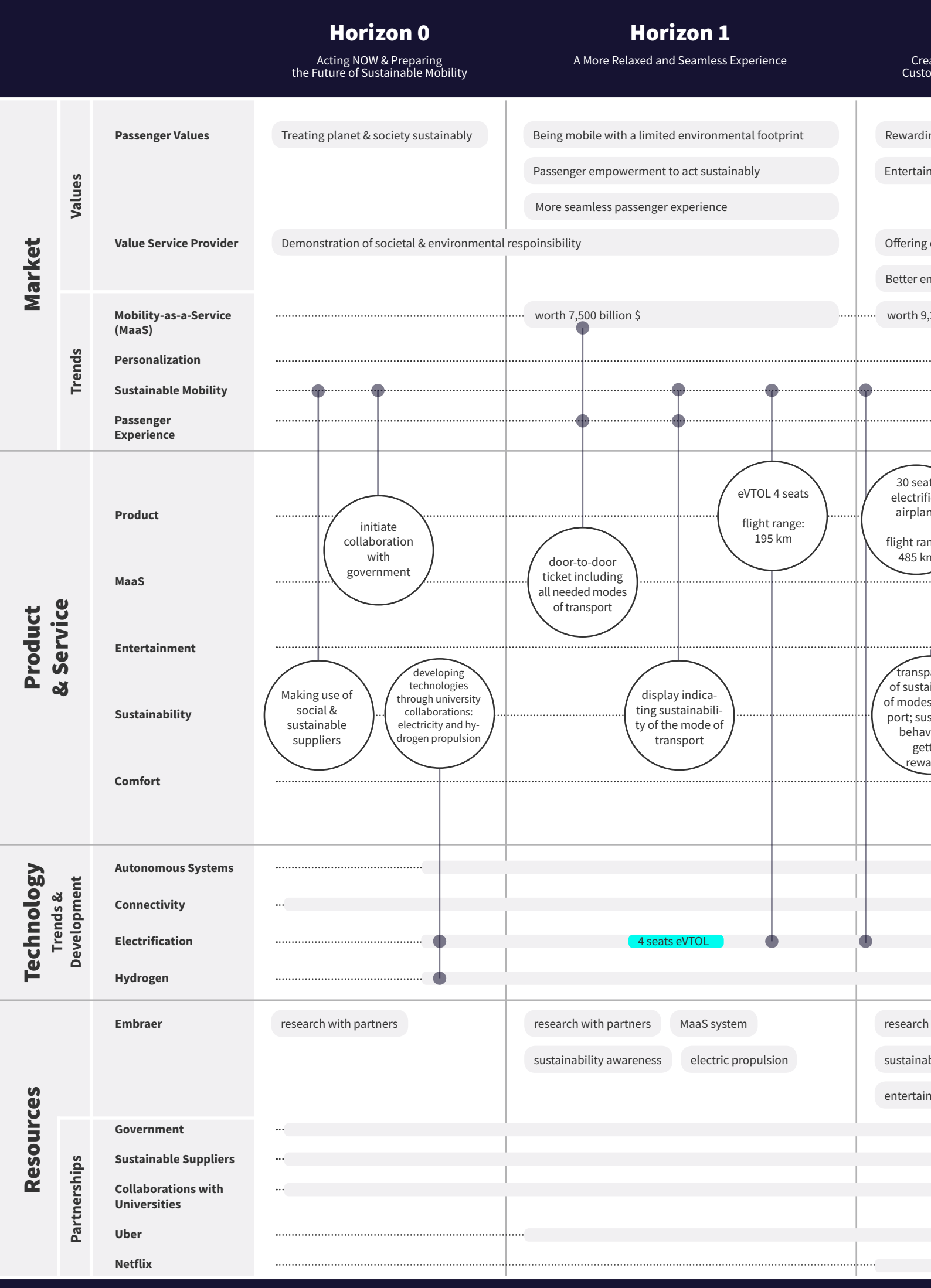
Figure 7_3: 30-seater hydrogen aircraft distance range

In 2035 Embraer launches its first 30-seater hydrogen aircraft. Still the route from Amsterdam to London is flown, but through the hydrogen propulsion larger routes up to 1000 km (Delgado Gozalvez, 2018) and even commercial supersonic aircrafts (Brewer, 2017) are now possible. While electric propulsion might rather take a place in the market of short haul flights due to the battery capacities, hydrogen is really light weighted and is mentioned by experts as the ideal future aircraft fuel (Fuel Cell Norway, 2006). Due to the current energy consuming production process of hydrogen and the price competition with kerosene the fuel can rather be expected on the commercial market by 2035. As hydrogen is the most common element in the universe there is also no issue with scarcity of resources (Sürer & Arat, 2017). In the future hydrogen airplanes even with 800 passengers are expected (Carrington, 2015).

