



**UHASSELT**

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## School for School of Transportation Sciences

Master of Transportation Sciences

### **Master's thesis**

***The Aviation vs. High-speed Rail Debate. A Study on Sustainable Business Travel at Hasselt University***

### **Maxime Walczynski**

Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences, specialization  
Mobility Management

### **SUPERVISOR :**

Prof. dr. Elke HERMANS

### **CO-SUPERVISOR :**

Prof. dr. Robert MALINA



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## Preface

As a hopefully soon-to-be graduate master student at the School of Transportation Sciences, specialisation Mobility Management, at Hasselt University, I chose to devote my master thesis to the dilemma between air travel and high-speed rail in Europe and also to how UHasselt can develop a sustainable business travel policy.

During my academic career, I have lived abroad twice. In Prague I studied at the Czech Technical University for one semester and in Berlin I was an intern at KCW GmbH. During these wonderful experiences I had several friends from Belgium who came to visit me, all with very cheap Ryanair flights. Then, during summer 2018, a friend of mine and I made a marvellous trip along the Trans-Mongolian Railway, all the way from Saint-Petersburg to Shanghai. I spent more than 130 hours in a train and I absolutely loved it. Especially the train ride from Beijing to Shanghai struck me: we travelled more than 1300 km in about 4 hours 30 minutes. These international experiences triggered something inside me: I soon started to fantasise about a complete, functional European high-speed rail network and a lot of questions on how our long-distance transport system in Europe is as it is popped up.

I started connecting the dots for this thesis when browsing the Internet: I noticed several universities have strategic sustainability plans in place, including a chapter on sustainable (business) travel. On the contrary, my own university, UHasselt, has none of those policies. By linking my strong interest in aviation and high-speed trains to the absence of sustainable travel policy at UHasselt, I decided that these topics should be the subject for my master thesis.

Maxime Walczynski

Diepenbeek, 24<sup>th</sup> of May 2019



## Acknowledgements

Throughout the writing of this thesis I have received a great deal of support. I would like to thank my promotor professor Hermans and my co-promotor professor Malina, whose expertise and feedback helped me to not stray of topic and develop my methodology.

Next, I would also like to thank Miss Lambrechts from the internationalisation office who helped me get approval for the topic and who gave her feedback on my recommendations.

I would also like to thank Miss Vandeveldde from UGent for providing additional information and professor Govers from KULeuven to take part in an interview.

I would also like to thank Jesse for the support with the SPSS data analyses and Pieter for the occasional language assistance.

Lastly, I would like to thank my friends to help me develop this idea and of course their support. Not to mention my parents, especially my mom, for being interested and opening new perspectives when I did not see the forest for the trees before the first deadline in December.



## Abstract

The purpose of this thesis is twofold: (1) investigate the current discord between high-speed rail services and air services in Europe and (2) examine how Hasselt University can reconcile its international focus and subsequent European business travel with the urgent need for climate change mitigation.

Firstly, a literature review discusses the concepts 'internationalisation', 'sustainability' and their interrelation. It continues by discussing several indicators that illustrate the existence of a discord between air transport and high-speed rail. The next chapter consists of an operational environmental comparison of both modes: it proves that from a traveller's perspective it is always 'greener' to travel by high-speed rail as its CO<sub>2</sub> emissions per passenger-kilometre are 3-9 times lower than those of travel by air. The literature review continues by identifying historical dynamics, economic policy and environmental policy that have contributed to the existence of the discord. Historically, technological revolutions and a fast-paced globalising world have favoured the use of aviation. Regarding economic policy, different paces of deregulation and standardisation towards the Single European Transport Area reinforce the discord. Regarding environmental policy, both modes are attributed an important role towards a future low-carbon Europe. However, limited policy developments so far subvert the competitive position of high-speed rail, while reinforcing the position of aviation in the discord. The literature closes off with an overview of strategies that can be taken at a European level in order to resolve or mitigate the negative outcomes of the discord.

Secondly, international business travel at UHasselt is investigated. Several other European universities' business travel policies are explored, after which a survey was designed. This survey was distributed among UHasselt staff and served to investigate and quantify (the impact of) their European business travel in 2018, as well as their attitudes towards sustainable business travel measures. Several interesting figures were found e.g. 60% of the 336 staff members who took part in the survey travelled in 2018, doing on average 3.2 business trips within Europe, of which 66% to cities within the 800 km sphere of influence of Hasselt. Also, only 4% of those business trips is done by HSR, whereas air travel accounts for 84%. The latter also makes up for 80% of CO<sub>2</sub> equivalent emissions from European business travel. Eventually, based on the survey results, this thesis suggests a number of recommendations for Hasselt University so that it can reconcile its international academic perspective with the climate goals determined in the Paris Climate Agreement of 2015.





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## List of abbreviations

AJF	Alternative Jet Fuel
CEF	Community of European Railway and Infrastructure Companies
CO <sub>2</sub> e	CO <sub>2</sub> equivalent (glossary)
CIWL	Compagnie Internationale des Wagon-Lits
Δ	Delta (difference)
EASA	European Aviation Safety Association
EATM	European Air Traffic Management System
EC	European Commission
ECA	European Court of Auditors
EEA	European Environment Agency
ERA	European Railway Agency
ERAA	European Regional Airline Association
ERTMS	European Rail Traffic Management System
ETS	Emission Trading Scheme
EU	European Union
FAB	Functional Airspace Blocks
GHG	Greenhouse Gases
GWP	Global Warming Potential
HSR / HST	High-speed Rail / High-speed Train
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IPCC	International Panel on Climate Change
KiM	Kennisinstituut voor Mobiliteitsbeleid
LCA	Life-cycle Assessment
LCC	Low-cost Carrier
LTO-cycle	Landing and Take-off cycle
PPP	Public-Private Partnership
RF	Radiative Forcing
SES	Single European Sky
SESAR	Single European Sky ATM Research
SG	Strategic Goal

TEE	Trans-European Express
TEN-T	Trans-European Transport Network
TGV	Train à Grande Vitesse
UIC	International Union of Railways
UN	United Nations
VC	Videoconferencing
WCED	World Commission on Environment and Development
WTP	Willingness-To-Pay
WW	World War

## Glossary

### **Cabotage**

Cabotage is the transport of goods or passengers between two places in the same country by a transport operator from another country.

### **Carbon-neutral growth**

Where the same amount of carbon dioxide is emitted year on year. For the aviation industry this means being able to continue to increase passenger traffic and aircraft movements, while keeping aviation industry emissions at the same level.

### **CO<sub>2</sub> equivalent**

The expression that describes different greenhouse gases in a single unit. For any quantity or type of greenhouse gases, CO<sub>2</sub>e signifies the amount of CO<sub>2</sub> which would create the same warming effect.

### **Drop-in fuels**

A substitute for conventional fuel that is completely interchangeable and compatible with conventional fuel. A drop-in fuel does not require adaptation of the engine, fuel system, or the fuel distribution network and can be used "as is" in currently available engines in pure form and/or blended in any amount with other fuels (US Department of energy, 2018).

### **High-speed train**

High capacity and frequency railway service achieving an average speed of over 200 km/h. The European Union adds an element and foresees three types of high-speed railway lines. The first type consists of lines exclusively constructed for high-speeds exceeding 250 km/h. The second type consists of upgraded conventional railway lines that allow speeds of 200 km/h as a minimum. The third type also consists of upgraded conventional railway lines, but with operational speeds below 200 km/h in order to overcome certain topographical issues (Givoni, 2006; EU, 2010).

### **Gauge**

The gauge of a railway track is defined as the clear minimum perpendicular distance between the inner faces of the two rails (Railssystem.net, 2018).

### **Global warming potential**

The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO<sub>2</sub>). The larger the GWP, the more that a given gas warms the Earth compared to CO<sub>2</sub> over that time period. The time period usually used for GWPs is 100 years (US EPA, 2016).

### **Greenhouse gases**

The gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>) and ozone (O<sub>3</sub>) are the primary greenhouse gases in the Earth's atmosphere (IPCC).



**Internationalisation**

the process of integrating an international, intercultural, or global dimension into the purpose, functions or delivery of postsecondary education (Brubacher, 1982).

**Low-cost carrier**

An air carrier that has a relatively low-cost structure in comparison with other comparable carriers and offers low fares and rates (IATA).

**Life cycle assessment**

A method for the environmental assessment of products and services, covering their life cycle from raw material extraction to waste treatment (Widheden, Windström; 2007).

**Sustainable academic internationalisation**

The process of contributing to a fairer and healthier global ecosystem for today as well as for the future, by actively acquiring or spreading knowledge beneficial to society in an academic context, outside one's own country in a way that does not negatively impact the global ecosystem.

**Sustainable development**

meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them (WCED, 1988).

**Passenger-kilometre**

Abbreviated as 'pkm', passenger-kilometre is the unit of measurement representing the transport of one passenger by a defined mode of transport (road, rail, air, sea, inland waterways etc.) over one kilometre (Eurostat, 2018).

**Water vapour feedback**

Increased water vapour leads to higher temperatures, which causes even more water vapour to be absorbed in the atmosphere (NASA, 2008).

## Introduction

Academic internationalisation is not a recent phenomenon: the European Erasmus+-programme is named after Desiderius Erasmus, a Dutch philosopher and humanist from the 15<sup>th</sup> century who at the time visited several universities across the continent. In the 21<sup>st</sup> century however, the increasing international orientation of universities conflicts with the urgent need to reduce carbon emissions in order to mitigate the worst outcomes of climate change. All too often, academics and scientists travel to conferences or meetings by airplane. Paradoxically, universities and the scientific community are the forerunners of sustainable development. Hence, the academic world should practise what it preaches by minimising the environmental impact of its ever-increasing international focus. Several universities, both Belgian and foreign, have well-elaborated sustainability strategies in which they, among other things, prescribe stringent rules regarding business travel. The principal goal of these policies is the reduction of greenhouse gas emissions generated by university-related business travel. Hasselt University on the contrary does not have a clear policy yet.

The pointed-out discord between academic internationalisation and sustainable development is tied in with the trendy aviation versus high-speed rail debate. In 2018, a time of worldwide youth protests advocating for more climate action, a new word was added to the Dutch dictionary: *'vliegschaamte'* (English: shame of flying). It is defined as the shame someone experiences when he uses air transport as a mode while there are other, more environmentally friendly modes (Den Boon, 2018). The creation of this word indicates the growing awareness of the burden that the thriving aviation industry comes with. Increasingly, policy-makers are looking for viable and sustainable alternatives, of which high-speed rail services are the most obvious ones (UNECE, 2017). Furthermore, it is agreed that climate change will affect the European transport system, however disproportionately. Air transport is expected to be more heavily impacted, which benefits rail transport as it is more resilient and reliable in severe meteorological conditions.

This thesis explores how Hasselt University can mitigate the environmental effects of its internationalisation by staff members. The dilemma between aviation and high-speed rail operations is the framework in which this exploration takes place.

In chapter 1 the problem definition, objectives, research questions and research methodology are described.

Chapter 2 first debates on sustainability, internationalisation and the connection between both. It continues on the operational environmental performance of both modes. Then, it discusses the historical dynamics and economic and environmental policy factors that play part in the discord between aviation and high-speed rail. Lastly, this chapter discusses several mitigation strategies for aviation externalities that can be taken at the European level.

Chapter 3 first explores other universities' sustainable travel measures and then detailly discusses the business travel characteristics of UHasselt staff, providing several interesting figures, tables and maps. Also, this chapter investigates the attitudes of staff towards sustainable business travel measures. Finally, it sketches an image of the environmental impact of the UHasselt business travel.



# 1 Problem definition, objectives, research questions, methodology

The academic world is increasingly focusing on internationalisation: student exchange programmes like Erasmus+ are widely known and promoted by governments, foreign lecturers are commonplace, and staff and professor business trips have become an integral part of their job. This brings benefits for students and the academic community, such as exchange of knowledge, cultural integration etc. However, internationalisation also generates international transport, which always implies a certain amount of pollution and impact on the environment.

In 2017, intra-European aviation grew by 10.2%, and a growth of 5% or more is expected until 2030 (EC, 2015). Competition in aviation has strongly reduced prices and hence offered lots of benefits to consumers, one of which is the fact they can fly to more destinations at lower prices. Even though flying is fast, there is consensus that it is the most polluting mode of transport in terms of CO<sub>2</sub> equivalent per km-passenger (Dobruszkes, 2010). Generally speaking we fly too much in Europe on distances that can be bridged with another, more sustainable mode: the (high-speed) train.

These two problems; the first one being the environmental impact caused by the transport related to increasing academic internationalisation, the second one being the exaggerated use of cheap flights in Europe and the undersized use of (high-speed) train will constitute the core of this thesis. Since universities can only modify their own internationalisation policy and not European policy regarding Erasmus+ and study-exchanges, this master thesis is narrowed down by focussing only on international business or work-related trips by staff members and lecturers of UHasselt within Europe, and not on students' internationalisation.

## 1.1 Objectives

Three major research objectives can be deducted. The first objective is to fundamentally comprehend the discord between passenger rail transportation and air transportation in Europe by exploring it from a historical, policy and environmental perspective. The second research objective is to quantify the extent of European internationalisation at Hasselt University (Erasmus+ teaching mobility, congresses, seminars, etc.) and then later to examine international travel behaviour and attitudes. Also, existing internationalisation policy documents of UH and other (Flemish) universities will be studied. The third and last research objective is to formulate objectives and recommendations for Hasselt University, in order to reduce the environmental impact of its internationalisation by means of transport (demand) measures.

## 1.2 Research questions

These objectives lead to the central research question: *How can Hasselt University mitigate the environmental impact of its staff internationalisation within Europe in the light of the discord between European passenger air services and rail transportation?*

Sub-questions are:

- 1) What is the relationship between internationalisation and sustainability?
  - What is internationalisation. What is sustainability?

- How does internationalisation affect sustainability?
  - What is the role of universities in a globalising world?
- 2) How did international European passenger transport grow historically and how does that explain the discord?
  - 3) How do intra-European air transport and HSR impact the environment and what is done about it?
    - What is the relative environmental impact of aviation compared to the one of HST?
    - What is mentioned on HSR and aviation in European policy?
    - How can the environmental effects of intra-European transport be mitigated?
  - 4) What are the characteristics and attitudes towards internationalisation at UHasselt?
    - What is the modal split of UHasselt business travel?
    - What is the environmental impact of this modal split?
    - What are the attitudes of UHasselt staff members towards more sustainable international business transport?
  - 5) How can the UHasselt make its international travel policy more sustainable?
    - How do other universities make their internationalisation more sustainable?
    - Which measures lie within Hasselt University's power?

### 1.3 Methodology

Both qualitative as quantitative methods will be used. Firstly, a literature study on sustainability and internationalisation is performed in order to find out the link between the two. Thereafter, a literature review on the history of aviation and train services is performed, as well as a review on European policy regarding aviation and HSR. Technical elements are raised, but they are not part of the main research.

Secondly, as the core of this study is on sustainable transportation related to internationalisation of the academic world, a comparison must be made between environmental impacts of both passenger aviation and HSR. This serves to quantify impacts and understand the severity and consequences of aviation focused travel inside Europe.

Thirdly, in order to do research on internationalisation at UHasselt, a comparative analysis is performed to determine how other universities go on sustainable internationalisation and business trips. Also, descriptive data should be obtained from the HR and internationalisation office. Besides, a survey is distributed to staff members including questions about travel mode, exchange destination, purpose of travel, travel time and money budgets, (reasons for) mode choice and personal opinion on greener transport. This survey will be built using Qualtrics. The survey will be distributed online to all UHasselt-associates concerned with the help of the internationalisation office. Lastly, interviews with staff members of the internationalisation office at UHasselt and with sustainability coordinators from other universities will serve to get more detailed responses regarding possible policy measures. These will all be informal, semi-structured interviews during which predetermined topics and questions are raised, but the interview will not be limited to those.

## 2 Literature review

### 2.1 Sustainability and internationalisation

In this chapter both concepts are defined and linked. The broader term ‘internationalisation’ is preferred as business travel is an integral part of it. This will serve to construct a specific definition of ‘sustainable internationalisation’ applicable to this research.

#### 2.1.1 Sustainability

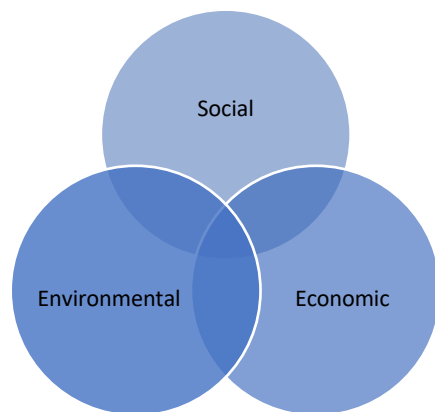


FIGURE 2: Sustainability threefold (WCED, 1988).

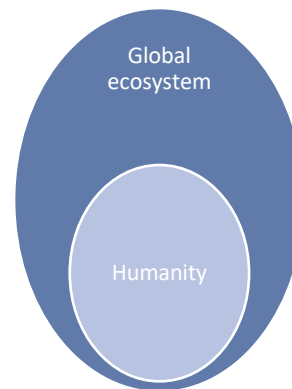


FIGURE 1: Egg of sustainability (Prescott-Allen, 2001).

The common definition of sustainable development was constructed by the World Commission on Environment and Development (WCED, 1988): “Meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them”. Sustainability does not only cover the natural environment; therefore, it is often displayed as a pyramid (FIGURE 2) consisting of a social, economic and environmental cornerstone. Accordingly, one could think that ‘sustainable’ decision-making improves conditions in the three constituents simultaneously. An example: would the average African get to the economic standard of an average American; several Earths would be required. Thus, physical barriers obstruct that less-developed countries evolve to standards of developed countries. It is impossible to solve social world problems like poverty or hunger by only expanding the use of natural resources. A redistribution of resources is more adequate for this (Wright, 2009). Note that the IPCC (2018) in its most recent report mentions climate change, sustainable development and eradication of poverty in the same breath.

To overcome this obstacle, Prescott-Allen (2001) developed a more suitable model for sustainability (FIGURE 1). His model constitutes of an ‘egg of sustainability’, in which humanity is the yolk inside the big egg white of global ecosystems. It indicates that our well-being is totally dependent on the global ecosystem, tackling certain perceptions that humanity would be ‘separate’ from nature. He concludes that sustainability only exists if both the human system and the ecosystem are healthy, thus categorising social and economic development as secondary, after the development of the global ecosystem.

### *The role of higher education in sustainable development*

Brubacher (1982) proposes a philosophy which underlies the function of a contemporary university. He states that universities exist in order to answer the great questions of life by seeking knowledge and truth and that universities also apply knowledge to solve the complexities inherent to human society. Scott (2006) adds to this philosophy that in modern times of increasing interdependence between nation-states, a new mission for universities was born: internationalisation. This interdependence is reflected in organisation like the EU, ASEAN<sup>1</sup> and NAFTA<sup>2</sup>, who already embraced internationalisation several decades ago. Furthermore, higher education is recognised to have a pioneering role in promoting sustainability and societal change. Universities exist to make people smarter, better informed, ethical, responsible, critical and capable of continuous learning.

Paradoxically, sustainability problems would primarily be the work of the well-educated, as ecological footprint models indicate that they consume the majority of natural resources. (Fox et al., 2009) Stipulate that scientists and academics typically are responsible for greater greenhouse gas emissions than the average population because of travel, often by airplane, to professional and academic meetings. Regarding students, Wright (2009) concludes that a disparity exists between what students are taught at university and should be taught in order to make science-based decisions e.g. teaching the monetary value of drilling for oil at economic faculties, but only briefly touching upon the earth's biological capacity. Faculties would need more interconnectedness in order to develop moral human beings.

Sustainable development, obviously a complexity inherent to human society as it is very likely to be anthropogenic, combined with the recent mission of internationalisation, leads to a focus on global sustainability. This can be nothing but positive, since there is no social problem greater than that of ensuring human survival on planet earth (Wright, 2009).

#### 2.1.2 Internationalisation

Already during medieval times, universities stood as a key institution in international organisation, e.g. The Dutch humanist philosopher Desiderius Erasmus studied theology in Paris and London. He also spent time in Brussels, Freiburg im Bressgau and Basel. During the Middle Ages, nation-states were not clearly defined and the main mission of universities was teaching (Schrever, 2010). However today, knowledge is the number one resource in today's society, after capital, land and labour. The 21<sup>st</sup> century is often referred to as the "information" era or "knowledge society". In this society, universities play a vital role as they produce (in form of research) and transmit (in form of teaching) new knowledge in society. Universities' number one mission is to serve the body of worldwide nation-states (Scott, 2006).

The term 'internationalisation' needs some clarification. Brubacher (1982) defines it as follows: "the process of integrating an international, intercultural, or global dimension into the purpose, functions or delivery of postsecondary education". According to Mitchell & Nielsen (2012) internationalisation is

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<sup>1</sup> Association of Southeast Asian Nations

<sup>2</sup> North-American Free Trade Agreement

something that higher education institutes actively *do* and they define it as “a focus on the intentional actions of individuals, groups and social institutions as they actively seek to cross national borders in pursuit of social, economic, political or cultural benefits”. The physical crossing of national borders is carried out by a certain transportation mode (business travel), which to a greater or lesser extent always comes with a negative impact on sustainability in the form of externalities like emission of greenhouse gases\*.

### 2.1.3 A definition for sustainable academic internationalisation

The previous paragraphs offer several constituents which are of use for composing a definition specific for this research. Sustainable internationalisation (of academic staff) can be defined as “*the process of contributing to a fairer and healthier global ecosystem for today as well as for the future, by actively acquiring or spreading knowledge beneficial to society in an academic context, outside one’s own country in a way that does not negatively impact the global ecosystem*”.

### 2.1.4 Conclusion

Chapter 2.1 answers research question 1 and its respective sub questions. Universities have a leading role in societal change and sustainable development. Internationalisation is an integral part of this through spreading of knowledge and research. Therefore, it is fundamental that the internationalisation itself is sustainable, as it appears that exactly academics generally have a large ecological footprint.



## 2.2 The discord between high-speed rail and air passenger transport

This chapter starts by illustrating in which way there exist a discord between the two modes. Then, an assessment of the environmental performance demonstrates which mode is to prefer from an individual consumer point of view would he want to cut back the ecological footprint of his intra-European travel. Thereafter, two sections consecutively illustrate how the contemporary discord came about. These sections are respectively a glimpse at the past of rail and air services on the European continent which reveals the contribution of historical dynamics and also an extensive analysis of environmental and economic European policy.

### 2.2.1 Indicators towards the discord

This section discusses five indicators that illustrate the current discord between (high-speed) rail services and air services in Europe. The indicators are modal split, passenger-kilometres travelled, fare level, frequencies and total travel time.

#### *Modal split of business or study trips in the EU*

A European Commission assessment by Fiorello & Zani (2015) indicates the modal split of business or study trips for distances between 300 and 1000 km, as well as for distances over 1000 km. The figures can be found in table 1.

TABLE 1: Modal split of trips for working, business and study purposes- EU 28 (EC, 2015)

Mode	300 – 1000 km	> 1000 km
Car	72%	53%
Plane	4%	25%
Conventional train	12%	7%
High-speed train	<u>4%</u>	<u>3%</u>
Other (ship, coach, motor)	8%	12%
Total	100%	100%

The relatively low share of aviation in the distance category 300-1000 km is remarkable. Extensive use of (company) cars could partly reveal how this figure is constructed as the assessment includes business trips of private companies. It is plausible that employees are more likely to drive a distance in this range as it requires no in advance planning of flight tickets and the trip is performed in a door-to-door way. Regarding distances over 1000 km aviation takes 25% of the modal split. This figure is rational, taking into account that there is no well-performing alternative in this distance category (Givoni, 2006).

Regarding rail, one should keep in mind that in geographically larger countries like Spain, France or Germany, it is possible to travel distances larger than 300 km and still be in the same country. As the

EC report did not exclude domestic travel, it can partly explain the 12% of conventional rail on distances between 300 and 1000 km. The 7% modal share of conventional on distances over 1000 km is higher than expected. It can probably not be traced back to business people who tend to prefer fast travel, but rather to students or others who travel on a budget and have a lower valuation of travel time.

Most remarkable is the low share of high-speed rail in both distance categories: only 4% of trips between 300 and 1000 km and only 3% of trips over 1000 km are travelled by HST. Understandable is the 3% share for trips over 1000 km since as stated before, there is no well-performing alternative in this range except for the car. But how can the 4% share on 300-1000 km trips be explained? This figure indicates something is off, as after all experts agree that on this range HSR is a viable alternative to car travel and aviation (Albalade, Bel, & Fageda, 2015; Moshe Givoni, 2006; Janić, 2003; Prussi & Lonza, 2018; Rodrigue, 2017). Taking into consideration that the long-term plan for Europe, described further on in the section 2.2.4.2.2 is to have more than 50% of medium-distance passenger transport go by rail by 2050. Table 1 illustrates there is still a long way ahead before this is achieved.

#### *Passenger-kilometres*

According to European Aviation Environmental Report by the EASA, EU, & EEA (2016), intra-European aviation reached a total of 1,370 billion passenger-kilometres in 2014. Then, high-speed rail in 2016 accounted for 124 billion passenger-kilometres according to the European Court of Auditors (2018) and 126.2 billion according to the UIC (2017). Although it is not entirely conclusive nor correct to compare these figures since they do not refer to the exact same year, this huge discrepancy is an indication towards the current discord as it shows that intra-European aviation produces more than ten times the passenger-kilometres of high-speed rail.

#### *Fares*

The KiM (2018) report on possibilities for substitutions from air services to rail services at the airport of Schiphol confirms the general perception that flight tickets in most cases are cheaper than train tickets. After calculations with their figures it was found that on average flying is 32,40 euros cheaper (there are however great variations according to day of travel and time of booking). Calculations can be found in annex 1 (p. 93).

#### *Frequency*

Calculations on the KiM (2018) data show that from Amsterdam on average there are 2 times more daily flight connections than train connections to destinations in Europe located at less than 800 km from Amsterdam. For example, KiM concludes that on average there are 51 daily flight connections from Amsterdam to London, whereas there are only 7 train connections. Solely the connection from Amsterdam to Brussels has more than twice the number of rail services than air services.

#### *Travel time*

Using the KiM (2018) data it was found that when considering total travel time, i.e. pre- and post-travel to and from airport or train station, check-in and actual travel time on flight or train, flying is on average 1h49 minutes faster than travelling by train to cities located in a radius of 800 km from Amsterdam. Total travel time factor is important, if not the most important factor in mode choice (Dobruszkes, 2011). That is why the International Union of Railways states that the share of HSR will drop under 50%

once the trip by train takes more than four hours. After this, air becomes the dominant mode of transport (International Union of Railways, 2018).

### *Conclusion*

The aforementioned indicators illustrate the preferential position of intra-European aviation as well as the disadvantageous position of high-speed rail. Nonetheless, these indicators do not clarify which shape both modes take in an environmental comparison.

## 2.2.2 Environmental evaluation

The formulated definition for sustainable internationalisation is *“the process of contributing to a fairer and healthier global ecosystem for today as well as for the future, by actively acquiring or spreading knowledge beneficial to society in an academic context, outside one’s own country in a way that does not negatively impact the global ecosystem”*. The mentioning of ‘healthy global ecosystem’ implies global climate. Consequently, environmental effects that play on a more local level such as noise, local air pollution and land use will not be discussed albeit also important.

The following sections discuss the relative environmental impact of aviation compared to the one of high-speed rail. This is carried out on an operational basis, as is motivated further on.

### *2.2.2.1 Environment and aviation*

In 1999 already, the IPCC concluded in its special report on aviation, that although improvements in technology for aircraft, engines and efficiency will bring environmental benefits in the future. These improvements will not catch up with the effects of increased emissions resulting from the projected growth of the aviation sector (IPCC, 1999).

Several stakeholders in the aviation suggest different figures on the impact of aviation to climate change. Institutes with connections to aviation published statements wherein they minimise the contribution of air transport to GHG emissions: IATA: 2%; BATA<sup>3</sup>: 3%. In fact, T&E & CAN (2006) calculated that the contribution of aviation to climate change is 5-12% in the EU. On the contrary, the ERAA<sup>4</sup> (2011) states that European aviation is only accountable for 0.5% of worldwide CO<sub>2</sub> emissions. This illustrates that figures can be severely biased, dependent upon the party that researches and publishes. Also, the research method is an important factor; depending on the factors one does include in his research one can obtain biased results.

The following sections discuss the direct GHG-emissions coming from aviation and their respective impact on the environment, which is particularly relevant as such emissions are not only locally confined in the form of local air pollution, but also move across the globe. Also, different GHGs have different lifetimes and thus impact climate differently (Janić, 2018a).

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<sup>3</sup> British Air Transport Association

<sup>4</sup> European Regional Airline Association

## *Emissions from aviation*

Energy is needed to power aircraft, which is obtained from the combustion of kerosene. Direct GHG-emissions that contribute to climate change are CO<sub>2</sub> and NO<sub>x</sub>. Additionally, aircraft emit water vapour (H<sub>2</sub>O), SO<sub>x</sub>, HC, aerosols and particulates. Commercial aircraft operate within two parts of the atmosphere: at ground level (under 915 metres) and in the troposphere (915 m – 12 km<sup>5</sup>) (Givoni, 2007). Emissions in the troposphere are the ones responsible for climate change since the impact of GHG increases due to their slower brake-down rate at this altitude. Emissions impacts are computed using the climate metric ‘radiative forcing’ (RF). RF is the difference between energy coming from sunlight absorbed by the Earth and the infrared energy it radiated back to space (International Panel on Climate Change, 2007; Lee et al., 2009).

### CO<sub>2</sub>

The planet regulates carbon dioxide (CO<sub>2</sub>) concentrations in the atmosphere by many natural processes like photosynthesis, which are part of the global carbon cycle. These processes can absorb some man-made CO<sub>2</sub> emissions, but mankind emits much more CO<sub>2</sub> than the planet can absorb. Experts agree that increasing GHG, and especially CO<sub>2</sub>-emissions greatly contributes to rising temperatures and hence climate change as it is often considered the number one GHG (IPCC, 2007; Lee et al., 2009). Also, the long lifetime of most CO<sub>2</sub> emissions implies that even in the long term, quantities will continue to accumulate. Consequently, the earth’s temperature will increase as to keep the radiative forces in balance (Janić, 2018a).

### NO<sub>x</sub>

Nitrogen oxides (NO<sub>x</sub>) is emitted when nitrogen oxides are released during combustion of kerosene. Especially at high altitudes, emissions of NO<sub>x</sub> are effective in forming ozone (O<sub>3</sub>) in the troposphere, contributing to global warming. NO<sub>x</sub> also reduces ambient levels of methane, a greenhouse gas more potent than CO<sub>2</sub>, resulting in a climate cooling effect. However, this cooling effect does not offset the forming of ozone (Derwent et al., 2002; Dessens et al., 2014).

### H<sub>2</sub>O

Jet aircraft also emit water vapour (H<sub>2</sub>O). Under certain atmospheric conditions, it can condense into contrails. These are visible line clouds, thought to also have an effect on global warming. NASA (2008) found that increased water vapour leads to higher temperatures, which causes even more water vapour to be absorbed in the atmosphere. This is known as the water vapour feedback. Besides, it can also enlarge the warming effect of other GHG. In the aftermath of contrails, it is possible that cirrus clouds are formed. Cirrus clouds are composed of ice crystals, formed at altitudes over 8 km. They reflect a significant part of sun rays, which results in a cooling effect. However, cirrus clouds also absorb infrared radiation emitted by the Earth, reducing the infrared energy escaping and hence leading to warming (Heymsfield et al., 2017). Givoni (2007) states the green-house gas effect of water vapour depends on altitude. Janić (2018) and Wilcox et al. (2012) conclude that water vapour has a negligible effect on climate due to its very short lifespan. Kärcher (2016) concludes that contrail cirrus clouds have a greater RF today than all CO<sub>2</sub> emissions from aviation.

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<sup>5</sup> 8 km at the polar regions, 16 km in the tropics

## SO<sub>x</sub>

Sulphur oxides (SO<sub>x</sub>) stemming from the reaction of sulphur in kerosene with oxygen, among other things react with H<sub>2</sub>O in the atmosphere, creating acid rain harming natural habitats balance (Janić, 2018a).

## HC

Hydrocarbons (HC) are emitted due to incomplete combustion of kerosene. They contribute to smog formation and hence affect climate through ozone production which extends the lifetime of methane. HC also converts into CO<sub>2</sub> and H<sub>2</sub>O under certain conditions (Janić, 2018a).

## PM

Of minor significance is the emission of particulate matter (PM) of soot and sulphate particles. Soot absorbs heat and has a warming effect; sulphate particles reflect radiation and have a minor cooling effect. The particulates impact the environment by increasing the scattering of solar radiation and they also contribute to changes in ozone. Soot particles can also influence the formation and characteristics of cirrus clouds (Kärcher, Möhler, DeMott, Pechtl, & Yu, 2007).

All atmospheric processes caused by direct emissions and chemical reactions of CO<sub>2</sub>, NO<sub>x</sub>, water vapour, SO<sub>x</sub> and particulates cause changes in the radiative forcing acting on the planet. These RF in turn cause climatological changes such as impacts on temperatures, agriculture, forestry, air quality, precipitation, sea level, energy consumption, biodiversity, health etc. All of these cause major effects on social welfare and produce huge costs for society (Lee et al., 2009).

### 2.2.2.2 *Environment and high-speed rail*

#### 2.2.2.2.1 Direct emissions

D'Alfonso et al (2016) & Givoni (2007) state that in general, high-speed trains in operation are not considered to contribute to climate change significantly. In contrast to aircraft, they are powered by electricity, generated in power plants. Fridell, Ferm, & Ekberg (2010) found that trains in operation produce a minimal amount of PM (no GHG but rather air pollutant) due to wear of rails, brakes, wheels and carbon strips. This requires no further discussion as it is a local effect. The environmental performance of electrically powered trains is thus strongly dependent upon the electricity production method. In case of high levels of renewable energy sources and nuclear power, HST is associated with low levels of green-house gas emissions.

An often raised argument in disfavour of high-speed train services is that one should assess its environmental impact not only during operation, but rather over its life cycle from raw material extraction until disposal, also known as a life-cycle assessment (LCA) (Widheden & Ringström, 2007). The ERAA (2011) incites to acknowledge the existence of a 'nuclear footprint' when producing electricity for powering HST in nuclear powerplants. Furthermore, it raises the following objections: land use and noise, low-occupancy scenarios, passengers moving away from conventional express trains. The following paragraph presents a few cases for which a life-cycle assessment was carried out. FIGURE 3 also visually represents the LCA.

#### 2.2.2.2.2 Life-cycle assessment, average and marginal emissions

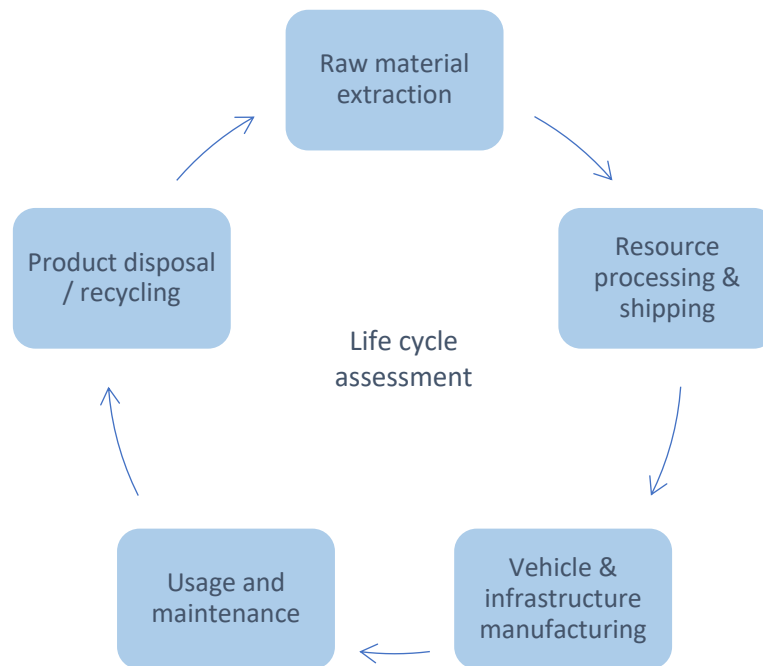


FIGURE 3: Schematic representation of the life-cycle assessment (own creation)

D'Alfonso et al. (2016) admit that attention must also be paid to phases other than operation, the LCA. Indeed, the phases of production, construction, maintenance and disposal can account for a significant environmental impact. Therefore, the International Union of Railways agrees that adding 5 grams of CO<sub>2</sub> emissions per passenger-kilometre on average accounts for the extra emissions not considered during operation. (D'Alfonso et al., 2016; IEA & UIC, 2012).

Robertson (2016) examined the life-cycle impact of short-haul flights and the substitution of it by HST between Sydney and Melbourne. He concludes that including the CO<sub>2</sub> emissions during phases other than operations admittedly do increase total CO<sub>2</sub> emissions per pkm, however it is still beneficial to substitute short-haul flight for HSR services, since total CO<sub>2</sub> emissions per pkm would still be significantly smaller than if the substitution would not have occurred.

Jones, Moura, & Domingos (2017) assessed the life-cycle performance for an HSR line in Portugal from Porto to Lisbon. They conclude that train operations contribute most to emissions, followed by train manufacturing. Moreover, they conclude that the impact of HSR can be underestimated, since 31% of CO<sub>2</sub>-equivalent emissions can be attributed to phases other than operation. Furthermore, electricity mix for powering and ridership levels have a very significant impact on emissions.

A study by Bueno, Hoyos, & Capellán-Pérez (2017) on a suggested HSR line in the Basque Country between Bilbao, Vitoria and San Sebastian shows that even in the most optimistic scenario, the line during its lifetime would not compensate CO<sub>2</sub> emissions linked to its construction and maintenance. These environmental burdens are among the highest in the world, since the layout of the line requires 60% of the network to be tunnelled and 10% to be elevated with viaducts. This case shows that GHG emissions reductions solely cannot be a general argument in favour of new HSR lines.

A study by Chester & Horvath (2010) on the life-cycle assessment of the Californian high-speed rail linking San Francisco, Los Angeles and San Diego shows that the high-speed rail is the best performing mode regarding energy consumption and GHG-emissions, on condition that there is continuous investment to achieve high occupancy rates in the HSR cars. Occupancy rate turned out to be the most important factor that influences emissions per passenger kilometre. The number one factor, as CO<sub>2</sub> emissions per pkm range from 100 g CO<sub>2</sub>/ pkm (very high occupancy) to over 700 g CO<sub>2</sub>/ pkm (very low occupancy rate) The second study on the Californian high-speed rail, performed by Chang & Kendall (2011) acknowledges the existence of life-cycle emissions, especially those from material production, tunnelling and aerial structure construction. They conclude that construction emissions would be recuperated in about two years and their global warming effect in about six years after the opening of the HSR line.

One can deduce that from an operational point of view, it appears that travelling by HSR is more sustainable than air travel. This is detailed further on in 2.2.2.4. Then, from a life-cycle point of view the environmental performance is highly dependent upon modal shift from car and air services, occupancy rates and geographic layout. The nuclear energy production dispute is a totally different matter, hence not further discussed.

The former paragraph leads to the average versus marginal emissions debate. According to Bigazzi (2019), the average emission factor for intercity rail is 10% than air travel, but the marginal factor is 60% lower. A change in transport demand (here shift from air to rail) does not impact all elements of the transportation system equally. Therefore, using average emission factors could be misleading. On the contrary, using marginal emission factors account for the transportation consumption change, with respect to current conditions. Bigazzi (2019) also shows that using average emissions instead of marginal emissions results in a bias against public transport as the environmental benefits are greater considering marginal intensity.

#### *Implication of average vs. marginal emissions*

From the perspective of a national government, an HSR service provider or even other passenger transport provides e.g. long-distance bus operators, the distinction between operational performance and life-cycle performance is very meaningful. These parties are rather positioned on the supply side of the market and have to weigh long-term environmental and social benefits of operation against the (long-term) environmental cost of constructing, building and maintaining and hence average emission intensities. On the contrary, UHasselt is a small consumer of transport supply and does not directly influence network decisions. Therefore, its business travel decision-making should be based on marginal emissions and not average emissions.

UHasselt should, given a certain supply of transportation possibilities, aim at making their transportation policy more sustainable by choosing the transport mode which has the lowest marginal emission intensity. Therefore, it makes sense to only compare green-house gas emissions from operation. For aviation these include emissions during the LTO-cycle (take-off, climb, approach, taxi) as well as emissions during cruise phase. For high-speed rail operation, green-house gases are a direct result of the energy mix used for power.

### 2.2.2.3 *Operational performance comparison*

In this comparing section, results from several studies are listed in order to illustrate the difference in environmental impact of both modes in operation. Emissions per passenger-kilometre were chosen as a unit since the subject of the research concerns individual travel impact.

Following Givoni (2007), only CO<sub>2</sub> and NO<sub>x</sub> emissions are considered. H<sub>2</sub>O, O<sub>3</sub>, SO<sub>x</sub>, HC and PM are not considered. H<sub>2</sub>O is left out since its effect depends on altitude and short-haul flights in Europe are not expected to reach altitudes where water vapour emissions affect climate, or only for a brief period of time. O<sub>3</sub> is not considered as it is not a direct emission of kerosene combustion. PM are not considered since contribution to climate change is of minor significance. Furthermore, Givoni uses a conversion rate to convert emissions from NO<sub>x</sub> to CO<sub>2</sub> equivalent. He states that the impact of flying on climate change is through NO<sub>x</sub> emissions as much as through CO<sub>2</sub> emissions since NO<sub>x</sub> is three times more potent GHG than CO<sub>2</sub> at ground level and 335 times more potent than CO<sub>2</sub> in the stratosphere.

Table 2 on the next page contains CO<sub>2</sub> and NO<sub>x</sub> emissions per passenger-kilometre. Details on how these figures can be found below the table. The NO<sub>x</sub> figures are aggregated by 100-year global warming potential (GWP), which allows comparison of the global warming impacts of different gases. NO<sub>x</sub> has a 100-year GWP of factor 310 (UNFCCC, 2019).



TABLE 2: Comparison of CO<sub>2</sub> and NO<sub>x</sub> emissions aggregated by 100-year GWP (own creation)

Route	Source	GWP of CO <sub>2</sub> per pkm		GWP of NO <sub>x</sub> per pkm	
		Air	HST	Air	HST
General	Janic (2003)	99,8 – 153.9	ICE: 27.5 TGV: 4.01		
	Nelldal & Andersson (2012)	140	48		
	CE Delft (2003)	450- 700	70- 130		
Paris - London	Givoni (2007)	126.7	14.388	4,433	39,835
	Prussi & Lonza (2018)	143	18		
Madrid-Barcelona	Hoyos, Bueno, & Capellàn-Pérez (2016)	127	20.9		
Paris – Marseille	MVV consulting & Tracetebel for EC (2010)	153.0	2.7		
Brussels-Berlin	Ecopassenger.com (2018)	189.86	29		
	CER & UIC (2015)	145	35		
Amsterdam-Frankfurt	Prussi & Lonza (2018)	116	33.6		
Amsterdam-London		124	24.9		
Paris– Amsterdam		133	15		

Janic (2003) finds that for a 100-seat airplane 99.8 g CO<sub>2</sub> are emitted per person kilometre, and 425 g CO<sub>2</sub> for a 150-seat airplane. His conclusion is that HSR burdens the environment less than aviation in terms of operational pollution rates.

Nelldal & Andersson (2012) constructed a model to forecast GHG-emissions for 2050 considering different scenarios. For 2010, the reference year in their study, they compute that rail services, on average, emit 48g of CO<sub>2</sub> per pkm and intra-European aviation 140 g CO<sub>2</sub> per pkm. They use figures from the Trans-tools forecast model (tools for transport forecasting and scenario testing). This is a European transport network model developed by the EC Joint Research Centre's and DG TREN (JRC-EC, 2008). Also, these figures are based on all intra-EU27 flights (2010).

A study by CE Delft (2003) concludes that the climate impact of flying is two to ten times the impact of high-speed rail services. (70-130 g CO versus 450-800 g CO<sub>2</sub>)

Givoni (2007) finds that air travel on the Paris-London route emitted 198.92 grams of NO<sub>x</sub> and 44,095 kilogrammes of CO<sub>2</sub> per seat. The HST journey on the contrary emitted only 17.57 grams of NO<sub>x</sub> and only 7,194 kilogrammes of CO<sub>2</sub>. When dividing these figures by the flight distance of 348 km (Prussi) or rail distance (approx. 500 km) this results in the figures displayed in the table. His conclusion: the impact of an aircraft journey is ten times that of an HST journey.

Prussi & Lonza (2018) calculated the emission of air travel based on the aircraft mix elaborated by Eurocontrol and an emission factor of 3.15 kg CO<sub>2</sub> / kg fuel (which is in accordance with the emission factor for jet fuel proposed by the IATA (2016)). The calculation of emissions from HST is based on the medium-voltage carbon intensity of the relevant countries.

An EC study on high-speed rail (2010) by MVV Consulting and Tracetebe found that on the route between Paris and Marseille a TGV emits only 2.7 grams of CO<sub>2</sub> per pkm, whereas the same route by plane is responsible for 153 grams of CO<sub>2</sub> per pkm.

Hoyos, Bueno, & Capellàn-Pérez (2016) studied the operational CO<sub>2</sub> emissions of several HSR lines and figured that they range between 5-15g CO<sub>2</sub> per person kilometre. Consequently, they computed emissions for the trip Barcelona-Madrid and found that the average for flight was 127 g CO<sub>2</sub> per pkm, compared to 20.9 g CO<sub>2</sub> per pkm for HST (this requires an occupancy of 70%).

Emissions for the route Brussels-Berlin have been computed using [eco.passenger.com](http://eco.passenger.com). The emissions from CER are found in the 2015 annual report by CER and UIC.

Prussi & Lonza (2018) also calculated emissions for other routes: Frankfurt-Paris, Frankfurt-London and Rome-Milan. They show that aviation emits between 3-8 times more CO<sub>2</sub> than high-speed rail.

#### *2.2.2.4 Conclusion*

With some variation, the same order of magnitude for emissions is found. All papers agree that per passenger-kilometre, flying is more polluting than travelling by high-speed train, especially with regard to marginal emissions. Based on the figures in table 2, one can conclude that per passenger-kilometre, air travel emits between 3-9 times more CO<sub>2</sub> than travelling by high-speed rail. Also, the important GWP of NO<sub>x</sub> must not be ignored. Thus, from an individual's or institution's perspective, like a traveller or staff in an organisation such as a university, it is always environmentally beneficial to use high-speed trains instead of air services to reduce individual ecological footprint.

## 2.2.3 Historical dynamics in European passenger transport

### 2.2.3.1 *From first heavier-than-air flight to low cost carriers*

The Wright Brothers, usually considered the founding pioneers of aviation, performed the first engine powered flight on December 17<sup>th</sup>, 1903 in the USA. Over the course of the next years, the Wright Brothers improved the technicalities of their design in order to enhance flight control and stability. In Europe, some scientists imitated the Wright Brothers' experiments and attempted to improve their designs. However, it was only in 1908, when Wilbur Wright performed the first demonstration in Europe, that European aviation started to develop rapidly.

Almost immediately after WWI, the first manifestations of commercial aviation started to show in Europe. Commercial aircraft were designed using modified bombers. Civil aviation has different requirements than military aircrafts as it requires more reliability, lifespan, safety and comfort. Thus, manufacturers commenced designing metal aircrafts with closed cabins

Again, the years leading to WWII and the war itself, accelerated progress made in airplane development. Soon, the first jet engines were designed, allowing the first supersonic flight in 1947. This period was characterised by the early start of the Arms race and Cold war and military and scientific development was going booming. Advancements in military aviation were quickly integrated in civil aviation (Torenbeek & Wittenberg, 2009).

Shortly after the war, larger propeller aircraft with piston engines appeared on the market and reached cruise speeds of about 550 km/h. Then, jet airplanes were soon able to reach speeds over 800 km/h and by the end of the 1950s, jet airplanes were fully commercialised. As will be discussed in the chapter on railway history, it is around this period that Trans-European Express (TEE) was established. There now exist two modes that can operate on middle- to-long distances: the electrified train and the airplanes with jet propulsion.

Since the 1960s, civil airplanes have always been improved: they became more efficient, more comfortable, larger and acquired an ever-wider range, leading to double-digit growth rates in aviation industry development. During the Golden Sixties aviation was gradually made accessible to a somewhat larger public (Torenbeek & Wittenberg, 2009). Shortly after, US air passenger transport was deregulated in 1979. This launched a global shift in aviation regulation, also in Europe. Before deregulation, air transport mostly developed under control of national authorities. In Europe, this implied that most airlines and airports were nationalised and there was no room for competition. The EC consequently introduced three packages towards liberalisation (International Air Transport Agency, n.d.). After steady growth in number of flights during the 1990s (relative to the increase in number of routes), the liberalisation has led to the emergence of the low-cost carriers\*, of which the most known is Ryanair (G. Burghouwt, Mendes de Leon, & de Wit, 2015). It has been shown that deregulation impacts the price of fares; prices drop and hence simple economics tell that demand increases (Dresner & Tretheway, 2002). Especially, low cost carriers have strong reduction effects on air fares (Wu, 2013). Deregulation and low-cost carriers are discussed in further chapters of this thesis.

### 2.2.3.2 *From steam-powered trains to high-speed trains*

About 70% of the railway lines in use in Europe today, were already put on the map by 1900 (Martí-Henneberg, 2013). Hence, a historical perspective on the railway network in Europe is indispensable in order to understand the current challenges.

Economic growth during the Industrial Revolution in the 19<sup>th</sup> century, went hand in hand with the birth and expansion of the European railroad network. In 1835, the first train ran on the European mainland between Brussels and Mechelen, which set the tone for further development of railroads. The tremendous expansion of the European railroad network during the 19<sup>th</sup> century can best be illustrated with figures: in 1840, a little less than 3000 kilometres of rails were laid out across Europe. Some 70 years later, in 1913, 362,000 kilometres of rail covered the European continent. Transport via rails was of significant importance for European nations, especially for those without an extended waterway network (O'Brien, 1983). During the 19<sup>th</sup> century, railway networks and infrastructure were nation-focused, with private companies rolling out the first rail infrastructure and operating the first services, in accordance with the regulations of their respective national government. In those days, interest in international standardisation was rather low. For that reason, some countries e.g. Spain, used different gauges than France while some other countries e.g. The Netherlands have converted to standard gauges in the 1850s when they realised the benefit of connection to 'the network' (Puffert, 2002). Also, during the 19<sup>th</sup> century, nations were competing for control over international overland traffic e.g. The Netherlands and Belgium competed to each connect its port (resp. Rotterdam and Antwerp) to the German Ruhr area (Anastasiadou, 2012).

In 1874, the Belgian engineer George Nagelmackers founded the long-distance passenger rail company 'Compagnie Internationale des Wagons-Lits' (CIWL). After observing luxury sleeper trains in the USA connecting the east and west coast, CIWL introduced luxury sleeper trains on the European continent. The Orient-Express, connecting Paris to Istanbul, is probably the most famous CIWL service. This service ran from 1883 until 1914. CIWL wanted to establish a rail connection between Saint-Petersburg and Lisbon. From Lisbon, travel towards the America's could be continued. In 1887, CIWL started operating the Sud Express, connecting Lisbon via Madrid to Paris. In 1896, CIWL started the North Express, which connected Paris via Brussels, Cologne, Hannover, Berlin, Kalingrad to Sint-Petersburg (Anastasiadou, 2012).

At the beginning of the 20<sup>th</sup> century rail transport was again strongly nationalised, blending the private companies into one national railway company. This was due to the monopoly character of the rail market, as well as an economic recession during the 1930s (COST, 1998). After WWI, rail transport gradually faced competition from road-bound transport. The motor industry grew and governments were investing in road infrastructure. However, despite the motor industry and nationalisation of rail companies, passenger rail services thrived.