Regarding the social aspect of the MaaS system users should in the third horizon be acquainted with MaaS.

Through autonomous luggage transporting assistants the journey will be made even more comfortable for better paying customers to still provide advantages in comparison to vehicle ownership.

Autonomous systems and cars will be more and more integrated in the system. The different modes of transports will be digitally connected and communicate to achieve a better connection time and a lower congestion rate.


Horizon 0
Acting NOW & Preparing the Future of Sustainable Mobility
Horizon 1
A More Relaxed and Seamless Experience
Market
Values
Passenger Values
Treating planet & society sustainably
Being mobile with a limited environmental footprint
Passenger empowerment to act sustainably
More seamless passenger experience
Value Service Provider
Demonstration of societal & environmental respoinsibility
Trends
Mobility-as-a-Service (MaaS)
worth 7,500 billion $
Personalization
Sustainable Mobility
Passenger Experience
Product & Service
Product
initiate collaboration with government
door-to-door ticket including all needed modes of transport
eVTOL 4 seats
flight range: 195 km
MaaS
Entertainment
Sustainability
Making use of social & sustainable suppliers
developing technologies through university collaborations: electricity and hydrogen propulsion
display indicating sustainability of the mode of transport
Comfort
Technology
Trends & Development
Autonomous Systems
Connectivity
Electrification
4 seats eVTOL
Hydrogen
Resources
Embraer
research with partners
research with partners
MaaS system
sustainability awareness
electric propulsion
Partnerships
Government
Sustainable Suppliers
Collaborations with Universities
Uber
Netflix
now
2025

Horizon 2

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mers Making Sustainable Conscious Choices

Horizon 3

A Smart, Sustainable & Seamless MaaS System

ng experience

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entertaining experiences

mbedment in infrastructure

200 billion $

Comfort

Quick & conscius mobility

System efficiency

worth 9,500 billion $

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building a more connected infrastructure

screens inside the aircraft for entertainment offer

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promotional campagne addressing people that travel to see friends or relatives

more comfortable seats for premium customers

autonomous luggage assistant for premium customers

AI calculating the most efficient and energy saving route

autonomous mobility forms integrated into MaaS system

30 seats hydrogen airplane

flight range: 1000 km

autonomous systems in MaaS

30 seats aircraft

30 seats aircraft

with partners

MaaS system

bility awareness

electric propulsion

ament offer

research with partners

MaaS system

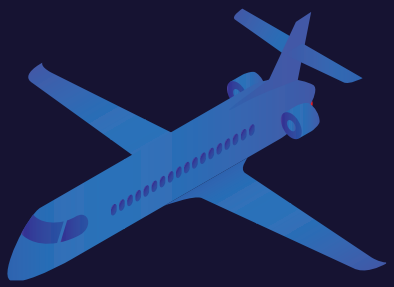
sustainability awareness

hydrogen propulsion

entertainment offer

intelligent systems

We envision the vanishing of different modes of transport towards an intelligent seamless one mode transport system. Sustainable impactful and emission limiting mobility will move you to the place, where you need to be, and provides you a passenger experience that supports you in mastering your day.



2030

2035

A.8.2

Initital Idea

DEVELOPMENT

The initial idea has mainly been discussed with Paul Peeters and was then further developed. Further experts that were involved in the idea validation process were presented an already developed idea. The findings of further experts were already presented in chapter 8.1 in the master thesis. In order to know why the initial idea had to be developed some quotes and further insights of Paul Peeters were clustered and can be found in the following text. The learnings from the talk with Peeters (2019) help Embraer to avoid mistakes.

QUOTES & INSIGHTS PAUL PEETERS

Electric aircrafts of 20+ passengers won't be there in 2030

- Not necessarily. It's economically technically easier to achieve such an aircraft in 2030, than a better battery based one because that will simply not be there. Not at the size of say 20 plus passengers.
- The easyJet example. It's it's just political, they say it has nothing to do with reality. And then know that there will be there will be no electric aircraft by 2030.
- Norway's the same problem, they Well, they hope to have it in 2040. Okay, they have delayed it already because of doubts about the viability of the battery. But it doesn't help them? Because there is no reason why it should be a bit related. If, because we cannot tell what kind of battery should be the lithium batteries, most likely, theoretically not able to do it. We must go to something else. But might be the lithium air battery, but there are so many problems at the moment is that concept in terms of reliability.

Time Pacing: don't develop every five years a new aircraft, this would only be possible for VTOLs (smaller aircrafts)

- And then five years? Well, it's doable for small aircraft. But it's certainly not for airliners anymore. They take more time, and you cannot do it. One reason that the, for more focus aircraft factory went bankrupt, was that they try to do such to such projects at the same time. It was difficult 5085 100 and those were derivative. So they were not completely new aircraft, but just an extension, so forth, of existing products, and even that killed them. So don't think too late about this.
- But I don't know, the electric VTOL, of course, those are smaller aircraft and much more project in terms of the total investment you need. So then you can do it. But if you do, at the same time, several new aircraft in the range of 30 to 100 passengers, then you run into trouble.