In the aftermath of WWI, CIWL expanded its rail services quantitatively as well as qualitatively. Quantitatively, it relaunched its pre-war services, but also supplied new ones e.g. the Simplon-Orient Express that reflected the new political order in Europe by not crossing through German and Austria-Hungarian territory, but instead connecting Eastern and Western Europe via Southern Europe. Before the war, the Orient Express was the only option from travelling between Eastern and Western Europe, by the 1930s there were several options. Qualitatively, CIWL expanded as a response to competition from road-traffic and air transport and also to the economic recession, CIWL now supplied not only luxury sleeper services, but also 2<sup>nd</sup> and 3<sup>rd</sup> class, thus acquiring more passengers. Long distance rail

transport became gradually more democratic during the inter-war period (Anastasiadou, 2012). CIWL survived the economic crisis of the 1930s thanks to this democratisation. During the interbellum (1918-1939), a shift from competing over overland international traffic towards a 'run for the Orient' happened. Railways proved to be an excellent medium for acquiring political influence outside the nation's territory and for constructing transnational and alliances. However, there was no shared vision and nations invested in and promoted international railway traffic mainly for their own interests. What lacked, was a coordinated, trans-national approach (Anastasiadou, 2012).

After WW II, large parts of European infrastructure were damaged. Infrastructure was rebuilt slowly. In 1957, the *Trans-Europe-Express* (TEE) was introduced by national railway companies. TEE's mission was to counter the rapid development of road and air transport by offering fast (100-120 km/h) and first-class rail connections across Western Europe. Nevertheless, in the long run the concept failed to achieve the desired success due to air transport becoming more attractive, as seen in the previous chapter, and road transport becoming financially more attractive and faster thanks to better infrastructure. Besides, the service quality of the TEE concept was declining. It has to be remarked that shrinkage of international rail services in this period happened mostly in Western-Europe, that once was the cradle of rail development. TEE however, can be thought of as a first manifestation of a European-wide passenger railway network.

In 1981, France opened its first TGV-line between Lyon and Paris. In 1987, after the abolition of the TEE-Concept, the domestic railway companies altered their approach by offering international destinations with EuroCity rail services. Two years later, after the fall of the Iron Curtain, Eastern Europe would slowly be integrated in the EuroCity Network. Different from the TEE-time, was that EuroCity trains would be displayed on the regular domestic train schedule as a regular InterCity-service and that EuroCity services came with 2 seating classes. Not long after the introduction of EuroCity, supply of and demand for sleeper services declined and at the same time the first real national high-speed train was introduced in Europe (Anastasiadou, 2012) (Martí-Henneberg, 2013)(Bienick, 2014). Since the 1980s and 1990s, Europe started focusing more and more on high-speed rail development: France, Germany, Spain, Italy took the lead. Finally, since the 1990's one can observe a general European shift on focus from road and air back to rail, with the idea of a Trans-European high-speed rail network (UN & UNECE, 2017)

### 2.2.3.3 Conclusion

Chapter 2.2.3 answers the second research question. Historically, rail services were the number one mode for international passenger transport, until the emergence of always fast air services after WWII. Globalisation, together with technological revolutions like the jet engine brought (the need for) important time savings. In a fast-moving world, long-distance sleeper trains services would be too time consuming. Also, the world-wide emergence of the private car after WWII played a major role in the decrease in international rail transport. More recently, the liberalisation in air transport further contributed to growth in civil aviation, while a continued national focus in railway operations led to a stagnation in international railway development. The historical trends in technological development, service quality increases in aviation and fast globalisation can unveil part of the dynamics responsible for the discord.

## 2.2.4 European policy on aviation and high-speed rail

The European agenda towards a territory without any borders or regulatory obstacles is known as the Single Market Strategy. In this market, people, goods, services and capital can move around freely. To be fully operational, barriers and hindrances should be removed, also regarding on transportation. This single market for transport is named 'Single European Transport Area'. The blueprint document in this regard is the *White Paper on Transport: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system*. In 2011, the EU reconfirmed its objective of reducing GHG-emissions by 80-95% by 2050 (compared to 1990) in order to do its part for keeping global warming under 2°C. Key is the reduction of carbon emissions. For transport, including aviation, two goals have been set in this respect: by 2030 emissions can still increase up to 20% compared to 1990 (effects need time to show), but by 2050 transport must cut its GHG-emissions by 54% to 67% (here: 60%)(European Union, 2011). It contains 10 goals which serve as a benchmark for achieving the 60% GHG-emission reduction target. The seven goals related to high-speed rail and aviation are discussed in chapter 2.2.4.2.

This chapter first discusses how the achievement of the Single European Transport Area can be pursued through deregulation and standardisation in both modes. Thereafter, environmental policy is reviewed, using 7 of the 10 White Paper goals which relate to high-speed rail and aviation as a framework and again discussing implications for both transport modes.

### 2.2.4.1 Economic: Single European Transport Area

#### 2.2.4.1.1 Deregulation

##### **I. Deregulation in passenger aviation**

With the idea of a Single Market, came the idea of a single market for aviation, also known as the Single European Sky (SES). Consequently, three Aviation Liberalisation Packages were introduced.

In 1983, the EC adopted a Directive to liberalise some inter-regional connections which was poorly implemented. Then, in 1987, The First Package was introduced which relaxed restrictions. It also allowed airlines to operate on non-domestic routes, removed the former 50% share of national airlines in the market and also removed the ability of Member States to block proposals for low fares. Following the First Package, some smaller airlines accessed the market and offered services on the important routes, asking the fares set by themselves.

The Second Package, agreed in 1990, introduced the principle of 'double disapproval' which implies that the disapproval of two Member States is required to decline a fare set by an airline. Hence, governments have little to say in price-setting. Secondly, the Package opened almost all routes between European airports and further relaxed restrictions on Freedoms of the air.

The Third Package was accepted in 1992 and discussed the further elaboration of licensing; the European Commission defined clear economic and financial standards for the granting of licenses. Also, market access was further liberalised; any licensed airline can now operate any intra-European route (cabotage). Lastly, the Package stated that when normal competitive conditions are met, prices must be set according to market forces. (Butcher, 2010).

An important consequence of the deregulation is that now most airline companies are privately owned, sometimes partly owned by governments. Therefore, operational decisions like pricing and route determination are determined by commercial forces rather than political ones (Pellegrini & Rodriguez, 2013). The Single European Sky has brought substantial benefits to not only customers but also airlines, airports and employees in the form of price reductions, more connections, increased quality and transparency (EC, 2018). The following paragraph discusses a new business model that emerged from the deregulation.

### *Low-cost carriers*

The liberalisation of European aviation brought the emergence of a new business model in aviation in the late 1980s: low-cost carriers (LCC). Despite the introduction of high-speed trains at around the same time, followed by reduced domestic air travel in some cases e.g. between Paris and Lyon, LCCs are responsible for a more important increase in air travel, namely through short or medium-haul, intra-EU flights. According to Clewlow et al. (2014) the net effect of HST introduction was negative, since LCCs emergence brought more new medium-haul connections, than short-haul flight were done away with.

Companies like Ryanair and WizzAir made air travel accessible to a much wider public via significantly lower fares (Akgüç, et al., 2018). A low-cost carrier is characterised by the following elements. Its core business is passenger transport in a point-to-point network. It operates from secondary airports to cut airport fees and usually operates only one single aircraft type. Besides, LCCs also tend to buy their fleet in bulk to cut costs and they maximise the airtime of each aircraft. Regarding its passengers and sales, LCC rely on digital reservation and therefore minimal sales costs. Their business model is also characterised by no-frills services and ancillary services. The former meaning that the airline only provides the strictly necessary (a seat), the latter meaning that LCC have revenue from sales of other products like commissions on car and hotel reservations, sales of cigarettes, reserved seats and in-flight beverages (Cento, 2009).

The Third Package brought a great expenditure of low-cost carriers after the year 2000. In 2017, LCCs had a market share of 42% on international aviation in Europe, whereas in 2002 it only acquired 10% (Akgüç et al., 2018). In their research over long-term effect of deregulation in Europe, Burghouwt & de Wit (2015) discuss a future fourth phase. Where LCCs mostly relied on secondary airports, they now also serve several primary airports e.g. Brussels Airport since 2014. Secondly, they forecast competition from Turkish and Gulf state carriers. This will further increase competition, especially for former flag carriers. They forecast even stronger competition resulting in further development of the European airline industry and reduction in costs.

## **II. Deregulation in passenger rail industry**

In the rail industry, the EC introduced four Railway Packages towards a Single European Railway Area. The next paragraph shortly discusses the four Packages.

Before 2001, the principle of separation between rail operators and rail infrastructure managers was introduced, but barely applied. Further applications of European Directives to liberalise the rail market were not applied.

The First Railway Package, also known as the Infrastructure Package, consisting of three Directives was approved in 2001. The first Directive is the most important one regarding international HSR: it enables operators to access the trans-European network without discrimination (Blauwens, De Baere, & Van de Voorde, 2016).

The Second Railway Package, approved in 2004, also consisted of three Directives. Of these, two aim at harmonizing procedures, requirements and interoperability. Directive Two focuses on improving interoperability of the European rail network, for both conventional trains and HST.

Railway Package Three, put into force in 2007, included three Directives of which Directive One is of importance for this research. This Directive settled the open access rules of international passenger services. (Blauwens, De Baere, & Van de Voorde, 2016).

The fourth and current Railway Package was introduced in 2016. Its primary goal is to raise the competitiveness of rail vis-à-vis private car and aviation by implementation of a common European single rail market as to provide qualitative transport without obstacles at national borders. It contains six regulations and directives, subdivided into two pillars: a technical pillar and a market pillar. The market pillar's objective is to reduce entry costs and administrative obstacles in favour of potential operators. The technical pillar introduces a central body, the European Rail Agency (ERA), which has a key role in promoting interoperability and harmonisation of technicalities. It also issues certifications for operating on the European network. Prior to the ERA, a different application certification was required from each national authority. Furthermore, the technical pillar ensures interoperability of the European Rail Transport Management System (ERTMS), updates safety legislation and gradually reduces the remaining national rules which could lead to indirect discrimination. The Package prescribes open access and competitive tendering for domestic rail passenger services by 2023, with some exceptions (Blauwens et al., 2016; Petr, 2016).

Albeit movements towards a competitive rail market, rail transport is mostly organised by a few large railway undertakings operating in one country. This applies less to high-speed rail than to conventional rail, since it is a rather new market and is less constraint by national borders. Nonetheless, the few railway undertakings in Europe operate in a sort of virtual monopoly (Pellegrini & Rodriguez, 2013).

#### 2.2.4.1.2 Standardisation

Two kinds of standardisation in transport are identified by Holler et al. (1997): standardisation to improve uniformity e.g. safety, pricing, convenience, predictability and standardisation to increase compatibility e.g. on management and control interfaces and for interoperability at cross-border sections.

##### **I. Standardisation in passenger aviation**

On a global level, the International Civil Aviation Organisation (ICAO) is tasked with providing standards throughout the aviation industry. Next to that, ICAO is also tasked with ensuring safety and aviation development (International Civil Aviation Organisation, n.d.). At European level, safety standards are set by the European Aviation Safety Agency (EASA). It unifies EU aviation by drafting legislation, certifying products e.g. aircraft and stakeholders, supporting Member States in shared jurisdictions like air traffic management (ATM), promoting the use of standards and by cooperating on an intercontinental scale (EASA, 2018b).



Where SES can be seen as a result of the aforementioned deregulation, it can also be seen as a tool towards a standardised air traffic system. The SES is managed by Eurocontrol, a body that in the first place develops a European Air Traffic Management System (EATM) and assists the EU on technology and regulatory elements. The SES comprises of a common set of binding EU rules on ATM, safety and interoperability. In the past, air traffic management was severely hindered by national monopolies and fragmentation, leading to inefficiencies, higher costs and lower capacity. One major inefficiency is non-direct flight paths: on average a flight is 49 km longer than its direct flight length, resulting in an estimated additional cost of 4 billion euros per year (Mihetec et al., 2017). For this cause, Functional Airblock Spaces (FAB) were introduced. These are a tool for achieving the SES: air traffic should be organised in functional airblocks according to traffic flows, rather than being based on national borders. Thus, a major objective of the SES is to replace the national airspace systems by a standardised EATM which covers the entire EU (EC, 2018; ECA, 2017; Holler et al., 1997). A map of Europe displaying the FAB can be found in annex 2 (p.94). In 2009 and 2013, two updates of SES, respectively SES II and SES2+ have been launched to further increase to economic, environmental and economic performance of European aviation (EC, 2015b).

Passenger aviation development is less disturbed by infrastructural and operational standards, but more by managerial standards. Once in the air, an airplane is not bound to physical infrastructure and hence air operators are free to choose the aircraft they put in service. Standardisation to improve uniformity is tackled by international safety regulations, the availability of different booking platforms and market forces regarding pricing. Standardisation to increase compatibility is tackled by SES, EATM and the FABs.

## **II. Standardisation in high-speed rail**

The European Railway Agency is tasked with standardisation at the European level. Following the aforementioned technical pillar of the fourth railway package, it imposes common technical and quality standards for all member states. This section discusses several barriers, which standardisation addresses in order to achieve the Single European Railway Area. These mainly concern barriers to compatibility.

A first barrier is the use different rail management systems all over the continent. ERA supports the implementation of standardised signalling tools such as the European rail traffic management system (ERTMS), which is a wireless global system for mobile communications, railways and the European train control system that guarantees interoperability. It is a standard that enforces compliance by trains with speed restrictions and signalling. Gradually, it is implemented on the entire European network, leading to huge cost reductions (EC, 2010a).

Another important barrier towards interoperability is rail gauge. On the domestic level, four different gauges exist in Europe. The European high-speed rail network however is constructed using the standardised gauge of 1435 mm, which eliminates this hindrance.

Furthermore, a barrier towards a fully interoperable network is the difference in electrification. The electrification standard on the European HSR network is 15 kV or 25 kV and 50 Hz. The difference in voltage is addressed by technical solutions e.g. a Thalys running from Amsterdam to Paris uses three different power systems (Thalys, 2018).

Lastly, the EC document on high-speed rail (2010) mentions the urgent need for standardised cross-border ticketing as well as a common framework for punctuality and customer service.

Standardisation to improve uniformity can be addressed by measures such as well-functioning cross-border ticket booking or central customer service points. Standardisation to increase compatibility is obtained via eliminating infrastructural barriers like different rail gauges or several electrification systems. Besides, standardisation of management is achieved via the development of a common platform for rail traffic management, ERTMS.

#### 2.2.4.1.3 Conclusion

The Single European Sky and the Single European Railway Area fit the bigger picture of the agenda towards the Single European internal market. Once completed, this internal market is foreseen to have major positive impacts on the long-term growth of the European economy.

On the domestic level, rail transport is still highly nationalised whereas aviation is a much more open market. On the European level, air transport and international high-speed rail are moving towards the intended direction of the European Commission. Deregulation in aviation facilitated the development of a new business model in the sector: low-cost carriers. On paper, High-speed rail is an open and competitive market, however one can observe a few large railway undertakings operating in quasi-monopoly conditions. The conclusion regarding deregulation is that it is gradually happening, yet not at the same pace since in practice the passenger aviation market is more deregulated and open than the high-speed rail market.

Regarding standardisation, aviation has a natural advantage as it is less bound to physical infrastructure. In this sector, standardisation of management plays a bigger role than standardisation of infrastructure. For high-speed rail, standardisation and uniformity of infrastructure are vital. Therefore, infrastructure is harmonised or newly built where needed and rail management is addressed via ERTMS. Some more on SES and ERTMS is raised in the following chapter. Table 3 summarises the effect of deregulation and standardisation in passenger aviation and high-speed rail.

TABLE 3: Summary table of economic policy effects (own creation).

Economic policy in favour / disfavour of aviation and high-speed rail		
	Effect on aviation	Effect on high-speed rail
Deregulation	++	±
Standardisation	+	±

#### 2.2.4.2 Environmental: White Paper on Transport

The White Paper on Transport serves as a guidebook towards a low-carbon 2050 Europe. For transport, it was agreed that by then, its emissions must be 60% under the emission level of 1990, without curbing mobility. The White Paper outlines 10 goals towards this future (EC, 2011). This chapter discusses each goal which relates to aviation and high-speed rail.

##### 2.2.4.2.1 Goal 2: 40% use of low-carbon sustainable fuels in aviation by 2050

*“Low-carbon sustainable fuels in aviation to reach 40% by 2050.”*

In 2016, the following alternative jet fuels (AJF) were approved by the EC: fuels from hydro processing of vegetable oils and animal fats, fuels obtained from biomass and synthetic iso-paraffin fuels. Biofuels are fuels made out of biomass, which is any agricultural and animal feed based biological material with carbohydrate (EASA, EU, & EEA, 2016b). Further sources seem to indicate that since 2016, others have been approved as well for blending, e.g. jet fuel derived from ethanol (Biofuelsflightpath, n.d.; EC, 2017a).

Regarding AJF, it is important to note that they are only slightly less polluting during combustion than conventional fuel, rather their environmental savings are obtained over the whole life-cycle of GHG emissions. These savings may be as large as 80%. That is to say AJF serve as ‘drop-in’ fuels, which spells they are compatible with existing aircraft and therefore have similar characteristics as fossil jet fuels. Attention must be paid to land use and the food chain when converting crops into biomass, waste treatment is better in this regard. Thus, the potential benefit of biofuels mainly depends on feedstock type, production process, the availability of such fuel and their life-cycle emissions reduction (ICAO, 2014; EASA et al., 2016).

In the regard of Goal 2 of the White Paper, it is relevant to mention that the IATA set a goal in same spirit: reduce the GHG emissions from aviation by 50% or more by 2050. Staples et al. (2018) argue that if AJFs are deployed to achieve this goal, the production of bioenergy and waste feedstocks will have to be heavily incentivised via good pricing and policies. Moreover, this bioenergy and waste feedstock should in the first place be used for the production of alternative fuel. They conclude that AJFs in certain scenarios could decrease lifecycle GHG emissions from aviation by a maximum of 68.1% by 2050 and also that it is very likely that offsets from other industries are necessary in order to reduce the CO<sub>2</sub> emissions of the aviation industry. However, Janić (2018) found that alternative fuels offer only marginal benefits, even if they substitute conventional kerosene completely. According to him, liquid hydrogen would complement conventional kerosene and alternative fuels would bring substantial GHG-emission reduction and allow achievement of the 2050 CO<sub>2</sub> targets.

In 2011, the EC founded the European Advanced Biofuels Flightpath in cooperation with Airbus and biofuel producers. Its ultimate goal is the achievement of two million tons of sustainably produced biofuels by 2020. It is improbable that this goal is achieved, more due to economic and policy issues than technical issues. The current price gap with conventional jet fuel and the lack of regular production of AJFs cause their implementation and usage to be negligible in 2014 (Biofuelsflightpath, n.d.; EC, 2016a).

#### 2.2.4.2.2 Goal 4: high-speed rail development

*“By 2050, complete a European high-speed rail network. Triple the length of the existing high-speed rail network by 2030 and maintain a dense railway network in all Member States. By 2050 the majority of medium-distance passenger transport should go by rail.”*

TRANSFORuM, a two-year pan-European consortium project, funded by the EU, gathered 11 leading research institutes, in order to provide fresh approaches in order to successfully implement the goals of the White Paper (Transport Studies Unit, 2018). The different institutes worked together from 2013 until 2015, and eventually released four Roadmaps towards the goals of the White Paper. This section will focus on Roadmap 3: High-speed rail.

The White Paper 2050 goal is twofold. On the one hand it suggests sharp increases in the length of the network (increase supply) and on the other hand it suggests a modal shift (>50% of medium distance passenger trips) in favour of rail and disfavour of aviation and car transport. Medium distance is defined as distances between 300-1000 km. To achieve this, TRANSFORuM identified several action points (which are not exclusive). Figure 3 shows to current and planned high-speed rail network in Europe.

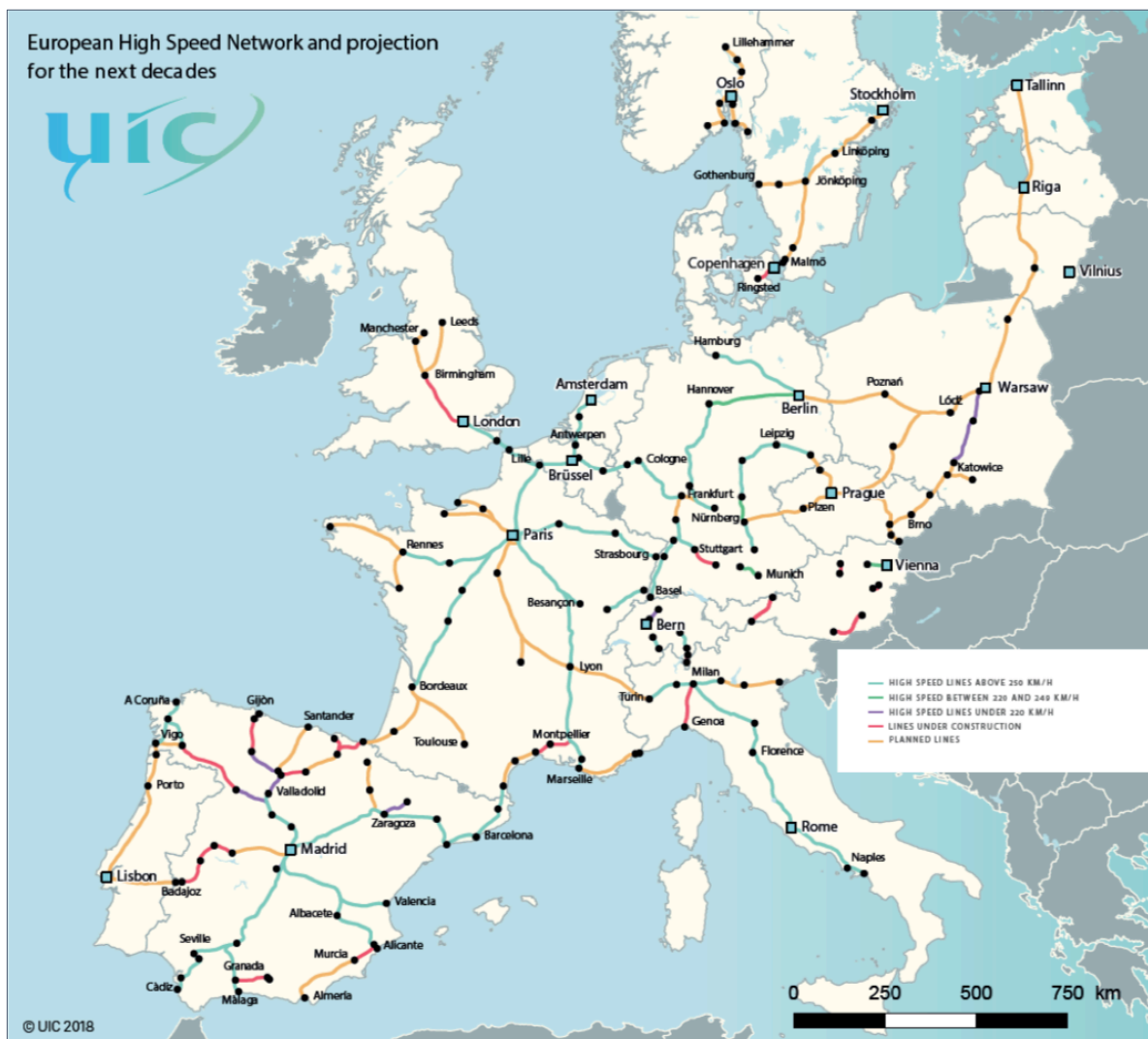


FIGURE 4: current and planned HSR network in Europe (UIC, 2018)

Firstly, tripling the length of the HSR network should expand the network to more than 30,000 km compared to the 2008 level of 9 700 km (ECA, 2018). This can happen in three ways: by freeing capacity on crucial nodes and upgrading of sections, by linking high demand cross border sections and lastly, by building brand-new HSR infrastructure. In the European case, decision-makers should see HSR development not as solely an infrastructure expansion, but rather a capacity expansion. Furthermore, the goal states that HSR development should not go at cost of the national networks, as HSR service can cause a reduction in use of conventional services (Moshe Givoni & Dobruszkes, 2013).

Secondly, public private partnerships (PPP) are raised as indispensable in developing more infrastructure. Different methods for PPP and risk-accountability should be developed, after which the right PPP must be chosen in function of the economic and political characteristics of the project.

Thirdly, with tripling the length of the HSR-network must come an increase in demand. Obtaining a modal share for rail >50% on medium-distance trips by 2050 is the ultimate goal stated in the White Paper. This can be done by raising the relative competitiveness of HSR via e.g. inclusion of external costs for all modes (flying and driving will become relatively more expensive) or stopping the subsidisation of regional airports etc. But naturally, an increase in HSR capacity by harmonising regulations and increasing supply also contributes to a larger modal share.

Fourthly, optimal integration of HSR with digital platforms, local, regional, national transport networks and key nodes such as airports; together with good accessibility, comfort and service, are a part of the solution.

Finally, next to operational and average speed, qualitative off- and on-board services are essential, as travel time is not automatically wasted time, e.g. people can continue working on trains. Furthermore, door-to-door time is often more important than speed, which once more emphasizes the need for integration with other transport networks (Crozet et al., 2015).

The TRANSFORuM Roadmap also addresses six barriers that could obstruct the success of the White Paper goal.

- 1) Finances are never 100% transparent which can be challenging for proper management of resources
- 2) Refusal by public opinion. This can be partly solved by clear communication and transparency
- 3) Technicalities: complete harmonisation in procedures, standards and requirements.
- 4) Political short-term thinking
- 5) Average speeds vs. multiple stops; competition with car and aviation. High-speed rail services should focus not only on speed, but also integration and overall service.
- 6) Cost structures and necessary funding are obstacles (Crozet et al., 2015).

The European Court of Auditors (2018) is the body which controls the EU budget. It argues that tripling the length of the HSR lines by 2030 is very unlikely, considering the following:

- no trustable analysis on the number '30,000' km exists,
- there is a lack of public finances since Member States are the main investors,
- An HSR line on average costs 25 million euros per km and on average takes 16 years to build,
- the power of the EC is limited as Member States decide on HSR independently. This leads to a patchy instead of integrated network,

- there is a risk of ineffective and inefficient spending as only three lines in Europe<sup>6</sup> meet the benchmark of 9 million passengers per year,
- there is no 'polluter pays' principle. Hence, competition with other modes is unfair.

Therefore, the ECA proposes the EU four recommendations.

- 1) The EC must adopt a *realistic* planning for its HSR network, based on key infrastructural projects that need completion e.g. all cross-border sections should be completed.
- 2) Revise the funding of HSR infrastructure.
- 3) The Union should as soon as possible simplify cross-borders constructions.
- 4) Convenience, information, comfort, ticketing and co/inter-modality should be given more attention as well as the consideration of externalities caused by every mode of transport (European Court of Auditors, 2018).

2.2.4.2.3 Goal 5 and goal 6: TEN-T + connection of core airports to (high-speed) rail network

*"A fully functional and EU-wide multimodal TEN-T 'core network' by 2030, with a high quality and capacity network by 2050 and a corresponding set of information services."*

*"By 2050, connect all core network airports to the rail network, preferably high-speed."*

Goal 5 and 6 can be joined together as they relate to TEN-T development. Trans-European Transport Networks (TEN-T) is a policy towards development and implementation of Europe-wide networks for all modes of transport. Ultimately, TEN-T will close gaps, remove bottlenecks and eliminate technical barriers between Member States. In this regard, TEN-T is more of a standardisation policy.

TEN-T consists of a dual-layer structure: a comprehensive and a core network. The TEN-T network is visualised in Figure 5 on the next page. The comprehensive network is multimodal, has high densities and guarantees all Member States good accessibility that strengthens their domestic economic, social and territorial development. The comprehensive network is planned to be finalised by 2050. The core network is all the parts of the comprehensive network which are accorded the highest strategic importance for internal and global transport flows. Especially the (improved) cross-border infrastructure will allow high-quality transport of goods and passengers. The core network is expected to be finished by end of 2030. In order to facilitate the implementation of projects along the core network, 9 major multimodal corridors<sup>7</sup> have been introduced. These 9 corridors are part of the core network stated above. The end goal of the 9 corridors is to complete seamless international connections for the sake of sustainable transportation, this by focusing on solving bottlenecks, constructing required cross-border infrastructure and promoting integration and interoperability.

Regarding rail, TEN-T envisages to upgrade railway lines and make them the backbone of a European-wide multimodal network. Regarding air transport, TEN-T envisages to have 39 major European airports (EC, 2018b, p.).

Regarding goal 6; TEN-T consists of 38 core airports, which will serve as gateways to Europe. In 2017, 23 of those were already connected to the TEN-T rail network (EC, 2017). Ideally, the rail network then

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<sup>6</sup> Madrid-Barcelona, Turin-Salerno and LGV Est-Européenne

serves a feeder for long-haul flights to destinations outside, thus heavily reducing the need for intra-European flights. More on the link between airports and HSR is discussed in chapter 2.2.6.1.

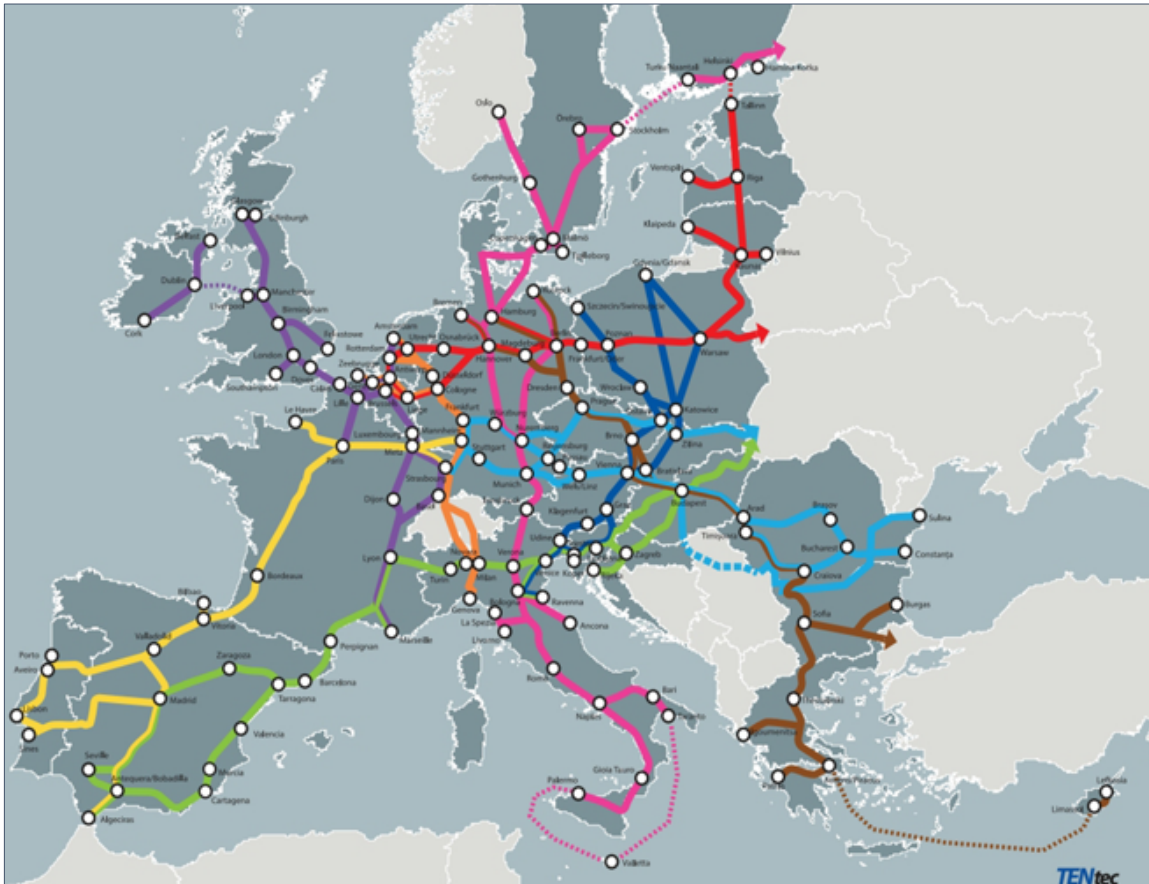


FIGURE 5: TEN-T Network (EC, 2018)

#### 2.2.4.2.4 Goal 7: deploy SESAR by 2020 and deploy ERTMS

*“Deployment of the modernised air traffic management infrastructure (SESAR) in Europe by 2020 and completion of the European Common Aviation Area. Deployment of equivalent land and waterborne transport management systems (ERTMS).”*

In the chapter on standardisation in aviation industry, the SES was already mentioned: it aims at making aviation in Europe more harmonised, safe and sustainable. The technology to achieve the SES is provided by the air traffic management research programme SESAR. The SESAR 2020 Goal is to improve fuel efficiency of any flight by 10%, solely by better air traffic management (European Aviation Safety Agency, 2018a).

The White Paper also mentions the deployment of ERTMS for rail traffic management, discussed in chapter 2.2.3.1.2. The EC (2017) implementation plan on ERTMS, dictates that by 2023, 50% of the core network should be equipped with ERTMS. A document on the progress of TEN-T (EC, 2017) however indicates that in 2017 only 9.5% of core network corridors were equipped with ERTMS.

2.2.4.2.5 Goal 8: By 2020, establish framework for European digital platform for transport

*“By 2020, establish the framework for a European multimodal transport information, management and payment system.”*

Already in the chapter on standardisation cross-border ticketing was raised as an issue. The technology for building Full Service-like and Mobility as a Service-like applications is present, but not yet used on the European level. An EC (2016) evaluation document states that achieving this goal can prove difficult and that progress so far is limited, as some national operators are not willing to share their travel schedule and travel data. It also urges for more bottom-up and local approaches to achieve this goal. It appears the technology is available, but a national focus is impeding development.

2.2.4.2.6 Goal 10: full application of ‘user pays’ and ‘polluter pays’

*“Move towards full application of ‘user pays’ and ‘polluter pays’ principles and private sector engagement to eliminate distortions, including harmful subsidies, generate revenues and ensure financing for future transport investments.”*

Transport charges, taxes and fares should reflect the real cost of every mode in terms of externalities and infrastructure costs. Prices must be set accurately and price distortions avoided. Fuel taxes should be revised as well as road-pricing schemes which differ from country to country. Moreover, spending of revenues should be wisely invested, taxes should be brought in accordance with environmental performance of concerned mode. More on this subject topic is to be found in chapter 2.2.5.1 and chapter 2.2.5.5, which respectively discusses measures to raise the relative competitiveness of high-speed rail vis-à-vis aviation and (the willingness-to-pay for) carbon-offsetting of air transport.

The EC (2016a) evaluation of the White Paper achievement and goals states that in any case, Goal 10 is a long-term process which requires structural reforms of transport charges and taxes, which in turn is a rather sensitive topic. Because a trans-national approach lacks, a patch of different national solutions exists that has several negative outcomes such as distortions, inefficiencies, non-response to negative externalities, absence of incentives for consumer behaviour change and business operation change and transport inequality.

2.2.4.2.7 Conclusion

The discussed seven goals demonstrate a substantial role for aviation and high-speed in achieving a low-carbon Europe by 2050. Alternative fuels will be indispensable for achieving carbon-neutral growth of aviation. Until now, their usage is negligible, largely due to political and economic issues. An extensive HSR network across Europe is a valuable objective, yet currently unrealistic. Its further continuation must focus on freeing capacity and upgrading infrastructure, have better financial management, must prioritise cross-border fluidity, must focus on services apart from transportation, must urge for modal shifts and must have transparent communication. Also, for deploying the full potential of the TEN-T corridors solving bottlenecks, again cross-border sections and investing in interoperability is necessary. Regarding traffic management it seems that SESAR is better implemented than ERTMS, which disfavours HSR development. A multimodal platform for intra-European transportation is hindered as where high-speed trains are by nature positioned in a somewhat hub-and-spoke network, aviation is more implemented in a point-to-point network. Noted should be that



in all this, aviation has a natural advantage as it is less bound by physical infrastructure at borders and interoperability. Lastly, the non-implementation of the polluter or user pays principle causes strong distortions in actual transport prices, the real price is not at all reflected.

Investigation of the White Paper goals allows to make a summarising table of the stated goals on the contemporary discord. (+) implies that the effect of the respective goal strengthens the position of the concerned mode in the discord, whereas (-) implies it soothes its position.

TABLE 4: Summary of White Paper goals and their effects (own creation).

Environmental policy in favour / disfavour of aviation and high-speed rail		
	Effect on aviation	Effect on high-speed rail
Goal 2: negligible use sustainable fuel	+	±
Goal 4: non-realistic HSR network development	+	-
Goal 5: TENT-T	+	-
Goal 6: connect core airports to HSR	-	+
Goal 7: deploy SESAR & ERTMS	+	-
Goal 8: multimodal platform system	+	-
Goal 10: user / polluter pays	++	-

## 2.2.5 Resolving the discord or mitigating its consequences at the European level

From the emissions comparison (see 2.2.2.3), high-speed train operations are generally much less impacting the environment than short-haul flights. However, simply substituting all short-haul flights by high-speed rail services is neither possible, nor required. In this section possible measures are considered that can be undertaken at a European level in order to mitigate externalities from intra-European travel.

### 2.2.5.1 *Improve relative competitiveness of high-speed rail*

Crozet et al., (2015) identify three approaches to increase the competitiveness of high-speed rail.

The first approach is the internalisation of external costs by pricing all modes fairly and efficiently e.g. including the economic cost of congestion in traffic taxes.

Secondly, they raise road-pricing as an approach towards more competitiveness, ideally investing the revenues of it into more sustainable modes like rail transport.

The third identified approach to increase the competitiveness of high speed rail is the abolishment of indirect subsidies and tax exemptions for air and road transport. Gössling, Fichert, & Forsyth (2017) define subsidies in aviation as *any form of financial aid or in-kind support extended to the aviation sector or its supply chain*. They conclude that a wide range of subsidies is used in aviation, as well as several tax exemptions. It is also argued that state-aid to aviation is covered by a large degree of secrecy and complexity. Furthermore, they conclude that the economic value of aviation can be overestimated while underestimating the environmental effects. T&E & CAN (2006) argue that taxes revenues are often seen as a cash machine for governments, but fact is that especially tax exemptions on international flight tickets and kerosene keep flight ticket fares artificially low. They raise the example that taxing products with undesirable outcomes such as kerosene and flight tickets is better than taxing labour. Krenek & Schratzenstaller (2016) even argue that a carbon-based flight ticket tax could function as a double dividend by reducing CO<sub>2</sub> on the one side, and an economical boost on the other side.

In addition, relative competitiveness can also be increased by raising travel speeds. High-speed rail should fight for its share on distances between 200 and 800 km, since as for now the car is preferred for these distances thanks to its flexibility in the last mile on short distances, and the airplane is more competitive for longer journeys (Dobruszkes, Dehon, & Givoni; 2014).

Finally, high-speed rail services should benefit from the inherent advantage that railway stations are often located in or close to city centres, whereas airports are usually located at the outskirts. This advantage positively influences total travel time, which in turn positively affects competitiveness (Givoni, 2005). Smaller check-in times and less strict security measures are other advantages inherent to travelling by HST. The UIC (2018) states that the share of HST drops under 50% once the trip by train takes more than four hours. This confirms the findings of Dobruszkes, Dehon, & Givoni (2014) who state that high-speed rail travel times have a great impact on air services, air seats, and air frequencies if the travel time by HSR is longer; consequently offering a competitive advantage to air services.

#### 2.2.5.2 *Integration and substitution instead of competition*

The principle of the HST is defined by some as being ‘twice as fast as the car, half as expensive as air’ (Sands, 1993a, p. 205). This definition implies that the high-speed train is a competing mode against other modes. As seen in the previous section, competition is important, however even more important is substitution through integration. To achieve this Givoni (2005) proposes four principles. When these principles are followed, the integration of services is a win-win situation for all stakeholders. Summarised, he states that HSR services should begin at the airport to in the first place discourage competition from airlines since such competition provides no motivation for substitution by the airlines and in the second place to allow fast and seamless transfers. Besides, preventing competition does not suffice. It should however be supplemented with full integration of both services e.g. reservation or customer service. Clewlow et al. (2014) add that from the point of infrastructure the airport’s rail station must be a through-station on a main rail. Hence, it should not be merely connected to the HSR-network via a branch as this heavily compromises high service levels and frequency. The benefits for stakeholders are increased passenger capacity at lower environmental cost and increased catchment area for airlines. The railways benefit by increased demand. Passengers benefit by either shorter travel times, or better service. Society benefits of the reduced environmental impact.

Givoni & Dobruszkes (2013) discuss the effect of high-speed rail introduction on mode substitution and induced demand. They conclude that few years after HSR introduction, on average 20% of the demand is induced demand, whereas 80% used other modes, often conventional rail. Thus, the effect of the introduction of HSR as an alternative for car and air travel can have undesirable effects for conventional rail. Properly integrating the local rail network as a feeder towards the high-speed rail network is crucial in this regard. Concerning air services, Givoni & Dobruszkes conclude that generally they are very much affected and are left two options: compete with the HSR by pushing fares down, or close the air service and cooperate with HSR. It should be noted that freed airport capacity could be allocated to longer-haul flights. Even without such rebound effect, the GHG emissions reduction thanks to substitution is relatively small compared to emissions from long-haul flights.

D’Alfonso, Jiang, & Bracaglia (2014) studied the environmental effects of competition between air travel and HSR. They found that they are not always positive, since there is a trade-off between the substitution effect and the traffic-generation effect.

#### 2.2.5.3 *Air Traffic Management*

Better air traffic management through the SES, which incorporates the Functional Airspace Blocks (see 2.2.4.1.2) and technological advancements made by SESAR, which in turn optimises flight paths and by smoothening climbs and descents, should allow 10% of fuel savings per flight by 2020, which would lead to a 10% reduction in CO<sub>2</sub> emissions (EC, 2015b).

#### 2.2.5.4 *Emission Trading Scheme*

The inclusion of intra-European Economic Area (EEA) emissions in the EU Emission Trading Scheme (ETS) allows monitoring and management of emissions by aviation. The ETS is a fundament of the EU climate policy and monitors the most important GHG NO<sub>x</sub> and CO<sub>2</sub>. Using a cap-and-trade system, a cap (maximum) of emissions is set. Over time, the cap is lowered as to decrease total emissions. Trade

implies that companies can sell or buy emissions according to their needs. In 2012, it was decided to include aviation in the ETS system. However, after heavy lobbying and some intimidations by non-EEA governments and airlines, the EC decided to only include intra-European Economic Area flight in ETS until 31/12/2023 (EC, 2016b; Govtrack, 2011; Lewis & Volcovici, 2012). Hence, even though the EEA is on its own, it has mobilised the industry to look for emissions abatement options and it has put international aviation emissions on the global political agenda (Preston, Lee, & Hooper, 2012).

Intra-EEA aviation emissions accounted for 64.2 million tonnes of CO<sub>2</sub>-equivalent in 2017, a growth of 4.98% compared to 2016 (Cabuzel, 2018). In the current, third trading period (2013-2020) the cap is to be lowered by 1.74% each year, resulting in an emissions level 21% below the 2005 level. Aviation falls under a different system: its emissions are capped at 95% of the average emissions levels of 2004-2005 (EC, 2016b). This cap was determined using data from Eurocontrol, actual fuel consumption information provided by aircraft operators and additional calculations. According to figures from the EC (2018a), around 100 million tonnes of CO<sub>2</sub> reductions or offsets happened between 2012 and 2018, even though continuous increases in intra-EEA aviation emissions. No further literature was found on the environmental impacts caused by the ETS scheme.

#### 2.2.5.5 *Carbon offsetting*

McLennan, Becken, Batty, & So, (2014) define carbon offsetting as a form to 'neutralise' one's emissions by investing into schemes that reduce atmospheric concentrations of GHG like CO<sub>2</sub> for example through reforestation. However, projects like forest protection and reforestation do not reduce atmospheric concentrations of CO<sub>2</sub> in a pure scientific sense and therefore it is wrong to promote offsetting as 'neutralising' aviation emissions. Rather, carbon emissions from combustion of fossil fuel should be seen as a source of CO<sub>2</sub> emissions, different from those from deforestation. Yet, offsetting into schemes for reforestation etc. must be part of an integral approach towards GHG mitigation, along with profound reductions of fossil fuel usage. It should be noted as well that other emissions than CO<sub>2</sub> have (even stronger) greenhouse effects (Becken & Mackey, 2017).

Carbon offsetting should only be considered when all other options; avoiding travelling, reducing emissions and substituting to lower carbon options, are exhausted. Too often, it is used either by companies to profile themselves as green, or by individuals who want to clear their conscience but still engage in carbon intensive activities (Hyams & Fawcett, 2013). These authors delve deeper into the ethics of carbon offsetting, but this thesis requires no further elaboration of the subject.

Brouwer, Brander, & Van Beukering (2008) examined the willingness-to-pay (WTP) of air travellers to offset their CO<sub>2</sub> emissions. They find that although there are large differences according to geographic region, travellers generally have a higher WTP than assumed. This WTP stems from a twofold feeling of on the one hand responsibility towards contribution and accountability to climate change and on the other hand a feeling of protection for future generations. Moreover, it is found that 75% of air passengers is willing to pay on average €25 per tCO<sub>2</sub>-equivalent emitted. However, on January 11<sup>th</sup> 2019, the price of one ton of CO<sub>2</sub> is €21.40 in the ETS scheme. This discrepancy indicates a stronger market potential for carbon offsetting.

#### 2.2.5.6 *Aviation industry*

The abatement and offsetting of emissions can result in tremendous cost increases for the aviation industry. The prospect of huge cost structures can incentivise the industry itself to directly reduce its CO<sub>2</sub> emissions via improved aircraft structure, engine technology, more efficient air and ground operations and the use of alternative jet fuels and drop-in fuels. While improvements in engine efficiency, aerodynamics and ATM brought better fuel consumption rates, aircraft are largely still powered with conventional fuel. According to the ICAO the biggest environmental savings for carbon-neutral growth (see glossary) of aviation are to be achieved through market-based measures and sustainable alternative fuels (ICAO, 2014). The former has been discussed in chapter 2.2.5.4, the latter in chapter 2.2.4.2.1.

#### 2.2.5.7 *Conclusion*

In order to solve and / or mitigate the consequences of the discord at a European level, in the first place the above described phenomenon of competition, substitution and integration indicate that (high-speed) rail must always be included in any discussion on the future of aviation. Moreover, several possibilities are available to raise the modal share of high-speed rail by improving its relative competitiveness; this is however a long-term project. High-speed rail should serve as a feeder to the core airports by infrastructural integration at airports and the substitution of short-haul services in cooperation with airlines, as states White Paper goal 6. Furthermore, a big role is reserved for economic and trade measures in the form of trading schemes and carbon-offsetting. Their application should be more stringent, as behavioural change often starts in the wallet. Lastly, the aviation industry itself must be incentivised to conduct further improvements in aircraft structure, technology, fuel efficiency and bigger developments in AJF.

This conclusion displays that solving or mitigating this discord requires a top-down, as well as a bottom-up movement. Top-down since political willpower and courage is required in order to implement certain (unpopular e.g. VAT on air ticket) but necessary measures as described above. Bottom-up since the European traveller will react to these measures by changing his travel behaviour (e.g. a tax on kerosene and VAT on air tickets raises air fares and hence less people will fly) or by becoming more aware of the problems this discord causes and increasingly offsetting his travel emissions. Important however is to always keep in mind that transport, also long-distance transport, must remain democratic.

### 3 International business travel at Hasselt University

On December 19<sup>th</sup> 2018 a brief interview was conducted with staff of the UHasselt internationalisation office. UHasselt staff members that travel for business purposes are left with a lot of freedom regarding the arrangement of their trips. They can either book trips through the portal of Omniatravel, or they can book their trips independently for which they are then reimbursed by the university. Hotels can only be booked on the website of the hotel itself and three flight options are always suggested. Also, UHasselt is currently working on a strategic sustainability policy document and is planning to hire a sustainability staff member in the future (not further specified).

The UHasselt website dedicates one webpage to the four strategic goals (SG) of UHasselt in terms of internationalisation. The first SG is the enhancement of the international appearance, SG2 is the stimulation and facilitation of high-quality international mobility, SG3 consists of carrying out an international mindset by all students, researchers and staff members. SG4 states the further development of 'education and science sharing' with development countries (UHasselt, n.d.). On this webpage, the term 'sustainable' is used twice, but not in the context of sustainable transport. UHasselt is also involved in several international projects (Erasmus+, Summer Schools, Joint Programmes, COST Actions, Horizon 2020 projects and Marie Skłodowska Curie Individual Fellowships, Global Minds, Institutional University Cooperation, Munaf...).

From this, one can learn that UHasselt has policy goals and measures on (sustainable) internationalisation. Yet, a section or plan regarding sustainable business travel is still lacking. Chapter 3 discusses how UHasselt can address this. This by means of:

- 1) exploring policy measures of other European universities and Belgian best practices,
- 2) analysis of a survey distributed among UHasselt staff.

#### 3.1 Exploration of other universities' business travel policy measures

This section starts by describing policy measures of other foreign universities. The University of Glasgow, the EHT Zürich, Leiden University, the University of Gothenburg and the University of Stockholm all have in more or less detail concrete actions towards mitigation of the impact of international business trips.

Then, the section continues by elaborating in more detail on two Belgian best practices, at the Catholic University of Leuven (KUL) and Ghent University (UGent). The former has been built using online sources and an interview with the sustainability coordinator of KUL, professor Gerhard Rovers on March 8<sup>th</sup> 2019 (annex 4, p. 96). The latter has been built using online sources and internal UGent documents provided by the UGent environmental coordinator Riet Van De Velde.

##### 3.1.1 The University of Glasgow

The University of Glasgow (2018) follows Scotland's National Travel Plan of which the philosophy is: "The greenest mile is the mile not travelled". It also includes a transport hierarchy:

- Need for travel: only undertake business trip when it is essential. Can video-conference, phone call or email have the same outcome?
- Walk

- Cycle
- Public transport: the preferred mode from medium to long distance travel
- Taxi / hire car
- Private car
- Air: absolute last resort

A Glasgow University employee must always ask himself the following:

- Is my journey absolutely necessary?
- If it is, how can I minimise my carbon impact?
- Is there a method or route which will maximise my productivity whilst travelling?
- Is the cost acceptable?
- Have I considered the risk factors (not further specified)?

It is mandatory to book business trips via appointed providers, though exceptions are possible.

### 3.1.2 EHT Zürich

EHT Zürich together with the University of Zürich have an elaborated strategy towards reduced air travel. The strategy stipulates four measures, categorised as follows:

- 1) Regulatory measures
  - Carbon budget or tax
  - Restrictions at flight type (e.g. restricting business class), restrictions at person (e.g. reducing number of allowed flights for PhD students) or restrictions on distance (flights for distances <700 km with a train connection are restricted)
- 2) Non-regulatory measures
  - Awareness campaigns e.g. “Academic Flying Blog” aims at voluntary self-commitment of employees to decrease their personal air travel.
  - Reward mechanism: positive incentives that trigger behavioural change e.g. monetary bonus for those who drastically reduce air miles
- 3) Changes in enabling conditions
  - Video-conferencing
  - Virtual workplace (however it is acknowledged that direct interaction builds trust and is more satisfying)
  - Centrally located conferences or multi-hub conferences connected via video
  - Centralised travel booking office and tool to compare travel options
- 4) Compensation schemes
  - Carbon offsets (Janisch & Hilty, 2017)

### 3.1.3 Leiden University

Universiteit Leiden (2018) has calculated that 25% of its CO<sub>2</sub> emissions come from business travel, largely all from air travel. It has the following policies in place:

- Booking through Uniglobe, this way the employee must not pay anything in advance.
- Trips of six hours or less must be taken by train rather than plane.

- Since 2016: annual check-up that maximum 10% of business trips to cities in that six hours reach are travelled to by airplane, in that six hours criterion is done by plane,
- Employees can travel first class on trains and must choose the lowest class when travelling by plane,
- In 2018 Leiden University wants to compensate for at least 90% of CO<sub>2</sub> emissions from air travel via e.g. Fair Climate Fund.