Horizon 1
Create electric busses or trains

- They go they use their experience with this construction of vehicles.
- Could be a vehicle to get the experience in, a quite cheap way. It's not too expensive to develop such a bus compared to an aircraft, I mean, it's probably 10 times less investment. So that could be that could be one route.
- But the other route is that if they want to have an aircraft doing the same market, they run a risk just from societal issues. And so political issues. First, there are solutions for those distances to run under 100 and 200 kilometers, that do work already that are zero emissions. Busses will be much cheaper. So you serve a much broader part of the society than you can ever do with aircraft.
- But why not learning from them? They have the experience already, they know what is on the market in terms of fuel cells. What works, what doesn't work. What the problems are, the reliabilities, they measured that, they have operational experience. All those big announced currently in aviation for such a fuel cell hydrogen aircraft, they have at least experience on the road with. So that can be very helpful to to assess if such a design would make sense and what you would need to make that a commercial thing.
- There, there are two types of hydrogen busses some that use the hydrogen combustion engine. So that helps quite a lot. It certainly helps if the hydrogen is based on on sustainable electricity in the production. But it doesn't. Well, it doesn't help so much for air quality issues. Though, of course, a diesel engine is much worse than an engine running on hydrogen.

- Melanie Rumpf:
And maybe for the first horizon, just rather, go into technologies. which are already existing. So maybe not electrical VTOL, but maybe busses or trains, which might be easier for the development, for the second horizon the fuel cells….
Paul Peeters
.. or at least try to learn from those projects by collaborating.

Sharing technologies - Wind energy might interesting as electric development for an aircraft manufacturer to look into
- Aerodynamics is very important in wind development. And they could have done something there. constructions, the same, those blades must be fairly lightweight and very strong. So you could have that pressure is a big issue, which is also an issue in most aircraft designs they could have done things there. They had the technology and the knowledge on the table.
- Come into contact with these bus manufacturers and try to share some technologies.

Suggestion for the 2nd horizon

- You can also assume, as a first step, hydrogen, kerosene based fuel cell, or another form of liquid fuel. So that there could be an alternative to convince them, it‘s okay, if you‘re afraid of hydrogen, skip that. And take something else. And that simplifies the design. … Shave off like 40-50% of the total emissions per passenger kilometer. So still worth to do it. And if you have done that, the step towards hydrogen is not that big anymore.
- I mean, if they look at the students project, it‘s exactly what they are producing at the moment, exactly the same type of aircraft. It‘s their market.
- I think the best thing that could deliver the world in terms is this fuel cell based airliner, if they are able to create it, that I think they‘ve really helped the world forward.

Having a prototype fuel cell airplane in 2030
- And yeah, in fact, if you do the thing in the right way, you could get to you the prototype into the market.
Melanie Rumpf
Okay, so in 2030, the prototype and then 2035, maybe the commercial available airplane.
Paul Peeters
Yeah. Start with a small one.
Hydrogen and fuel cells are not developed before 2025
Even for those, the hydrogen and fuel cell option should be taken on board, and maybe it‘s not developed before 2025? That‘s, you not gonna have started to develop the technology you need. And of course, the electrical part is still the same.

Drivers
- Dutch government being interested in hydrogen airplanes
I know that for instance, in the in the Netherlands, the Dutch government, the Ministry of Economic Affairs, they have discussions also with these guys. Because they really take it as a very serious proposition.

How to realize it
- And of course, if if I were in charge of an aircraft factory, I would have at least two teams working on this, and one developing the hydrogen variant, the other one with kerosene with fuel cells, and maybe a third one that does the battery one.
- Considerations: “And, of course, criteria cost. Is the technology available? Can we do it now? Or do we do have to wait for others to to develop the technology? And how about safety and that sort of thing?” And then you will learn that probably the hydrogen is not so not so bad.

Partnering up for realization
- So the I mean, the the challenge to have electric engines that are working in, in aviation is is the same for both if it‘s not, depending on whether you use a battery or a fuel cell. So maybe you should split it in different development pathways. The first one is the electric engine. And, of course, every cannot do that themselves. But they could cooperate with electric engine factory like Siemens or other ones.
And then for fuel cells, you need another partner and for battery still another one. The airframe that’s what Embraer has to do themselves.
But they can do that, they have a lot of experience in that field.

There is a risk of looking into VTOLs
- Well, probably not. So then the other route is for is they they are taking a risk if they go into a market where so many competitors are already established. And that‘s the very short whole market of taxis, that sort of thing.

Appendices
Melanie Rumpf