#### 3.1.4 University of Gothenburg

The University of Gothenburg (2018) has published an elaborate action plan for environmental and sustainable development 2017-2019. Regarding travel, it tasks the deans or head of departments with:

- Reducing flights between Gothenburg and Stockholm
- Promoting use of technology for travel-free meetings (video)
- Facilitate and create incentives for staff to 'green' travel (not further specified).

Besides, it has a Centre for Environment and Sustainability which is tasked with the development and administration of the University's climate compensation system. Finally, Gothenburg University strongly discourages flying distances of less than 500 km from Gothenburg.

#### 3.1.5 University of Stockholm

Stockholm University (2017) has several instructions for climate-friendly travel and travel-free meetings:

- Domestic travel: train where possible
- Hold travel-free meetings via videoconference
- Monitor air travel per department
- Documentation of each flight in a central database
- Forbid flying to destinations at less than 500 km from Stockholm
- Encourage train travel for longer distances
- Avoid layovers when travelling by air within Europe
- Encourage overnight stay for longer journeys

#### 3.1.6 Catholic University of Leuven

The KUL has published its renewed strategic plan in 2018. It is founded on five pillars, including internationalisation and sustainability. The pillar 'sustainability' comprises three priorities regarding business trips. KUL also has a technical note which details how it aims at decreasing the carbon footprint of KUL staff. For 2013, it was calculated that 6.8% of their carbon emissions came from plane travel. The KUL wants to go towards a rationalisation of flying. The financial, temporal and climate costs should be weighed against the added benefit of a flight. KUL already has the following measures in place:

- 1) Centralised booking in Omniatravel
  - Booking via Omniatravel is compulsory.



- Omniatravel (trip booking software) must report information on carbon emissions for each flight to the booker,
  - All KUL travel data is archived in Omniatravel.
- 2) Incentivize alternatives for flying and restrict flying
- KUL has a system of 'white' and 'grey' cities. 'White' cities are cities reachable in three hours or less by train. Travelling by train to such cities is practically 100% obligatory.
    - o 'Grey' cities are cities reachable in seven hours or less. When booking a trip to such cities via Omnia, the system adjoins the train alternative. Hence, staff can still decide to travel by air e.g. due to an exceptional family situation. KUL strongly encourages train travel, but does not enforce it endlessly as to not appear as the 'sustainability police'. When booking via Omnia, a pop-up message appears stating: "this city is on the grey cities list, we suggest you travel by train. Here you can find the train travel options".
- 3) Videoconferencing
- For KUL, qualitative videoconferencing (VC) infrastructure consists of a user-friendly software and service. Staff must also be trained to use it. The VC infrastructure needs to be intuitive and needs to launch automatically after entering a 'meeting-key'.
  - Essential is that staff do not have to potter anymore with hardware, cables, monitors, speakers, internet connections etc. The VC system must start automatically and colleagues must hear and see each other well. The infrastructure should not be too sophisticated either, as this increases investment costs and the need for specialised technical personnel. The VC infrastructure can be partly financed by recovered expenses from flights.
- 4) Awareness-raising
- KUL does not use posters or stickers. Again, KUL does not want to be seen as the 'sustainability police'. KUL raises awareness by reaching out to its staff members: in a personalised email, the carbon footprint of the individual business air travel of each staff member was determined with the Omniatravel data. This email also provides further information that allows to interpret this carbon footprint as well as what compensation would cost. KUL prefers to raise awareness using personal communication rather than large advertising campaigns etc.
  - Furthermore, KUL thinks that staff that does an effort to reduce its air travel consumption, should be accorded a certain recognition for it. On the other hand, KUL also watches out as to not stigmatise staff that still fly. Finding balance in this is difficult: KUL wants to display the efforts it does with regard to sustainability, but it also wants to develop support among its staff. Using the same sticker as UGent (annex 3, p. 95) would prove challenging at KUL: certainly, the ostrich would not be welcomed.
- 5) Compensation
- KUL wants to set a correct price on flying. Currently, KUL internalises the social cost of carbon at €40 per ton of CO<sub>2</sub>. Some research indicates the real cost is more around €60, some even state +€200. The price in the ETS scheme in 2019 swings between €20 and €30. Thus, KUL displays a certain willingness to be ambitious by setting its price higher than the

ETS. Also, its price lays between the ETS price and €60 barrier. But apart for that, there is no hard data that indicates which is the correct price to set.

- It is questionable whether €40 / ton CO<sub>2</sub> suffices to trigger a travel behaviour change. For short trips, KUL's aim is to strongly cut down on air travel. For longer trips, the compensation mechanism is not intended to strongly reduce flying over longer distance as there simply is no 'travel-alternative' to flying, except video-conferencing. Staff fly because they consider the trip essential to their research. Thus, the compensation scheme for long-distance flights must be seen in the spirit of: 'KUL staff members fly because they consider it essential for their job or research. However, KUL staff knows that air travel is polluting and it is prepared to compensate for it.' KUL also does not close its eyes for reality: it knows staff will continue flying, but wants to minimise the externalities thereof.

#### 6) KULeuven Climate Fund

- For the moment, the €40 per ton CO<sub>2</sub> compensation is voluntary.
- This implies that staff have to manage research budgets and can decide to spend part of it for business travel compensation. Compensations are collected by means of an annual compensation invoice. The revenues from compensation are collected in the KUL Climate Fund. The KUL Climate Fund is a bottom-up fund. This means that each and every staff member individually contributes to this fund, contrary to the KUL board merely determining the compensation cost with calculations based on number of trips, travel mode etc. KUL chose this system as it attaches great importance to a university-wide debate on this topic and wants to grow a business travel conscience among its staff.
- Today, The KUL Climate Fund can be used for four 'types' of compensation:
  - a) investing in video-conferencing infrastructure,
  - b) reforestation,
  - c) supporting non-profits such as Carbon+Alt+Delete,
  - d) financing climate research projects.

#### 3.1.7 Ghent University

The executive committee of UGent published a note on sustainable business travel in May 2018. It estimates that 15% of its CO<sub>2</sub> emissions comes from business trips. UGent acknowledges its strategic sustainability pillar ("*UGent wants to be a leading knowledge institution for a future that is ecologically, socially and economically sustainable, within a local and global context*"). The note also suggests four concrete actions in order to fulfil this commitment (translated from Dutch).

##### 1) Centralised booking in Uniglobe Smart Travel

- UGent has a framework agreement with Uniglobe Smart Travel. Since 2017 a database collections information on mode, destination, travel time etc.
- Most of the trips are done via Uniglobe. Staff that book a trip outside the contract (individually online) are notified by the Finance department on the obligation to comply with the framework agreement.
- Uniglobe provides awareness-raising information when a trip is booked.

## 2) Incentivize alternatives for flying and restrict flying

- UGent employs a list of green and orange cities (annex 11, p. 119). Green cities are cities for which the travel time by bus or train from Ghent is 6 hours or less, or cities of which the travel time by train is less than or equal to the travel time by air. Flying to green cities is prohibited.
- Orange cities are for which the travel time bus or train from Ghent is 8 hours or less, or cities of which the travel time by train is less than or equal to the travel time by air. Flying to orange cities is strongly discouraged and train or bus rides are offered as the preferred option by Uniglobe.
- Travel to 'orange cities' for which travel by train or bus is maximum 8 hours will be strongly discouraged by plane. This creates an opportunity to realise a change of mind-set. Travel mode choice is still completely free, but staff has to say 'no' to the sustainable option instead of the airplane.
- Exceptions are possible but they must be duly justified in a field available for that purpose when ordering the journey at Uniglobe.
- UGent wants to deploy the Greenpoints system for staff and students which is the NMBS Europe loyalty programme for companies that give priority to train travel. These Greenpoints can then be used to obtain a discount on future train journeys.

## 3) Videoconferencing

- UGent organises workshops to learn how to use videoconferencing rooms.

## 4) Awareness

- UGent informs new employees about sustainable alternatives to air travel from the start of their career.
- UGent replaces aircraft images with images that promote more sustainable forms of travel.
- UGent distributes visually attractive information on the high CO<sub>2</sub> emissions of air travel as not all staff are aware.
- UGent organises workshops and preparation of a roadmap to learn how to organise conferences with a low environmental impact.
- UGent uses its "I didn't fly!" sticker that can be used by staff in presentations, documents etc. when the staff member travelled used alternative travel modes. The sticker can be found in annex 3. This way, UGent wants to profile itself as a progressive university and it creates a positive social dynamic.

## 5) Compensation

- UGent offsets the CO<sub>2</sub>-emissions of every plane trip, where possible. The framework contract with Uniglobe currently allows for CO<sub>2</sub> compensation when booking international flights. It is unknown whether UGent has a specific climate fund to collect compensations in.

Uniglobe cooperates with CO<sub>2</sub> Logic. The compensation fees vary between €2 and €50. The compensation finances UN-approved climate projects.

- UGent realises that by limiting travel possibilities and the more expensive train tickets, compliance with the Uniglobe framework agreement can be jeopardised. It suggests to charge an (administrative) compensation of €50 per airline ticket purchased outside the framework agreement, which is to be stored with the CO<sub>2</sub> compensation revenues.

6) Cooperate with governments, industries and society to develop more sustainable internationalisation

- UGent wants to take on an exemplary role on sustainable internationalisation by cooperating with its Flemish, European and international networks and associates.
- Via these networks, UGent wants to lobby for the abolishment of subsidies and for the international levy taxation on CO<sub>2</sub> in aviation (and other polluting sectors).
- Cooperate with the EU in order to integrate sustainable travel in the Erasmus programmes (Bestuurscollege UGent, 2018; Lenoir, 2018; UGent, 2018)

### 3.1.8 Conclusion

Analysing travel policies of other European universities has resulted in the following list of possible measures towards curbing ecological footprints of UHasselt:

- Videoconferencing,
- Oblige booking via a central platform,
- Prohibit flying for distances smaller than 500-700 km,
- Prohibit flying to cities that can be reached by train or bus in less than 6 hours (or 8 hours),
- Awareness and reward campaigns e.g. stickers, personal emails, learn how to organise low environmental impact conferences,
- Prohibit and restrict flying for certain associates e.g. PhD students,
- Calculate and communicate carbon emissions per staff member and compare,
- Set a price on carbon (€20-40 per ton CO<sub>2</sub>),
- Set a carbon budget,
- Set up a transport hierarchy,
- Support a climate fund (e.g. Fair Climate Fund) or set up a University Climate Fund,
- Organise centralised conferences,
- Offset carbon emissions,
- Avoid layovers,
- Encourage overnight stays for longer journeys,
- Cooperate with institutions e.g. EC or the industry: NMBS Greenpoints.

## 3.2 International business travel survey

### 3.2.1 Sample size

From the UHasselt human resources office the following figures with respect to the UH staff were obtained: 319 independent academic staff (professors), 118 postdocs, 603 PhD students and 414 administrative and technical staff. Besides, there is also an unknown number of other researchers e.g. temporary or voluntary assistants. These are not included in the sample calculation.

The aforementioned numbers result in a total of 1453 staff members (not full time equivalent). The following formula determines the sample size needed in order for the research to be representative.

$$n \geq \frac{N \times z^2 \times p(1-p)}{z^2 \times p(1-p) + (N-1) \times F^2}$$

With:

- $n$  = required number of respondents
- $z$  = standard deviation (1.96 at 95% confidence is common)
- $N$  = population size = 1453
- $p$  = chance that someone gives a certain answer (50% is common)
- $F$  = error margin (5% is common)

The formula stipulates that 304 respondents are necessary in order to have a representative sample at a confidence level of 95%.

### 3.2.2 Design and method

The survey includes 19 questions, questioning the following:

- Function at UHasselt,
- Affiliation to faculty,
- Number of international business trips in 2018,
- Characteristics of business trip booking,
- European countries and cities visited,
- Purpose and duration of business trip,
- Transport mode,
- Factors affecting mode choice,
- Feeling of responsibility for contribution to climate change,
- Opinion on several measures, listed in 3.2.8.

The survey opened on February 14<sup>th</sup> and was closed on the 8<sup>th</sup> of March 2019. After eliminating the 106 non-completed responses, 336 respondents were left. Throughout the inferential analyses, a significance level of 5% is adopted. This figure suffices in order to have a 95% confidence level. The complete survey can be found in annex 5 (p. 103).

### *Determining emission factors*

An emission factor has to be chosen in order to determine the environmental impact of the sample's business travel. These emission factors should as closely as possible reflect the real, all-inclusive environmental damage. The 2018 UK Government (DEFRA)<sup>8</sup> emission conversion factors for GHG company reporting is an appropriate emissions database for the reasons following reasons. It has a detailed, free-to-download Excel file.

- The spreadsheet is updated annually: compared to the previous year's factors, changes may be made due to new data availability, methodology improvements or corrections to errors in methodology.
- It comes with detailed environmental reporting guidelines (also updated annually) which help companies and organisations with reporting on a range of environmental matters, including GHG emissions reporting. The 5 steps in environmental reporting are discussed in the next section.
- It distinguishes three scopes that each categorise different emissions-releasing activities. Scope 1 concerns the direct emissions, scope 2 the emissions from indirect energy consumption and Scope 3 other indirect emissions. Scope 3 is the most all-inclusive and hence used in this database.
- It clearly indicates how GHG emissions must be calculated for a particular activity:
  - o  $GHG\ emissions = activity\ data \times emissions\ conversion\ factor$
- By using this spreadsheet, one can report on seven GHGs, as covered by the Kyoto Protocol: CO<sub>2</sub>, methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF<sub>6</sub>) and nitrogen trifluoride (NF<sub>3</sub>).
- It presents the emission factors as CO<sub>2</sub>e (equivalent), which is the universal unit of measurement to indicate the global warming potential (GWP) of GHGs, expressed in terms of GWP of one unit of CO<sub>2</sub>. The GWPs used in the CO<sub>2</sub>e calculations are based on the UN International Panel on Climate Change's Fourth Assessment Report (GOV.UK, 2018).

In the below section, the five steps in environmental impact reporting as presented by DEFRA are described. TABLE 5 on page 45 merges the emission factors relevant for this thesis. These figures will be used in the further emission calculations.

- 1) Determine the boundaries of UHasselt.  
Previously, it was discussed that this thesis limits itself to the direct emissions caused by UHasselt business travel. Thus, the boundary is all of the UHasselt related business travel.
- 2) Determine the period you should collect data.  
This thesis aims at determining the environmental impact of UHasselt related business travel in 2018 of the survey sample.
- 3) What are the key environmental impacts for your organisation?  
UK GOV identifies six categories: 1) greenhouse gases, 2) water, 3) waste, 4) materials and resource efficiency, 5) biodiversity and ecosystem services, 6) emissions to air, land and water. Business travel relates to category 1) and 6).
- 4) Measuring

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<sup>8</sup> Department for Environment, Food and Rural Affairs

- The only data available for measuring is the activity data from the survey.
- For flights, it is important to distinguish between short-haul and medium-haul flights. UK Government defines domestic flights as flights between domestic airports. Short-haul flights are defined as flights, typically to Europe, of less than 3700 km. However, EUROCONTROL (2005) defines short-haul as < 1500 km and medium-haul between 1500 km and 4000 km. Long-haul flights are flights over 4500 km, but irrelevant for this thesis. For the purpose of this thesis short-haul will be defined as flights <800 km and medium-haul flights as flights <3700 km. 800 km is chosen as this is, as seen during the literature review, the tipping point between rail and air services. 3700 km is chosen as to facilitate working with the UK Gov emission conversion dataset.
- Furthermore, one has to choose between including well-to-tank (WTT) and Radiative Forcing (RF) or not. WTT air conversion factors account for emissions associated with extraction, refining and transporting aviation fuel. RF is a measure of the additional environmental impact of aviation. These include NO<sub>x</sub> and H<sub>2</sub>O when emitted at high altitude.
- In the literature review it was argued that emissions other than CO<sub>2</sub> must also be considered and also that the aviation industry does not account for all emissions it indirectly emits. Therefore, WTT-factors will be used. Then, UK Gov also advises organisations to include the influence of RF in order to capture the maximum climate impact of their travel habits. However, it should be noted that significant scientific uncertainty exists around the magnitude of the additional environmental impacts of aviation. Keeping in mind the uncertainty, this thesis will consider RF, as including it draws the most complete image of environmental damage, which is the best answer to the research question of this thesis.

#### 5) Reporting

Results must be reported in a transparent and balanced fashion. Firstly, the report should specify how the different steps have been carried out and what the outcome was for each. Secondly, the report must explain how the organisation manages its impacts e.g. EU Eco-Management and Audit Scheme (EMAS), ISO 14001 and who has responsibility for this. An Environmental Management System (EMS) ensures good data management and they help organisations to meet their own environmental and sustainability targets.

(GOV.UK, 2019)

#### *Retained emission factors*

In section 2.2.2.4 it was concluded that air travel emits 3-9 times more CO<sub>2</sub> than high-speed rail travel. TABLE 5 shows that when accounting for radiative forcing and all greenhouse gases (thus CO<sub>2e</sub>), travelling by international train is the least harmful, followed by coach travel.

CO<sub>2</sub> equivalent is the expression that describes different GHG in a single unit. For any quantity or type of GHG, CO<sub>2e</sub> signifies the amount of CO<sub>2</sub> which would create the same warming effect. Using CO<sub>2e</sub> makes sense as it allows the bundle GHGs in a single number and it facilitates comparing different GHG bundles in terms of their total global warming impact (Ecometrica, 2012). Especially for evaluating the effect of air travel, CO<sub>2e</sub> proves useful. In air travel, it is important to consider more than only CO<sub>2</sub>, as for example H<sub>2</sub>O has a larger RF than CO<sub>2</sub> solely. Thus, in order to picture environmental impact in the most accurate way, CO<sub>2e</sub> is the unit to be used.

Flights shorter than 800 km appear to indeed emit about 3 times more GHGs compared to an international train. In the literature study it was argued several times that high-speed rail is potentially very competitive with flights shorter than 800 km. The table is consistent with the finding in the literature review.

The figures in TABLE 5 will be used in 3.2.3.3 to determine the environmental impact of the UHasselt sample.

TABLE 5: Emission factors (GOV.UK, 2018)

Mode	Class / type	Unit	kgCO <sub>2</sub> e
Bus	coach	pkm	0.0278
Rail international	international	pkm	0.01226
Car (unknown fuel type)	Average	pkm	0.18064
Flight <800 km	economy	pkm	0.26744 (2017)
Medium-haul flight <3700 km	economy	pkm	0.16103 (2017)



### 3.2.3 Results

In this section, the SPSS survey output and Excel calculations are used to illustrate:

- the characteristics of business travel at UHasselt (travel frequencies, arrangement of business trips, trip destinations, modal split, influential factors in mode choice, travel purpose),
- the attitudes of UHasselt staff towards sustainable business travel measures,
- the environmental impact of the UHasselt (sample) business travel (estimation).

#### *Distribution of respondents according to function and faculty*

After elimination of incomplete surveys, 336 respondents are kept for further analysis. Their respective distribution over positions and faculties can be found in table 7<sup>9</sup>.

TABLE 6: *Distribution according to UHasselt function and faculty*

Function	n	%	Faculty	n	%
Professor	84	25.0	Architecture	23	9.3
Postdoc	50	14.9	Business economics	37	15.0
PhD student	80	23.8	Life sciences	30	12.1
Other researcher	32	9.5	Engineering technology	26	10.5
Member of CAM	90	26.8	Transportation sciences	16	6.5
Total	336	100	Rehabilitation sciences	13	5.3
			Sciences	87	35.2
			Law	13	5.3
			Educational sciences	2	0.8
			Missing <sup>10</sup>	89	26.5
			Total	247	100

<sup>9</sup> A minor error must have occurred somewhere since *n* (member of central administrative service) equals 90, yet missing equals 89 at faculty level

### 3.2.3.1 UHasselt business travel characteristics

#### 3.2.3.1.1 Travel frequency

##### Absolute

- 201 of the 336 respondents travelled for UHasselt related purposes in 2018. This equals 60%.
- 17 of those 201 solely travelled outside Europe and are omitted from the analysis.
- Hence, 184 respondents travelled in Europe in 2018 (54%). FIGURE 6 displays their travel frequency.
- The average UHasselt staff member (only travellers) made 3.2 business trips in 2018 (580/184).
- The average UHasselt staff member (whole sample) made 1.7 business trips in 2018 (580/336).
- The median is 2 business trips in 2018 (n=336).

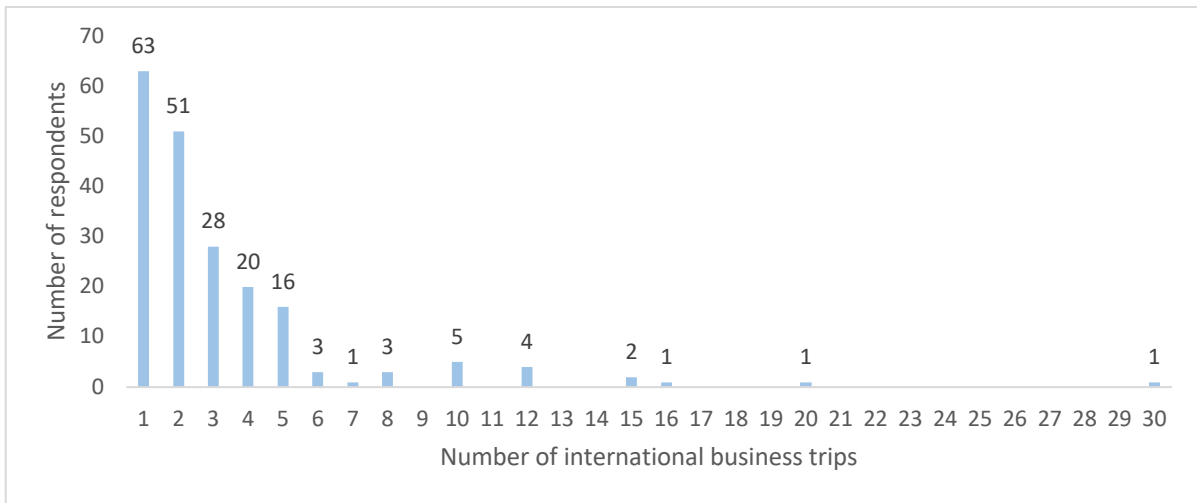


FIGURE 6: Travel frequency of UHasselt staff in 2018 (n=184)

##### Average number of trips per UHasselt position

A detailed table can be found in annex 12 (p. 121). On average, professors and PhD students seem to travel most. Members of the central administrative services travel less on average, yet a much greater variation is present within this group. FIGURE 7 is a bar plot that displays the means and the whisker indicates the standard deviation. Detailed figures can be found in annex 12.

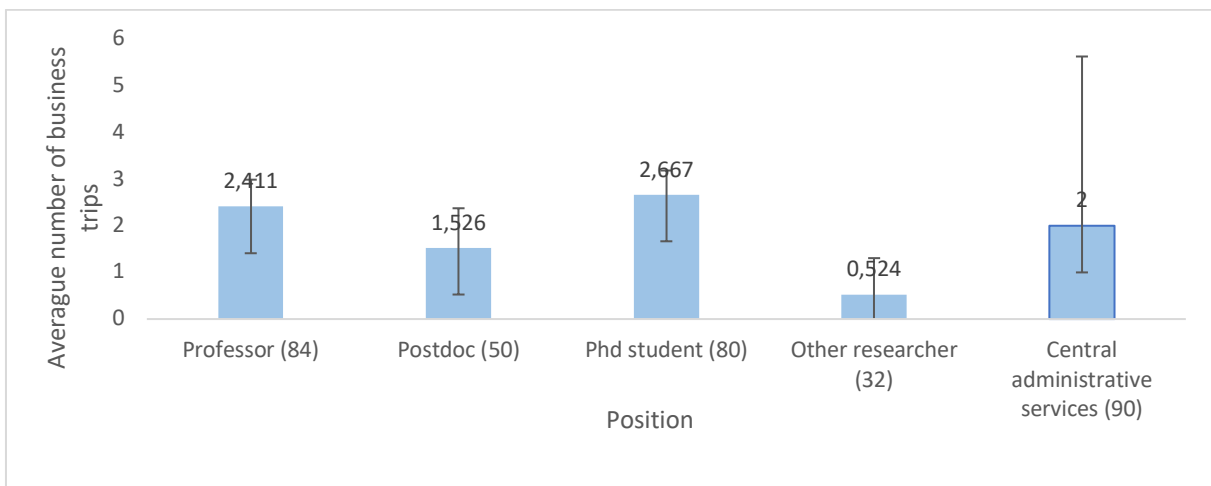


FIGURE 7: Average number of business trips per position in the year 2018 (n=336)

Average number of trips per faculty

The number of respondents for this graph is 247. When considering all respondents (n=336), one has to subtract that number with the central administrative service (n=89). FIGURE 8 is a bar plot that visualises this data. The figures atop the bars are the faculty average. A table containing detailed information on this graph can be found in annex 10 (p. 118).

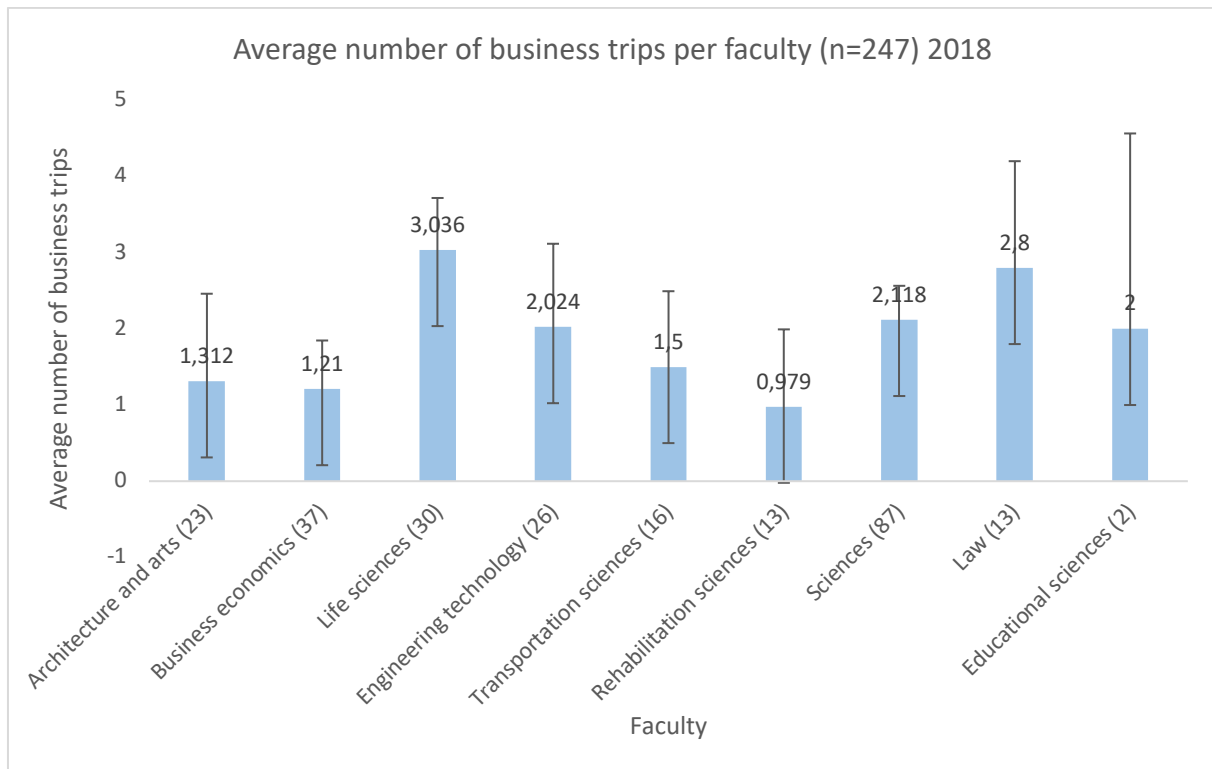


FIGURE 8: Average number of business trips per faculty in 2018 (n=247)

Effect of UHasselt staff position and faculty affiliation on number of trips.

A generalised linear model is constructed with 'number of trips' as the dependent variable. Since 'number of trips' is a count variable, ANOVA techniques should not be used. As can be seen in annex 6 (p. 112), 'number of trips' is a count variable best approximated by a Poisson probability distribution. For the sake of completeness, interaction effects are also included. This regression model as a whole is significant ( $\chi^2 = 126.312$ ,  $df=30$ ,  $p<0.001$ ).

With 'professor' as reference category, no significant effect of faculty was revealed ( $p>0.05$ ).

Effects of UHasselt position are displayed in TABLE 7. Postdocs and other researchers appear to travel significantly less than professors. For PhD students and central administrative services, no significant effect is found. In this regard, the large standard errors should be noted. Especially for central administrative services, the large standard deviation (3.628) shown in FIGURE 7 should be noted.

Next, the significant interaction effects are also displayed in TABLE 7. Postdocs affiliated with the Faculty of Architecture & Arts and that of Life Sciences appear to travel significantly more than the

professors of that faculty. Also, PhD students affiliated with the faculty of Life Sciences appear to travel significantly more than the professors of that same faculty.

TABLE 7: General Linear Model of the effects of positions and faculties (SPSS)

Parameter	B	Standard error	p
Intercept	0.693	0.7071	0.327
Postdoc	-0.680	0.1625	<b>&lt;0.001</b>
PhD student	-0.288	0.3873	0.458
Other researchers	-0.296	0.1143	<b>0.010</b>
Central administrative service	0.288	0.7500	0.701
Architecture & arts * postdoc	0.952	0.4004	<b>0.017</b>
Life sciences * postdoc	1.162	0.3368	<b>0.001</b>
Life sciences * PhD	1.224	0.4686	<b>0.009</b>

### 3.2.3.1.2 Business trip arrangement

FIGURE 9 shows how the 184 staff members from the sample arrange their business trips. 24% book their trips via the (faculty) secretariat, 35% book their trips via Omniatravel and 41% book their trips individually.

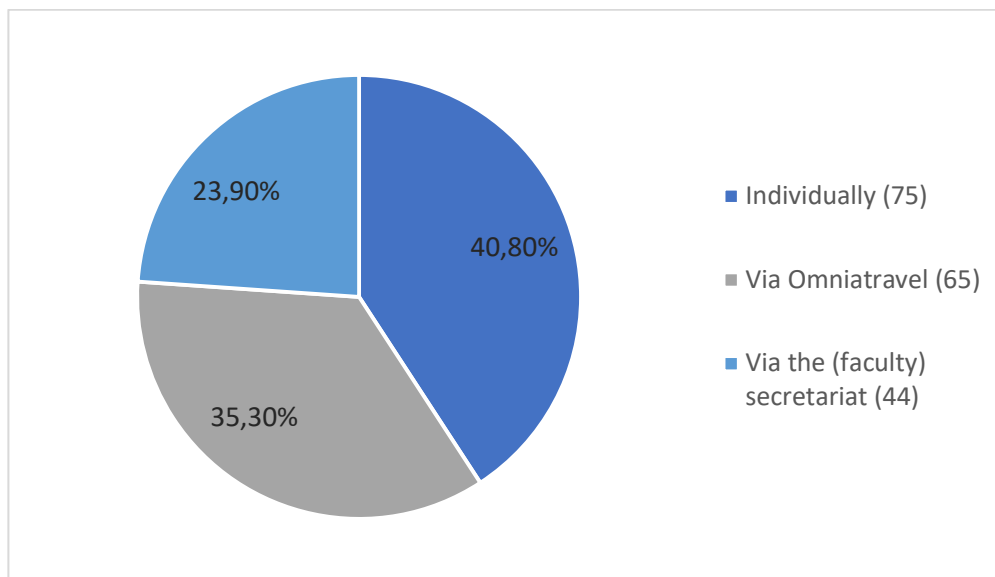


FIGURE 9: Arrangement of business trips in 2018 (n=184)

### 3.2.3.1.3 Business trip destinations

#### Per country

FIGURE 10 is a map of Europe which visually displays the travel frequencies of the 184 staff members that travelled in Europe in 2018. All maps in this section are made using Tableau Software. The table in annex 7 (p. 113) shows how many business trips were taken to every country on the European continent.

- 580 individual business trips are recorded.
- 383 of those trips were outbound to one of Belgium's neighbouring countries: the Netherlands, Germany, Luxemburg, France and The United Kingdom. This represents 66% of all business trips.
- European countries not visited: Croatia, Montenegro, Albania, Kosovo, Latvia, North Macedonia, Moldova, Ukraine, Georgia, Armenia and Azerbaijan (+ micro states e.g. Liechtenstein).

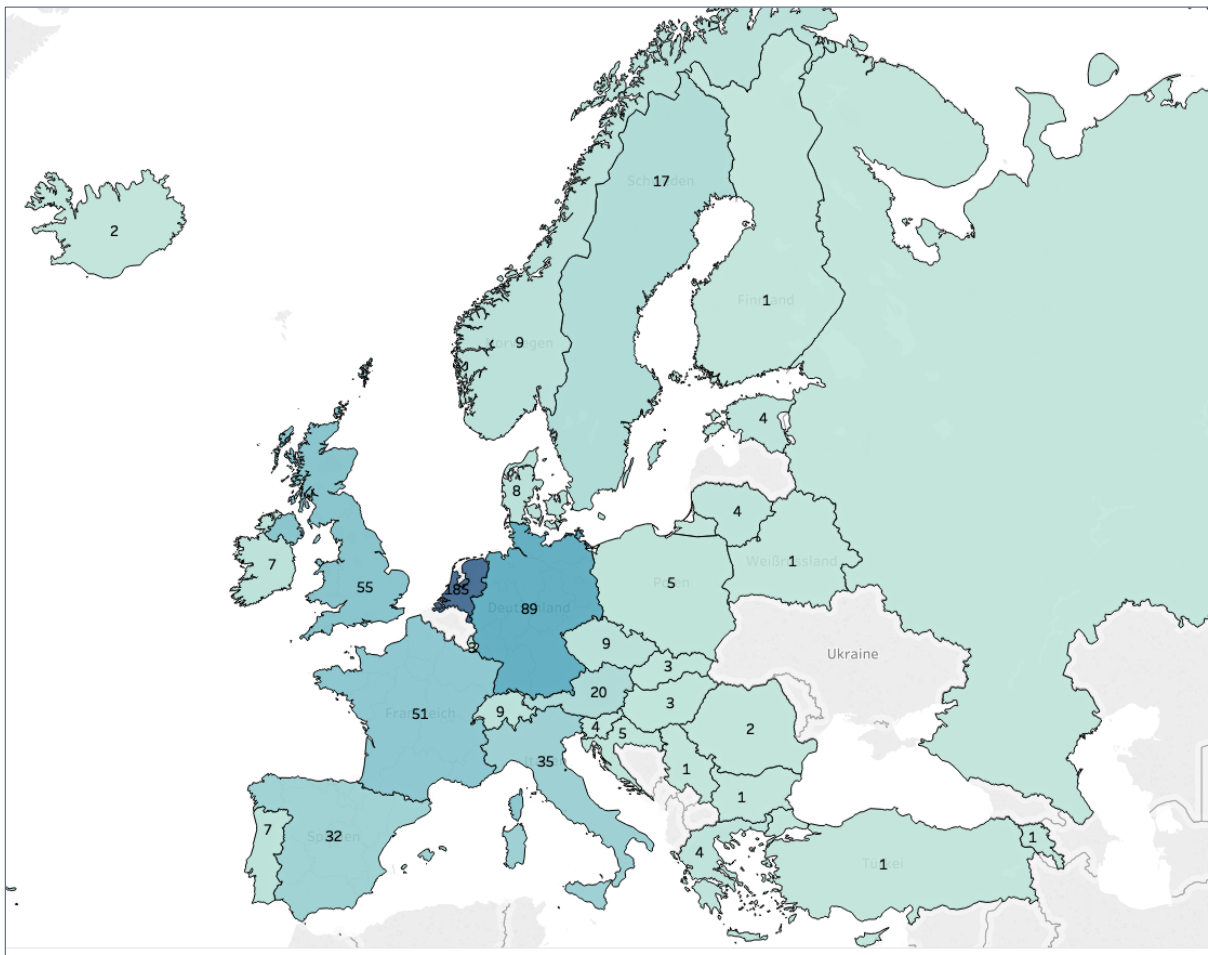


FIGURE 10: Number of business trips to European countries in 2018 (n=184)

Per city

FIGURE 11 visualises all cities that respondents in the sample travelled to. 580 trips are considered. The dot size varies according to the number of respondents that have travelled to the respective city. The list of cities used for drawing the following maps can be found in annex 8 (p. 114). Trips to cities in the following countries are not displayed, as these cities are located outside the map:

- Armenia: Yerevan
- Cyprus: Nicosia
- Norway: Trondheim, Bodo, Bergen, Oslo,
- Russia: Yekaterinburg,
- Spain: Malaga, Granada, Almeria, Tenerife,
- Sweden, Stockholm, Uppsala.

A cluster of cities can be identified in the Meuse-Rhine Euroregion<sup>11</sup> which is a territorial cooperation between administrative bodies e.g. provinces of the Netherlands, Belgium, Germany. They cooperate on higher education, cultural institutions, health institutions and businesses (Euregiomr, 2019).

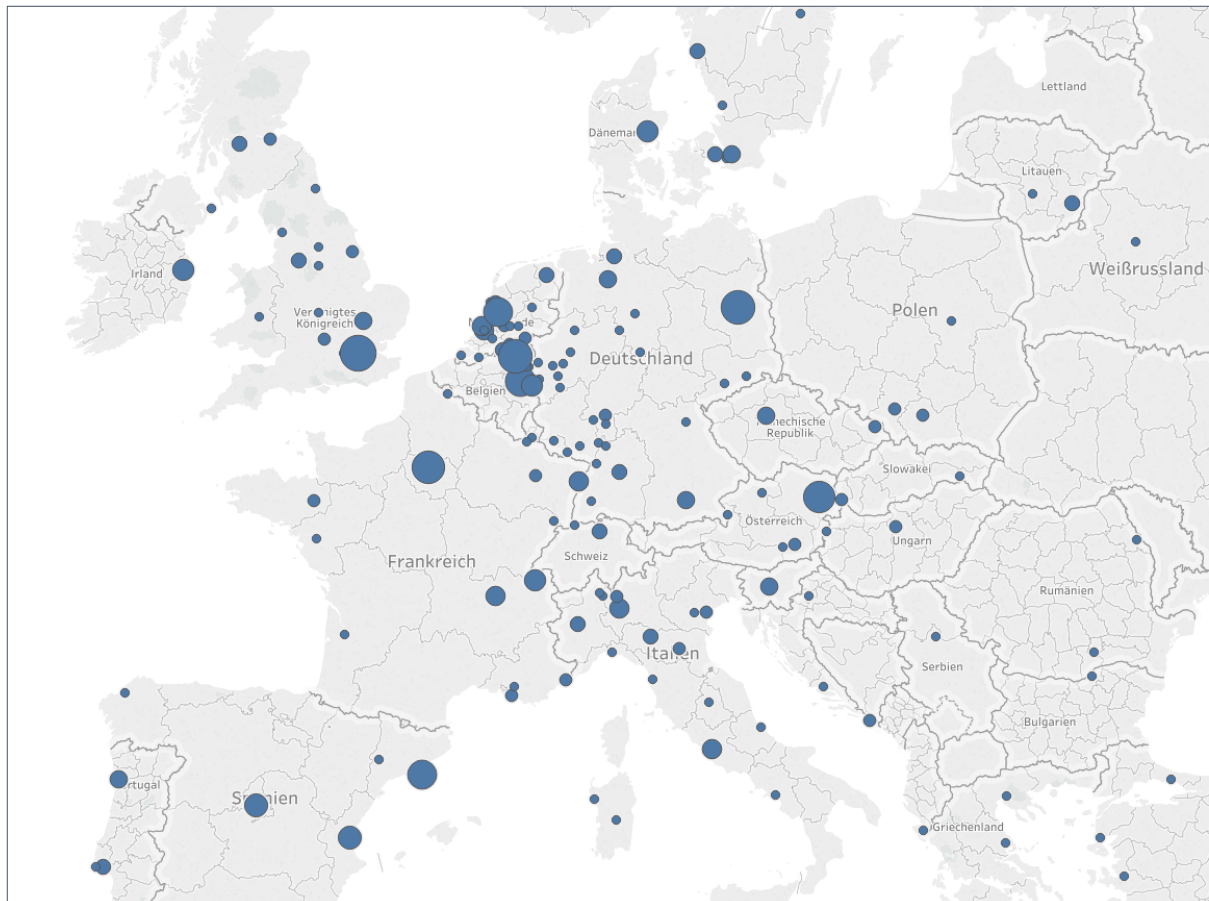


FIGURE 11: Cities visited in Europe in 2018 (n=184)

<sup>11</sup> Dutch: Euregio Maas-Rein

FIGURE 12 visualises all cities in the 500 km, 800 km, and 1000 km sphere of influence of Hasselt. TABLE 8 quantifies the spheres of influence of FIGURE 12. It shows that:

- 37% of European cities that UHasselt staff travelled to in 2018 lie within a 500 km range of Hasselt,
- 60% of European cities that UHasselt staff travelled to in 2018 lie within an 800 km range of Hasselt,
- 67% of European cities that UHasselt staff travelled to in 2018 lie within a 1000 km range of Hasselt.

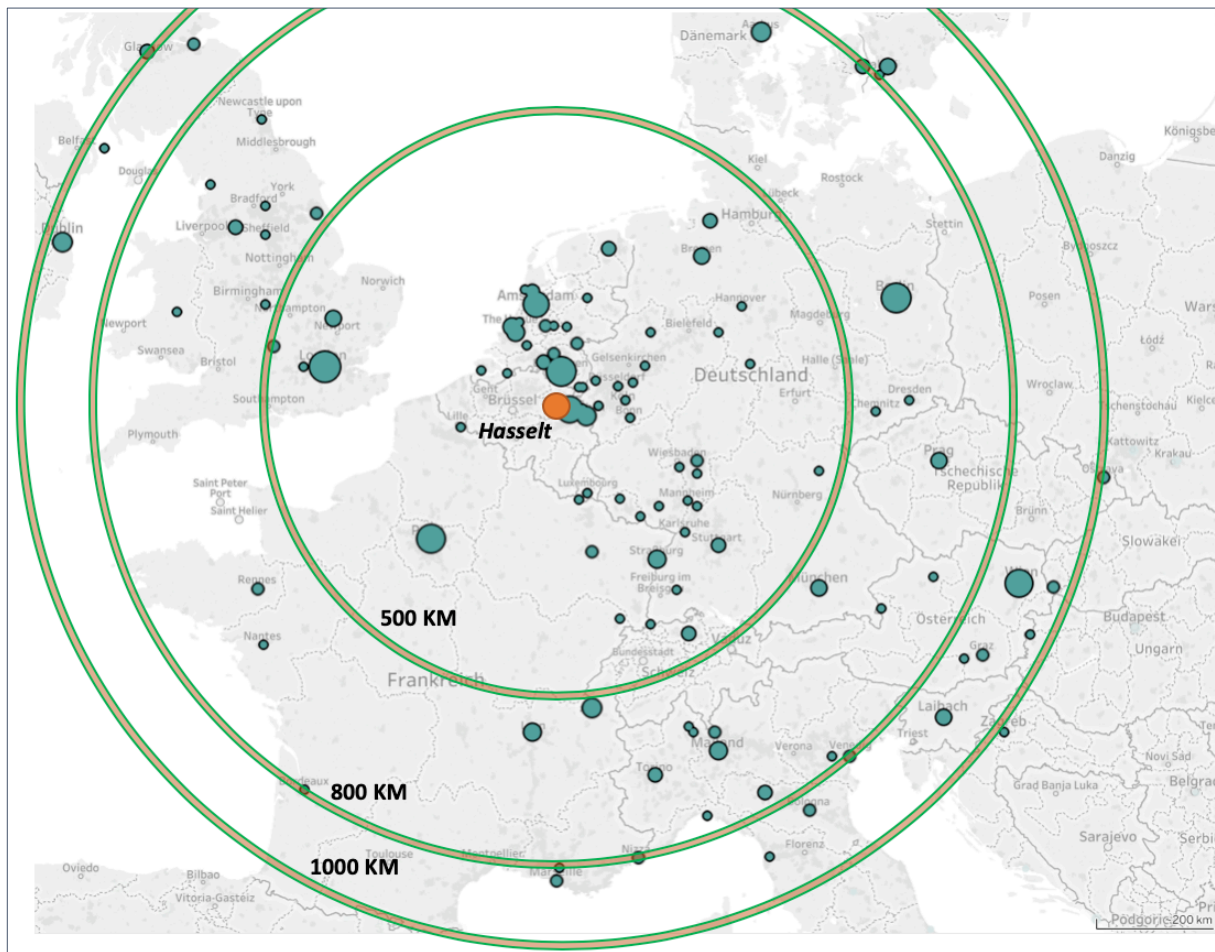


FIGURE 12: Cities in the 500-800-1000km influential sphere of Hasselt

TABLE 8: 500-800-1000km Hasselt-destination spheres of influence (own creation)

Sphere of influence	... of 170 cities	%
500 km	63	37
800km	102	60
1000km	114	67

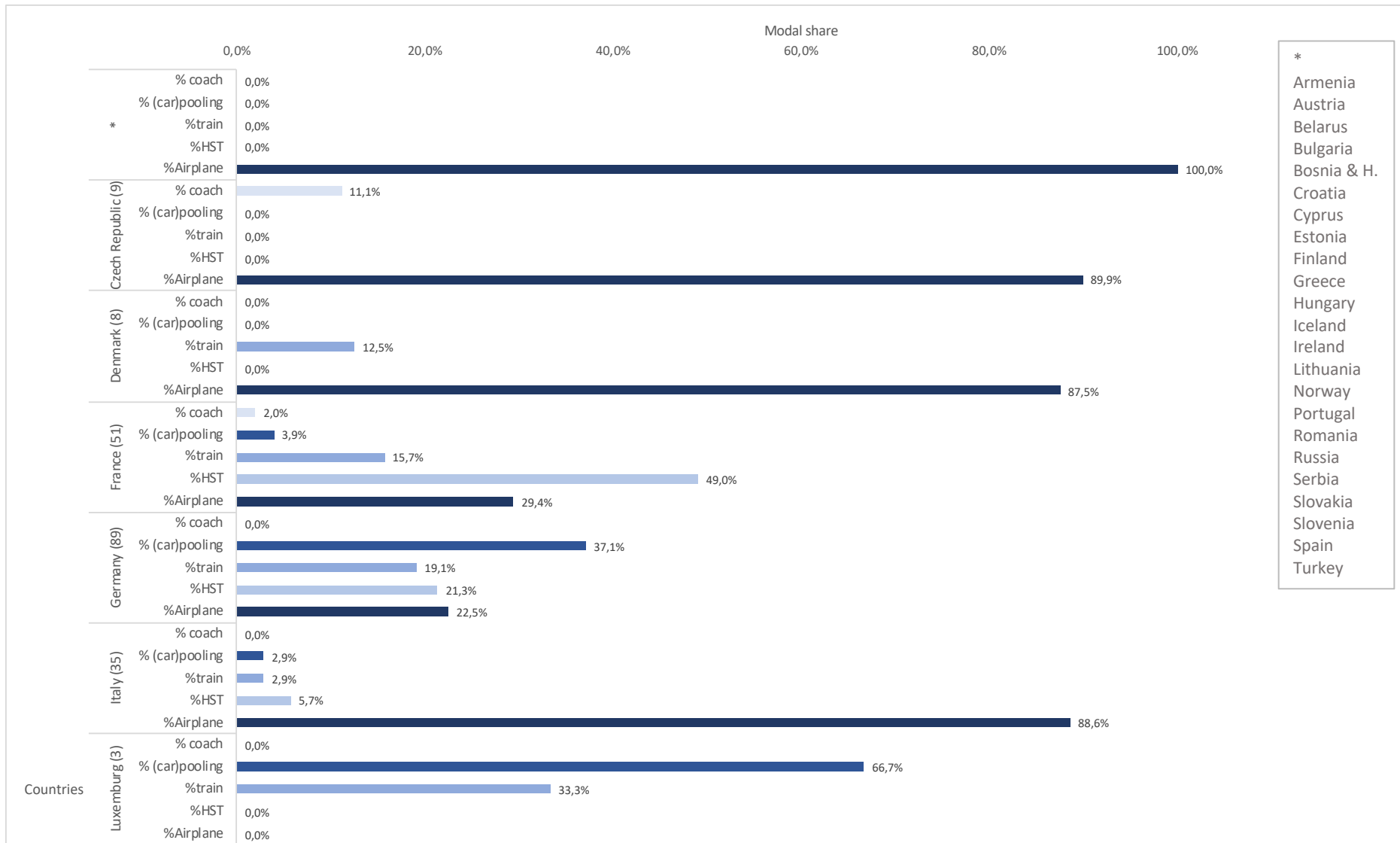
#### 3.2.3.1.4 Modal split

The modal split of European travel per country of the UHasselt survey sample is pictured in FIGURE 13 on the next two pages. TABLE 9 shows the total modal split of the 580 trips of the sample.

*TABLE 9: Modal split of European travel of UHasselt sample in 2018 (n=184)*

Mode	n	Modal share
Coach bus	6	1.2%
Car(pooling)	177	6.2%
Train	73	4.2%
HST	84	4.2%
Airplane	240	84.3%
Total	50	100%





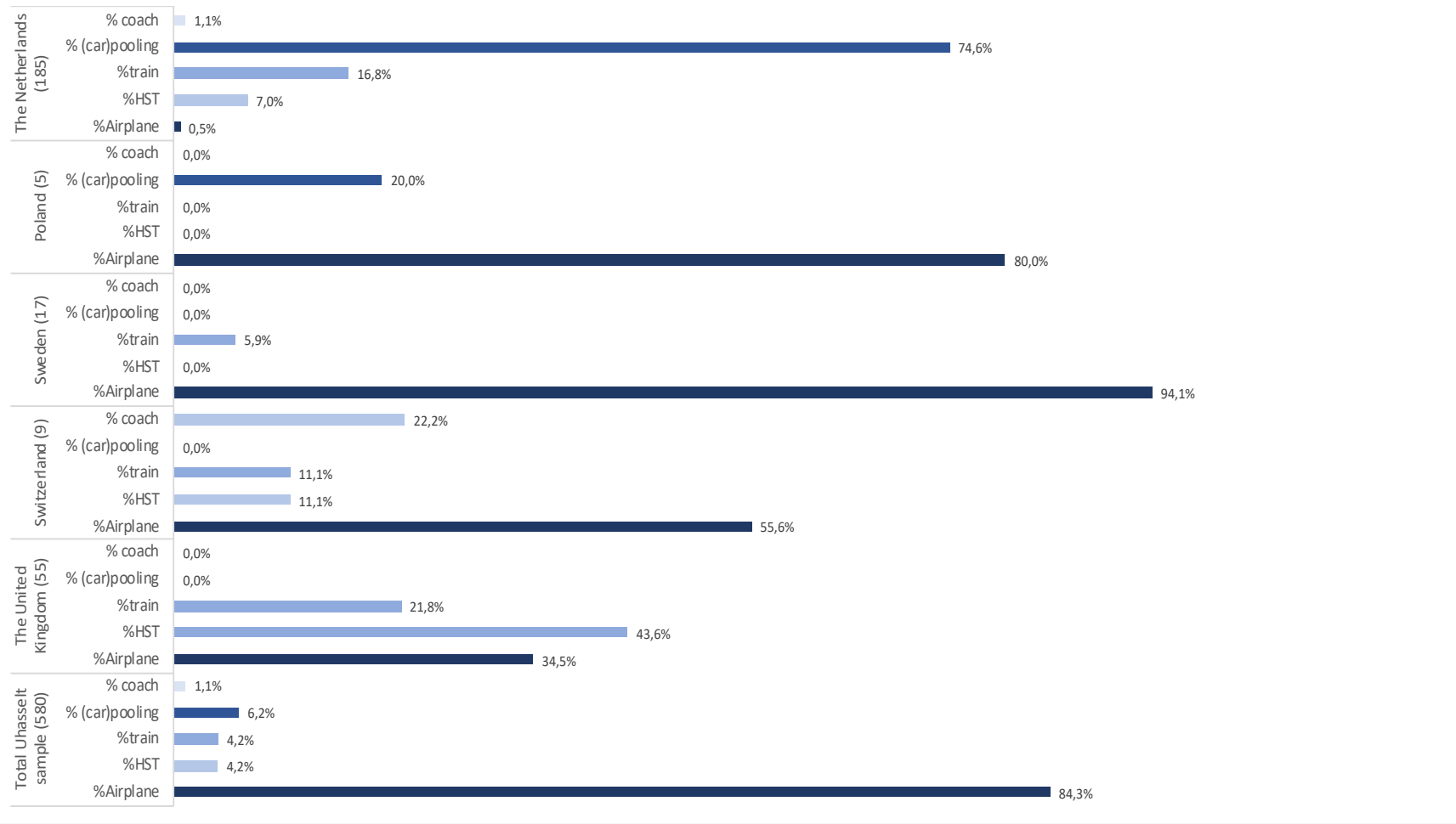


FIGURE 13: Modal split of European business travel in 2018 (n=184)

*Influential factors in mode choice*

In this section five factors that potentially influence mode choice are investigated. The boxplot graph in FIGURE 14 shows that the boxplot for ‘price’ and ‘comfort’ are both comparatively stretched. This suggests that staff hold quite different opinions about both factors.

The boxplot for ‘travel time’ is comparatively short. This suggests that staff have a high level of agreement on the high importance of travel time, outliers not considered. Yet, it is also uneven in size. This suggests that although many staff members attribute high importance to travel time, the longer lower whisker in this boxplot means that staff views are varied amongst the most negative quartile group, and similar for the most important quartile group.

The boxplot for ‘environmental considerations’ and ‘safety’ are comparatively average in size.

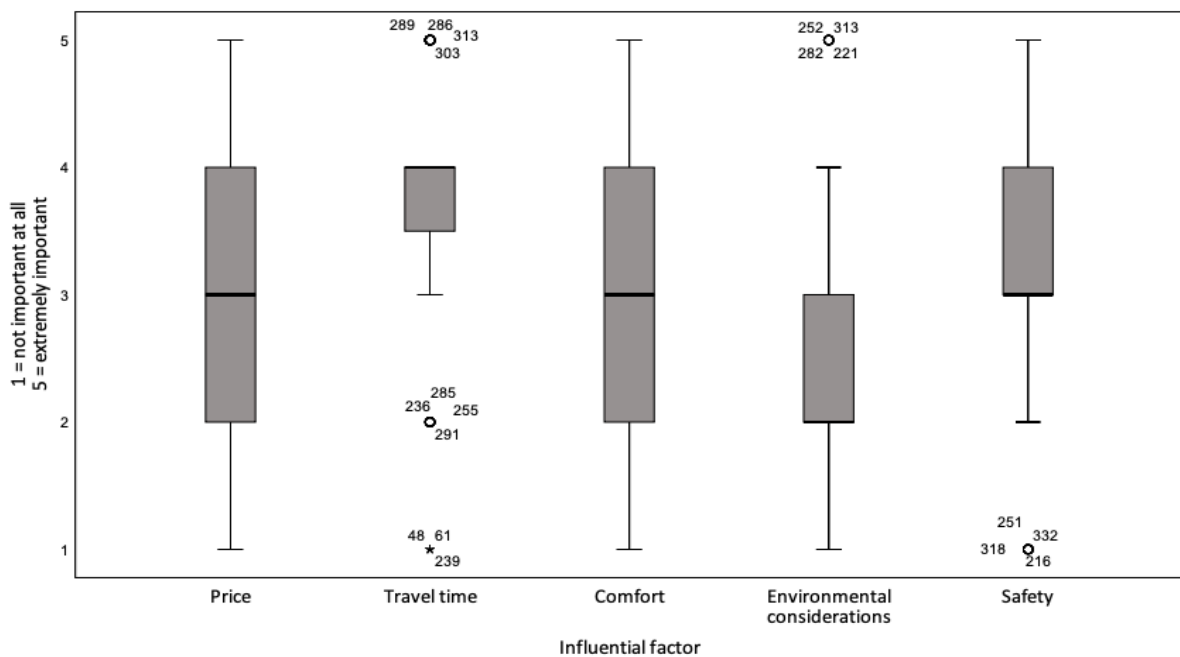


FIGURE 14: Importance of factors influencing mode choice in 2018 (n=184)

The Estimated Marginal Means (EMM) show the importance of the five influential factors (in descending order of importance):

- 1) travel time ( $\bar{x} = 3.87$ ,  $SE^{12} = 0.86$ ,  $95\% CI^{13}[3.74; 3.99]$ ),
- 2) safety ( $\bar{x} = 3.24$ ,  $SE = 1.05$ ,  $95\% CI[3.09; 3.40]$ ),
- 3) price ( $\bar{x} = 3.19$ ,  $SE = 1.00$ ,  $95\% CI[3.04; 3.34]$ ),
- 4) comfort ( $\bar{x} = 3.09$ ,  $SE = 0.88$ ,  $95\% CI[2.96; 3.22]$ ),
- 5) environmental considerations ( $\bar{x} = 2.58$ ,  $SE = 0.99$ ,  $95\% CI[2.44; 2.73]$ )

The 95% CI of ‘travel time’ and ‘environmental considerations’ never overlaps with that of another factor. With 95% confidence one can thus say that ‘travel time’ is the most, and ‘environmental

<sup>12</sup> Standard error

<sup>13</sup> Confidence interval

considerations' the least influential factor in mode choice. 'Safety', 'price' and 'comfort' do not differ significantly in importance.

By means of a repeated measures ANOVA the model is further tested. The dependent variable is mode choice. Mauchly's test of sphericity, used to test the assumption of sphericity in within-subject ANOVAs, indicates that the assumption has been violated ( $\chi^2=43.8$ ,  $p < 0.001$ ). This assumption is that: *the difference scores between each within-subject variable have similar variances*. The violation implies that the one-way repeated measure ANOVA is biased in that it too easily returns a statistically significant result. To correct for this bias, an adjustment in degrees of freedom is made in order to produce a more accurate significance ( $p$ ) value. This correction is called the Greenhouse-Geisser Epsilon ( $\epsilon=0.909$ ) (Mauchly, 1940).

After correction, the ANOVA tests whether the mean values of the variables differ significantly more *within* the individual levels of the dependent variable 'mode choice' than they differ *between* the individual levels of the dependent variable 'mode choice'. The test of within-subject effects shows a result of  $F=48.222$ . This result is statistically significant ( $p < 0.001$ ,  $df=4$ ). The test of between-subject effects shows a result of  $F=6759.792$ . This result is statistically significant ( $p < 0,001$ ,  $df=1$ ). This leads to the finding that the variance between the influential factors as well as variance within influential factors is significant, yet differences are larger between than within the influential factors. The multivariate test reveals an  $F$  value of 48.474. This result is statistically significant ( $p < 0,001$ ). Hence, the ANOVA can be considered valid.

The post-hoc pairwise comparisons in TABLE 10 with Bonferroni correction show the same hierarchy as the EMM. Travel time is significantly more important than all other factors ( $p < 0.01$ ), hence the most important factor. Environmental considerations are significantly less important than all other factors ( $p < 0.001$ ), hence the least important factor.

TABLE 10: Post-hoc comparisons of influential factors in mode choice (SPSS)

Factor 1	Factor 2	Mean difference	Standard error	p
Travel time	Price	0.679	0.080	<b>&lt;0.001</b>
	Comfort	0.783	0.707	<b>&lt;0.001</b>
	Environmental cons.	1.288	0.102	<b>&lt;0.001</b>
	Safety	0.625	0.090	<b>&lt;0.001</b>
Environmental cons.	Price	-0.609	0.093	<b>&lt;0.001</b>
	Travel time	-1.288	0.102	<b>&lt;0.001</b>
	Comfort	-0.505	0.100	<b>&lt;0.001</b>
	Safety	-0.663	0.100	<b>&lt;0.001</b>

### 3.2.3.1.5 Purpose of business travel

By means of calculations in Excel and SPSS the following distribution of travel purposes for the reported business trips within Europe in 2018 were determined. Calculations can be found in annex 9 (p. 117). FIGURE 15 is a bar graph that visualises the purposes of business travel.

- 43% of staff travelled in order to attend a conference, seminar etc.,
- 7% of staff travelled in order to lecture or teach at a foreign institution,
- 18% of staff travelled for research purposes,
- 22% of staff travelled for meeting with peers of the scientific community,
- 4% of staff travelled for meeting with a government body (not further specified),
- 2% of staff travelled for meeting with a private company,
- 4% of staff travelled for other purposes.

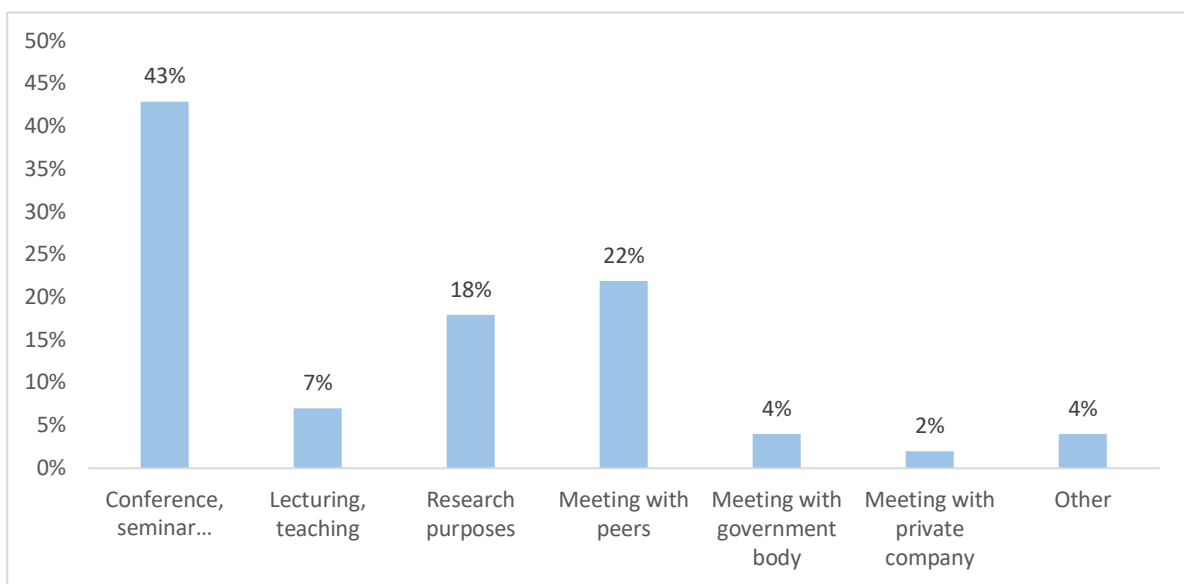


FIGURE 15: Purpose of business trip in 2018 (n=184)

### 3.2.3.2 Attitudes towards sustainable business travel measures

FIGURE 16 displays in descending order the attitudes of UHasselt staff towards business travel measures. It displays the mean for each measure and the whisker visualises the standard deviation. Then, an exploratory factor analysis elaborates further on the attitudes in order to identify latent variables in the attitudes.

Both staff who did travel and staff who did not travel in 2018 answered the same questions. Hence, it is interesting to join the response of both groups together. At the end of this section, a t-test is used to compare the attitudes between both groups. To close, the effect of travel frequency (less/more than 2 trips) on attitudes is investigated by means of correlation matrices and two regression analyses.

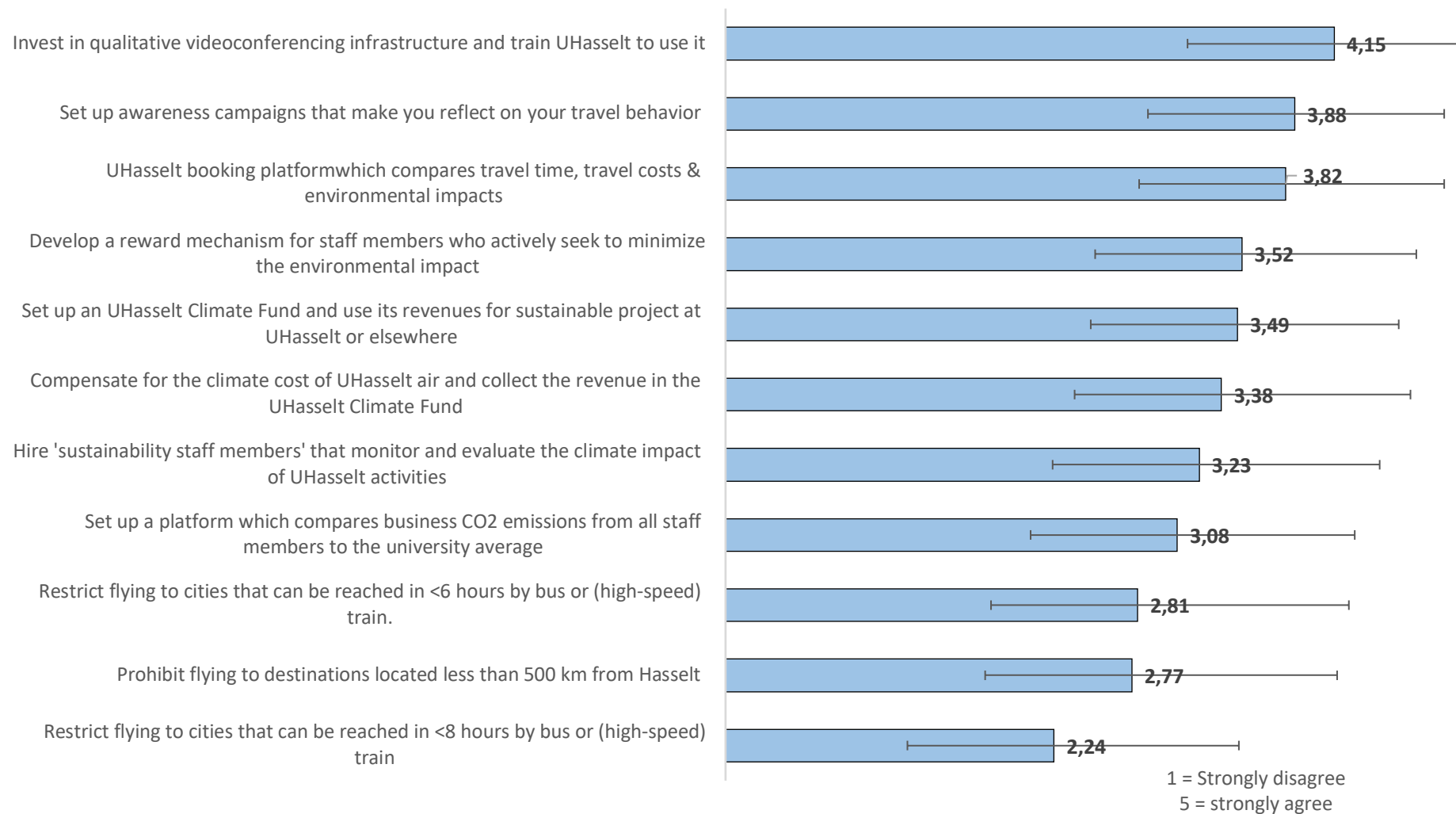


FIGURE 16: Attitudes towards business travel measures in 2018 (n=336)

### 3.2.3.2.1 Latent variables in attitude

A factor analysis is a method for data reduction, based on the correlation of the variables involved. It reduces data by identifying latent variables, that can cluster several manifest variables. The Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity measure the strength of relation among the 11 variables. The KMO test shows that the data is well suited for a factor analysis (0.826). The Bartlett's test shows that the significance level ( $p < 0.001$ ) is small enough to reject the null hypothesis that the correlation matrix is an identity matrix (idre, 2019; Projectguru, 2015).

The dependent variable is the attitude towards business travel measures. This variable consists of 11 measuring variables and covers a scale from 1 (strongly disagree) to 5 (strongly agree). Two factor analyses were carried out. In the second one the variable *Build an intuitive, centralised UHasselt platform for booking business trips which compares travel time, travel costs & environmental impacts* is omitted as it is not sufficiently loaded (0.448). This second factor analysis indicates that latent variable 1 (main component) declares the equivalent of 4 manifest variables (subcomponent) (4.099). Latent variable 2 explains 2 manifest variables (1.577) and latent variable 3 explains 1 manifest variable (1.053). The Rotated Component Matrix in TABLE 11 shows that 3 components are extracted. The rotation serves to reduce the number of factors on which the variables have high loadings and hence facilitates the interpretation. Factor analysis is based on the correlation matrix of the variables involved. The cut-off value is set at 0.5 per factor loading: on from that correlation value between the latent variable and a manifest variable, one can consider the measuring value sufficiently loaded in order to interpret it in that concerned latent variable. Only factor loadings larger than 0.5 are displayed in the table in order to keep it uncluttered.

In order to determine whether the different measures under one principal component can be summarised into one scale, Cronbach's alpha ( $\alpha$ ) must be larger than 0.7 and therefore this value is used as cut-off. Component 1 ( $\alpha=0.784$ ) and component 2 ( $\alpha=0.869$ ) reveal sufficient correlation. The measures under component 3 are not adequately correlated ( $\alpha=0.297$ ). Considering this, only component 1 and component 2 are further discussed. The factor scales for component 1 and component 2 are constructed by taking the means of variables of sufficient factor loading. The result is a 1-to-5 scale, in which higher values correspond with a more positive attitude towards sustainable business travel measures.

The rotated component matrix in TABLE 11 shows that with a cut-off value of 0.5, five measures are covered by factor scale 1:

- develop a reward mechanism for staff members who actively seek to minimize the environmental impact of their business trips (e.g. financial bonuses),
- set up an UHasselt Climate Fund and use its revenues for sustainable project at UHasselt or elsewhere Hire 'sustainability staff members' that monitor and evaluate the climate impact of UHasselt activities,
- compensate for the climate cost of UHasselt air travel and collect the revenue in the UHasselt Climate Fund,
- hire 'sustainability staff members' that monitor and evaluate the climate impact of UHasselt activities,
- set up a platform which compares business CO<sub>2</sub> emissions from all staff members to the university average.

Based on this, factor scale 1 can be named 'centralised UHasselt initiatives (with a monetary aspect)'.

Factor scale 2 covers three of the eleven measures with a substantial factor load:

- restrict flying to cities that can be reached in <6 hours by bus or (high-speed) train. If you choose to fly, transport costs are not reimbursed,
- restrict flying to cities that can be reached in <8 hours by bus or (high-speed) train. If you choose to fly, transport costs are not reimbursed,
- prohibit flying to destinations located less than 500 km from Hasselt.

Factor scale 2 can be named 'air travel restrictions'

Three measures are left out of the factor analysis. These are:

- build an intuitive, centralised UHasselt platform for booking business trips which compares travel time, travel costs & environmental impacts,
- invest in qualitative videoconferencing infrastructure and train UHasselt to use it,
- set up awareness campaigns that make you reflect on your travel behaviour.

The interpretation of the figures in the matrix is to be found in 3.3 Discussion.



TABLE 11: Rotated component matrix with factor loads for the eleven measures (SPSS)

Measure	Factor loading of scale. 1 (Eigenv. = 39.402)	Factor loading of scale. 2 (Eigenv. = 15.768)	Factor loading of scale. 3 (Eigenv. = 10.053)
Invest in qualitative videoconferencing infrastructure and train UHasselt to use it			<b>0.923</b>
Set up awareness campaigns that make you reflect on your travel behaviour			<b>0.555</b>
Build an intuitive, centralised UHasselt platform for booking business trips which compares travel time, travel costs & environmental impacts			
Develop a reward mechanism for staff members who actively seek to minimise the environmental impact of their business trips (e.g. financial bonuses)	<b>0.711</b>		
Set up an UHasselt Climate Fund and use its revenues for sustainable project at UHasselt or elsewhere Hire 'sustainability staff members' that monitor and evaluate the climate impact of UHasselt activities	<b>0.809</b>		
Compensate for the climate cost of UHasselt air travel and collect the revenue in the UHasselt Climate Fund	<b>0.676</b>		
Hire 'sustainability staff members' that monitor and evaluate the climate impact of UHasselt activities	<b>0.662</b>		
Set up a platform which compares business CO2 emissions from all staff members to the university average	<b>0.672</b>		
Restrict flying to cities that can be reached in <6 hours by bus or (high-speed) train. If you choose to fly, transport costs are not reimbursed		<b>0.906</b>	
Prohibit flying to destinations located less than 500 km from Hasselt		<b>0.800</b>	
Restrict flying to cities that can be reached in <8 hours by bus or (high-speed) train. If you choose to fly, transport costs are not reimbursed		<b>0.899</b>	

### 3.2.3.2.2 Differences in attitude

#### *Difference between travellers and non-travellers*

An independent samples t-test revealed a statistically significant difference between the attitudes of staff that did travel in Europe in 2018 (184/336) and staff that did not travel (135/336). This test consists of two elements.

- 1) The first part is the Levene's test for equality of variances. For factor scale 1, 'centralised UHasselt initiatives (with a monetary aspect)', this test reveals that equal variances are not assumed, following the result of an F-value of 4.928. This test is statistically significant ( $p=0.027$ ). The second part of the independent samples test is the t-test for equality of means. For this test, equal variances are not assumed. The t-test reveals a t-value of 2.953. This result is statistically significant ( $p=0.003$ ,  $df=333.311$ ,  $\Delta$  95% CI [0.09, 0.50]).
- 2) The same test is run for factor scale 2, 'air travel restrictions'. For this factor scale, the Levene's test reveals an F-value of 2.120. This result is not statistically significant ( $p=0.146$ ), thus equal variances are assumed in the independent samples test for this variable. The t-test for equality of means reveals a t-value of 2.853, which proves to be statistically significant ( $p=0.005$ ,  $df=334$ ,  $\Delta$  95% CI [0.12, 0.64]).

This t-test shows that staff who travel have a significantly more negative attitude towards both components. This could indicate a 'status-quo bias', which is an emotional bias: a preference for the situation as it is today and the preference to keep business-as-usual (Samuelson & Zeckhauser, 1988).

#### *Difference between two factor scales*

A paired sample t-test revealed the 336 respondents to have a significantly better attitude towards 'centrally rolled out UHasselt initiatives (with a monetary aspect)' than they have towards 'air travel restrictions' ( $t=11.50$ ,  $df=335$ ,  $p<0.001$ ).

#### *Link between travel frequency and attitude towards measures*

##### 1) *Correlation matrices*

The bivariate<sup>14</sup> relationships between the attitudinal components of climate mitigation are displayed by means of a correlation matrix. Two groups are compared: 'frequent' travellers and 'non-frequent' travellers. To distinguish between 'frequent' travellers and 'non-frequent' travellers in the staff sample, a cut-off value of 3 is suggested<sup>15</sup>. Hence, staff that made one or two business trips are considered 'non-frequent' travellers, staff that made three or more business trips are 'frequent' travellers. With this cut-off value, 114 respondents are 'non-frequent' travellers and 85 are 'frequent' travellers'. Using the SPSS function 'split cases' now allows to compute correlations for each group. TABLE 12 and TABLE 13 display the correlation matrices of both groups considering the two factor scales and two related variables 'sense of responsibility for climate change' and 'environmental considerations in mode choice'.

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<sup>14</sup>statistical procedures that involve the comparison of summary values from two groups on the same variable or of two variables within a group.

<sup>15</sup> The median is 2, the sample average is 3.2.

The significant relationships between the attitudinal components of climate mitigation correlations of frequent travellers are also the significant ones of non-frequent travellers. However, the correlations of the former tend to be a bit stronger than those of the latter.

Secondly, the matrix tables show an interdependent correlation between the two factor scales 'air travel restrictions' and 'centralised UHasselt initiatives (with monetary aspect)' ( $p < 0.001$ ). They also show an interdependent correlation between the two variables 'sense of responsibility for climate change' and 'environmental considerations in mode choice'.

Thirdly, the tables show that the more one feels responsible for his/her contribution to climate change, the more he/she is positive towards 'centralised UH initiatives (with monetary aspect)', but not towards 'air travel restrictions'

Lastly, the more one considers environmental impact in mode choice, the more he/she holds a positive attitude towards both factor scales. This corresponds with the finding in the paired sample t-test.

TABLE 12: Correlation matrix of non-frequent travellers (SPSS)

Measure		Air travel restrictions	Centralised UHasselt initiatives	Responsibility for climate change	Environmental considerations in mode choice
Air travel restrictions	Pearson Correlation	1	0.410*	0.116	0.427*
	p		<b>&lt;0.001</b>	0.254	<b>&lt;0.001</b>
	n	114	114	98	99
Centralised UHasselt initiatives	Pearson Correlation	0.410**	1	0.288*	0.343*
	p	<b>&lt;0.001</b>		<b>0.004</b>	<b>0.001</b>
	n	114	116	98	99
Responsibility for climate change	Pearson Correlation	0.116	0.288*	1	0.429*
	p	0.254	<b>0.004</b>		<b>&lt;0.001</b>
	n	98	98	98	98
Environ. Considerations in mode choice	Pearson Correlation	0.427*	0.343*	0.429*	1
	p	<b>&lt;0.001</b>	<b>0.001</b>	<b>&lt;0.001</b>	
	n	99	99	98	99

\*Correlation is significant at 0.01 (2-tailed)

TABLE 13: Correlation matrix of frequent travellers (SPSS)

Measure		Air travel restrictions	Centralised UHasselt initiatives	Responsibility for climate change	Environmental considerations in mode choice
Air travel restrictions	Pearson Correlation	1	0.354*	0.169	0.448*
	p		<b>0.001</b>	0.124	<b>&lt;0.001</b>
	n	85	85	84	85
Centralised UHasselt initiatives	Pearson Correlation	0.354*	1	0.331*	0.488*
	p	<b>0.001</b>		<b>0.002</b>	<b>&lt;0.001</b>
	n	85	85	84	85
Responsibility for climate change	Pearson Correlation	0.169	0.331*	1	0.514*
	p	0.124	<b>0.002</b>		<b>&lt;0.001</b>
	n	84	84	84	84
Environmental considerations in mode choice	Pearson Correlation	0.448*	0.488*	0.514*	1
	p	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	
	n	85	85	84	85

\*Correlation is significant at 0.01 (2-tailed)

### 3.2.3.3 Environmental impact

When applying the emission factors discussed in TABLE 5, the modal split of emissions (calculated in CO<sub>2</sub>e) is the following (see FIGURE 17). 580 business trips are considered.

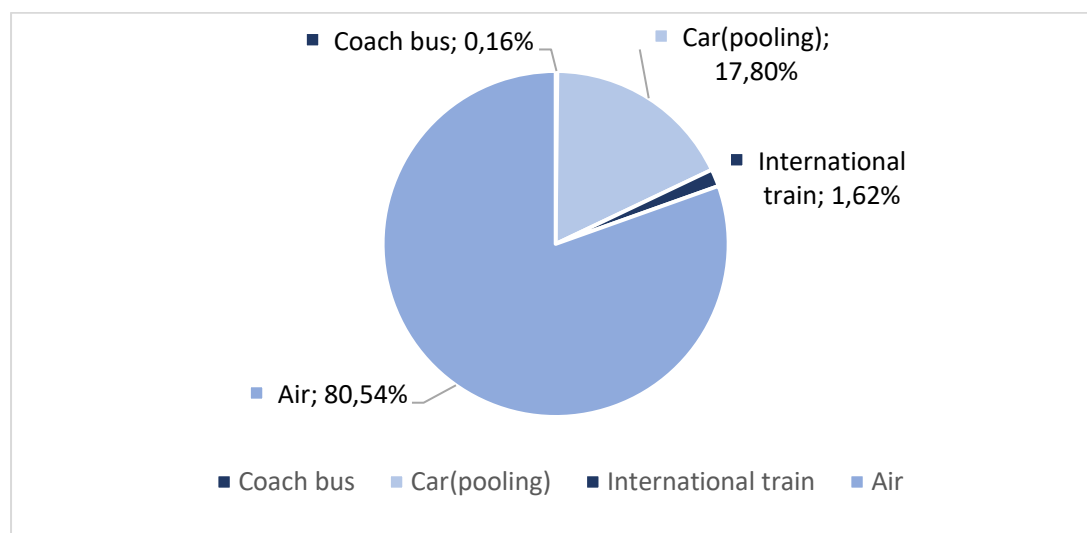


FIGURE 17: Modal split of emissions of UHasselt staff sample in 2018 (n = 184)

Further calculations show the following distribution of emissions per mode. These calculations were made on the following conditions:

- Distance:
  - o Only whole trips are considered e.g. return flight Stockholm, return train ride Cologne
  - o Road travel: shortest driving distance from Hasselt to capital city of the respective country via Google Maps (km)
  - o Rail travel: same distance as road due to lack of information on rail distances
  - o Air: flight distance according to: <https://nl.distance.to/Brussel>
- Number of trips: the emissions per country vary according to frequency of visit of the respective country

TABLE 14: Environmental assessment of European UHasselt business trips in 2018 (n=184)

Mode	Coach bus	Car(pooling)	International train	Air travel
Total emission / mode (kg CO <sub>2</sub> e)	167.67	19,070.89	1,732.58	86,176.77
Percentage	0.16%	17.80%	1.62%	80.54%
Total CO <sub>2</sub> e (equivalent) emissions business travel sample (n=580 trips)	<b>107,147.91 kg (± 107 ton)</b>			

The environmental effect of the business trips of UHasselt staff in the survey sample is the emission of about 107 tons of CO<sub>2</sub> equivalent in the atmosphere. According to Yousustain.com, 107 tons of CO<sub>2</sub> equals driving an average car for 173 days non-stop, powering an average house for 8 years or taking 21 cars of the road for one year. Considering 184 respondents travelled in Europe, (excluding business trips outside Europe) the total emissions per staff member would be 589 kg CO<sub>2</sub>e. This roughly equals a return-flight from Brussels to Barcelona in economy class.

An estimation of the CO<sub>2</sub>e emissions of intra-European UHasselt business travel of all staff (N=1453) is possible using the previous information and considering the following assumptions (analogue to sample (n=336)):

- Sample: 184 of 336 staff travelled in Europe (54%) → 785 staff in population (0.54\*1453)
- Sample: n trips sample = 580 → N trips population = 2474 ((580\*785) / 184)
- Modal split population is identical to modal split sample.

An estimation for the emissions of all intra-European UHasselt business travel is 457,041.26 kg CO<sub>2</sub>e. According to Yousustain.com, 457126 tons of CO<sub>2</sub> equals driving an average car for 2 years days non-stop, powering an average house for 35 years or taking 90 cars of the road for one year. This number considers 785 staff that are assumed to have travelled in Europe, excluding business trips outside Europe.

### 3.3 Discussion

In this chapter, the results from the previous chapter will be detailly interpreted. Discussed are: business travel frequencies, arrangement of trips, factors influencing mode choice, business trip destinations and respective modal splits, business travel purposes, attitudes towards sustainable business travel measures and finally the environmental impact.

#### 3.3.1 Travel frequency

60% of the staff members that took part in the survey travelled in 2018, making 3.2 business trips on average. 6% of those travelled solely outside Europe.

On faculty level, no significant effect of belonging to a certain faculty was found. This could imply that all faculties are involved in internationalisation to a certain degree and that no faculty is lagging behind in this regard. This corresponds with SG 3 of the UHasselt internationalisation policy.

On position level, professors travel significantly more than postdocs and other researchers. This is not surprising since many professors are involved in international research projects, specialised research, foreign doctorate studies e.g. member of PhD jury and are affiliated to several international universities and research centres.

When looking for interaction effects between faculty and position, it is revealed that postdocs affiliated with the Faculty of Life Sciences and with that of Architecture & Arts appear to travel significantly more than the professors of those faculties. Also, PhD students affiliated with the Faculty of Life Sciences appear to travel significantly more than the professors of that same faculty. This might seem strange, yet a logical explanation, limited to the Faculty of Life Sciences, is that professors cannot travel that much as they are often required to treat patients or perform surgeries etc. in Belgium at e.g. Virga Jesse Hospital or ZOL<sup>16</sup>. PhD students and postdocs might not be required to be present that often, therefore they can travel more often. Dr. Buckinx, Director of Administration of the Faculty of Medicine and Life Sciences, agrees that “when counting ‘per head’, as done in this thesis, this explanation could be part of the answer. However, if counting per total full-time equivalents, one compensates for working in hospitals but then there are also relatively more PhD students per full-time professor.”

For the Faculty of Architecture & Arts, a plausible explanation is provided by Miss Heynickx, Head of the administration Faculty of Architecture and Arts. *“The faculty was only initiated in 2013 and therefore it has relatively few full-time ZAP<sup>17</sup>. Our faculty has several ZAP members with small appointments. Guest professors have also been appointed, also with very small appointments (5% - 10%). There is also a group of lecturers and senior lecturers who are still appointed within the integration framework (faculties that in the past were college education e.g. architecture) and therefore do not work under the status of UHasselt. The mission of this group consists for 100% of education. However, international trips are almost always made in the context of research.”* The complete emails of both addressees can be found in annex 15 (p. 123).

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<sup>16</sup> Ziekenhuis Oost-Limburg

<sup>17</sup> Abbreviation of: ‘Zelfstandig Aangesteld Personeel’ which means self-employed staff e.g. professors

### 3.3.2 Business trip arrangement

When asked about the arrangement of business trips, 24% of the surveyed staff book their trips via the (faculty) secretariat, 35% book their trips via Omniatravel and 41% book their trips individually. When researching the business travel policies of other universities (see 3.1), an element that often recurred was the use of a centralised booking platform. Setting up a centralised UHasselt booking platform, possibly with an external partner, offers several advantages. The recommendation section in chapter 4 further discusses this.

### 3.3.3 Influential factors in mode choice

Travel time appears to be significantly more important than price, comfort, safety and environmental considerations. In turn, environmental considerations appear to be significantly less important than all other factors. Price, comfort and safety do not significantly differ in importance for mode choice. Here, awareness-raising methods such as pop-up messages or personalised emails, could be applied in order to increase the consciousness about. The recommendation section in chapter 4 further discusses this.

### 3.3.4 Business trip destinations and respective modal split

On a sample of 336 respondents, 580 individual business trips were made. 383 (66%) of those were outbound to one of Belgium's neighbouring countries: the Netherlands, Germany, Luxemburg, France and The United Kingdom.

#### 1) *Per country*

The map in FIGURE 10 displays a division in business trips frequency very similar to the 20<sup>th</sup> century Iron Curtain that divided Europe into a capitalistic Western bloc and a Soviet-influenced Eastern bloc. It indicates a strong potential for future internationalisation opportunities in order to raise the level of academic education and research throughout the whole of Europe.

#### 2) *Per city*

Interesting is that 37% and 60% of the visited cities are in the 500 km, respectively 800 km sphere of influence of Hasselt. 67% are in the 1000 km sphere of influence. Yet, when looking at the modal split, high-speed rail is only used for 4% of business trips, whereas air travel is used in 84% of the cases. This again illustrates the discord discussed in 2.2.1. These figures very clearly depict room for improvement.

#### 3) *Neighbouring countries*

This section details on modal split<sup>18</sup> of Belgium's neighbouring countries France, Germany, Luxemburg, the Netherlands and the United Kingdom. Especially these countries have a high potential for use of rail instead of air services as they all are within the 800 km of Hasselt (except for more far-away regions like Northern UK, Southern France, Eastern Germany). The number between brackets indicates the number of trips to the respective country.

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<sup>18</sup> Figures are rounded to the nearest integer



France (51)	Modal split	Interpretation
Coach	2%	Coach travel tends to be the least comfortable way of travelling.
Car(pooling)	4%	See HSR.
Train	16%	Probably destinations in Northern France.
HSR	49%	Major cities in France are well-connected to Paris, which in turn is well-connected to Brussels via the Thalys service. Since travel time is the most important factor, the high share of HSR implies that travelling to France is often fastest by HSR and hence faster than driving.
Air	23%	Probably destinations in South-East or Southern France.

Germany (89)	Modal split	Interpretation
Coach	0%	Analogue of France.
Car(pooling)	37%	Hasselt is located relatively close to Ruhr and Western Germany. Also, Germany does not have a speed limit on the 'Autobahn' which might increase the speed of road travel. Lastly, the popularity of services such as Blablacar could explain the high share of car(pooling) use.
Train	19%	Probably cities in Western Germany.
HSR	21%	Hasselt is connected to Liège, which is well connected to Cologne (one of the hubs in the polycentric German high-speed rail network).
Air	23%	Probably Eastern or Southern Germany e.g. München.

Luxemburg (3)	Modal split	Interpretation
Coach	0%	Analogue of France.
Car(pooling)	67%	Driving from Hasselt to Luxemburg takes about 2h20m, it is relatively close. Driving is at least twice as fast as travelling by train.
Train	33%	The fastest connection from Hasselt takes about 4h40m (Google maps).
HSR	0%	Belgium has no HSR connection to Luxemburg (Paris does).
Air	0%	No scheduled flights exist between Belgium and Luxemburg.

The Netherlands (185)	Modal split	Interpretation
Coach	1%	Analogue of France.
Car(pooling)	75%	Driving might often be the most convenient due to close proximity of NL.
Train	17%	Close proximity of Maastricht could explain the modal share of train. Maastricht is connected to Hasselt by bus and rail (though on a slow route). What will be the effect of the Spartacus-tram on this modal share?
HSR	7%	Probably staff that travel between Hasselt and Rotterdam or Amsterdam (Thalys).
Air	0.5%	

The United Kingdom (55)	Modal split	Interpretation
Coach	0%	Analogue of France.
Car(pooling)	0%	Many travel interruptions happen when driving. Driving from origin to Calais, then wait for train boarding, travel in Channel Tunnel, then disembark the train and then continue driving. This greatly influences travel time.
Train	22%	Should probably be considered together with HSR since only one rail connection exists between the European continent and the UK.
HSR	44%	Eurostar.
Air	35%	Probably the north of the UK or less rail-accessible regions since the fastest train connection from Hasselt to London is 3h46m.

4) *Other countries within 800-1000 km of Hasselt*

Switzerland, Austria (but not Vienna), Czech Republic, Denmark, (Northern) Italy, Ireland, Poland (but not Warsaw), Slovakia, Sweden (not Stockholm) and Slovenia all have part of their territory in the 800-1000 km sphere of influence of Hasselt. Their modal split, based on the sample, is the following (number of trips between brackets):

- Czech Republic (9): 19% coach, 89 air
- Denmark (8): 12% train, 88% air
- Italy (35): 3% car(pooling), 3% train, 6% HSR, 89% air
- Poland (5): 20% car(pooling), 80% air
- Switzerland (9): 22% coach, train 11%, HSR 11%, air 56%
- Sweden (17): 6% train, 94% air
- Austria (20): Ireland, Slovakia, Slovenia: 100% air

These figures show that except for Switzerland (56%), all other countries in this sphere have an enormous majority (88-100%) of air travel arrivals. For these countries, the difference in travel time between air travel and alternative modes is probably too large to appeal to the average staff member.

The modal split of European business travel at UHasselt (see 3.2.3.1.4) shows similarities as well as dissimilarities with the modal split in the EU28 (see 2.2.1). The share of HSR and train are very similar. The share of air travel is much larger at UHasselt (84% compared to 4% for 300-1000 km and 25% for >1000 km). The share of car travel is much lower (6.2% compared to 72% for 300-1000 km and 53% for >1000 km). This could be related to car possession and business operations.

### 3.3.5 Purpose of business travel

The most interesting purpose figures are (n=580 trips):

- conference or seminar attendance (43%),
- to meet with peers (22%),
- research purposes (18%)

Conference or seminar attendance consists of two parts: the actual conference and the opportunities to network. Especially the network aspect is often important. For research, physical attendance is undoubtedly necessary in most cases. However, meetings with peers could possibly be partly replaced by videoconferencing.

### 3.3.6 Attitudes towards sustainable business travel measures

An array of potential measures (11), some more radical and restrictive than other, have been identified.

A statistical reduction method<sup>19</sup> shows that the 11 measures can be reduced to two factor scales, from now on categories: (1) centralised UHasselt initiatives (with a monetary aspect) and (2) air travel restrictions. Generally speaking, staff members have a significantly more positive attitude towards (1) than (2), probably since (1) is less restricting. This should be taken into account when drawing recommendations: (1) should definitely be worked out, while (2) should be approached more prudently. Table 15 shows the ranking of measures and also their subdivision into one of two factor scales.

Staff who have travelled in 2018 have a significantly more negative attitude towards both (1) and (2) than staff who did not travel. This might suggest that they do not want to shoot themselves in the foot and also that staff who are not involved are less concerned.

When dividing staff into non-frequent travellers (1 or 2 business trips) and frequent travellers (>3 business trips), the significant correlations between (1) and (2) and two other climate-related variables ('environmental considerations in mode choice' and 'sense of responsibility for climate change') are significant for non-frequent travellers as well as for frequent travellers. However, the correlations of frequent travellers tend to be a little stronger, which might suggest that this group is more aware of the impact of its travel behaviour. A second argument that supports the suggestion of travellers not

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<sup>19</sup> Factor analysis

wanting to shoot themselves in the foot is that 'sense of responsibility for climate change' significantly correlates with (1), but does not with (2).

TABLE 15: Ranking of measures

Category	Specific measure	ranking
Three measures not retained in factor analysis	Invest in qualitative videoconferencing infrastructure and train UHasselt to use it	1
	Set up awareness campaigns that make you reflect on your travel behaviour	2
	Build an intuitive, centralised UHasselt platform for booking business trips which compares travel time, travel costs & environmental impacts	3
(1) centralised UHasselt initiatives (with a monetary aspect)	Develop a reward mechanism for staff members who actively seek to minimise the environmental impact of their business trips (e.g. financial bonuses)	4
	Set up an UHasselt Climate Fund and use its revenues for sustainable project at UHasselt or elsewhere	5
	Compensate for the climate cost of UHasselt air travel and collect the revenue in the UHasselt Climate Fund	6
	Hire 'sustainability staff members' that monitor and evaluate the climate impact of UHasselt activities	7
(2) air travel restrictions	Set up a platform which compares business CO2 emissions from all staff members to the university average	8
	Restrict flying to cities that can be reached in <6 hours by bus or (high-speed) train. If you choose to fly, transport costs are not reimbursed	9
	Restrict flying to cities that can be reached in <8 hours by bus or (high-speed) train. If you choose to fly, transport costs are not reimbursed	10
	Prohibit flying to destinations located less than 500 km from Hasselt	11

### 3.3.7 Environmental impact

The emission factors employed for the calculation of the environmental impact are consistent with the findings in the literature review section 2.2.2.3.

The staff that travelled in Europe in 2018 (184 of 336 respondents) have a carbon footprint of 107 tons CO<sub>2</sub>-equivalent<sup>20</sup> which equals driving an average car for 173 days. The total UHasselt carbon footprint of business travel can only be a multiple of that as it has 1453 staff members (estimation on page 67).

Air travel is by far the biggest contributor (80%) to business travel emissions. Second comes car (18%), followed by international train<sup>21</sup> (2%) and (coach 0.16%). This indicates that car travel also substantially contributes to emissions, as it accounts for only 6% in the modal split.

By knowing its exact business travel carbon footprint, UHasselt can set strategic targets for modal shift and carbon reduction. Also, to dwarf the gap between the fact only 4% of trips is done by HSR, yet 60% of cities visited are located at less than 800 km from Hasselt, a list of 'green' and 'orange' cities comes in handy. Agreed upon by several experts is that 400-800 km is the distance range at which HSR is a very competitive mode.

### 3.3.8 Limitations, validity and reliability of the research

To get a more accurate picture of the environmental impact (not only European), business trips outside of Europe should also be taken into account.

There are some detail levels that lack in the data. There is no data on modal split of specific cities. For example, Paris will probably have a very high share of HSR, whereas Nice will mostly be travelled to by air. Also, the survey should have distinguished between individual car use and carpooling. Finally, the survey should have specified the difference between regular train and high-speed rail.

Regarding internal validity, all performed tests were valid models and no assumptions were breached. No bias was encountered. The results unambiguously and correctly answer the research questions. However, utilising other emission factors will undoubtedly result in different emission levels. Regarding external validity, the power-test in 3.2.1 shows that 304 respondents are required to have a representative sample at a confidence level of 95%. In this study, 336 respondents were retained.

### 3.3.9 Suggestions for further research

Further research could consist of:

- Do research on other facets of UHasselt CO<sub>2</sub> emissions e.g. heating, food, energy, green space
- Also take into account business travel outside Europe.
- Do a scenario study e.g. in case UHasselt completely restricts flying to cities in the 8h range, which carbon savings would this bring about etc.
- Do an evaluation study about the implemented measures after 1 year.

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<sup>20</sup> CO<sub>2</sub> equivalent is the expression that describes different greenhouse gases in a single unit. For any quantity or type of greenhouse gases, CO<sub>2</sub>e signifies the amount of CO<sub>2</sub> which would create the same warming effect.

<sup>21</sup> regular train and HSR together. This makes an internal validity bias since HSR need more power than regular trains

- Cooperate with EC and EU to make the Erasmus programme more sustainable. E.g. research costs / benefits etc. of giving every Erasmus-goer a free, 80%, 50% reduction on (first class?) (high-speed) train ticket. Ryanair already cooperates with the Erasmus Student Network (ESN): 15% discount on 8 single flights (or 4 return flights); free check-in luggage of 15kg with each of these 8 flights booked; weekly travel offers for Erasmus students and tailored Ryanair in-journey offers on the mobile app



## 4 Conclusions and recommendations

Within this thesis, the central research question was: *How can Hasselt University mitigate the environmental impact of its staff internationalisation within Europe in the light of the discord between European passenger air services and rail transportation?* This was researched through a literature review, an exploration of other universities' business travel policies through an interview and online research and lastly a survey, distributed amongst the 1453 UHasselt staff members. Recommendations for UHasselt are to be found on page 79.

Universities have a leading role in societal change and sustainable development. Internationalisation and business travel are an integral part of this through spreading of knowledge and research. Therefore, it is fundamental that the internationalisation itself is sustainable. However, academics tend to have a relatively large carbon footprint. Sustainable internationalisation can be defined as *“the process of contributing to a fairer and healthier global ecosystem for today as well as for the future, by actively acquiring or spreading knowledge beneficial to society in an academic context, outside one's own country in a way that does not negatively impact the global ecosystem”*.

The most important figures from the survey on business travel at UHasselt (n = 336 or 23% of the 1453 population) are the following. 60% of the staff travelled abroad in 2018. 6% of those travelled only outside Europe. These international travellers made 3.2 business trips on average. 24% booked its trips via the (faculty) secretariat, 35% via Omniatravel and 41% individually. When arranging a business trip, 'travel time' is the most important factor, while 'environmental considerations' is the least important. 'Safety', 'comfort', and 'price' lie between those two factors with regards to the importance for business trips. 66% of the 580 reported European business trips in 2018 were to the Netherlands, France, Germany, Luxemburg or the United Kingdom. Also, 60% of these business trips were to cities less than 800 km from Hasselt, 67% to cities less than 1000 km from Hasselt. 'Conference or seminar attendance' was the purpose of business travel in 43% of the cases, followed by 'meeting with peers' (22%), 'research purposes' (18%), 'lecturing' (7%), 'meeting with a government' (4%), 'meeting with a company' (2%). 1% of the reported business trips is made by coach bus, followed by car(pooling) (6%), regular train (4%), high-speed train (4%) and air travel (84%). Regarding environmental impact, 80% of UHasselt business travel CO<sub>2</sub>e emissions come from air travel, followed by car(pooling) (18%) and international rail travel (2%). These figures include radiative forcing.

The environmental performance evaluation of high-speed rail and air travel proved that from the point of view of an individual or an institution like a university, it is always beneficial for one's carbon footprint to travel by high-speed train (in the range of 3-9 times less CO<sub>2</sub>), since the marginal emission factors of train travel are substantially lower than those of air travel. However, other GHG like NO<sub>x</sub> must not be ignored since its 100-year GWP is 310 times that of CO<sub>2</sub>. Unfortunately, in reality more factors than environmental performance play a role: frequency, fares but above all travel time are accorded a big role (Dobruzkas, 2011). The survey research confirms that travel time is the most important factor in mode choice.

Indeed, when observing historical dynamics since the dawn of the first railway, one can distinguish a gradual shift from rather slow rail transport to the faster alternative: air travel. This dynamic was supported by significant technological developments after WWII and also service quality improvements in the air industry. Since a few years after the first TGV in France in 1981, interests in high-speed rail was revived. However, the European Commission's goal to triple the European high-speed rail network to 30,000 km by 2030 is unlikely to be reached.



The economic policies of liberalisation and standardisation towards achieving the Single European (Transport) Market happen at a different pace for high-speed rail and air travel. The faster deregulation in aviation increased the attractiveness of air travel via among other things lower fares and more point-to-point connections. High-speed rail, being more constrained by physical barriers like cross-border sections, historical national monopolies, more need for standardisation in management, gauge, electrification and ticketing, is put in an unfavourable position.

The environmental policy for transportation as portrayed in the White Paper on Transport 2050 (EC, 2011) attributes a big role to both aviation and high-speed rail towards a carbon-free Europe. Since its launch was just in 2011 and it is a strategic long-term plan, major results are not yet observable. Alternative jet fuel usage gets off the ground only slowly, high-speed rail network development as suggested by the European Commission is non-realistic as it stands, TEN-T struggles with cross-border connections and interoperability and traffic management systems especially for high-speed rail struggle with implementation. Furthermore, the development of a multimodal IT-platform for management information and payment of long-distance transport in Europe is impeded by national transport operators and a non-implementation of the 'user or polluter pays' principle distorts prices and disadvantages high-speed rail. As long as the focus on high-speed rail lacks, it is hard to compete with aviation and therefore it will always be in a more favourable position. Nonetheless, one can notice glimpses of advancement in all fields as described in section 2.2.4.

In order to mitigate the consequences of the discord between high-speed rail and aviation at a European level, developments in one cannot go without consultation of the other. In the first place, high-speed rail cannot substitute (short-haul) air travel completely, yet its relative competitiveness must absolutely grow. Several measures exist for that: internalisation of external costs for all modes, road-pricing to raise revenue and invest it in rail, stop indirect subsidies and tax exemptions for air and road travel, increase travel speeds and lastly play out the geographical asset of train stations. Secondly, in case increasing competitiveness is not possible, then high-speed rail should integrate with airport infrastructure and airlines. Thirdly, a big role in mitigation is reserved for economic and trade measures in the form of trading schemes and carbon-offsetting. Their application should be more stringent, as behavioural change often starts in the wallet. Fourthly, the aviation industry itself must be incentivised to conduct further improvements in aircraft structure, technology, fuel efficiency and bigger developments in alternative jet fuels. The White Paper is not all-inclusive, yet most of the aforementioned measures are in some way described in it. Ultimately, solving this discord is a two-way street: it requires political courage (top-down), as well a societal change in reaction (bottom-up). Sustainable business travel at universities illustrates the bottom-up actions people or institutions can undertake.

### *Recommendations for UHasselt*

Travel is and will always be an important part of an academic lifestyle. As seen in the literature review, always faster travel modes like air travel greatly contributed to more international cooperation but now the negative consequences thereof must be addressed. The 7 proposed recommendations could help UHasselt to reconcile its international orientation with climate change mitigation action.

- 1) Hasselt University could invest in qualitative videoconferencing infrastructure and train its staff to use it.
  - “The greenest kilometre is the kilometre not travelled”. Departing from this philosophy, videoconferencing should be heavily promoted. Infrastructure must be automated, user-friendly and intuitive. Some departments already invested, but investment should increase.
  
- 2) UHasselt could set up awareness campaigns that make staff reflect on travel behaviour. A combination of personal communication and poster and sticker awareness campaigns is advised.
  - New employees must be informed about sustainable business travel from the start of their career and workshops or information sessions on sustainable business travel workshops should be organised. During these sessions the use of videoconferencing systems must also be promoted and instructed.
  - In its (internal) communication, UHasselt could use as much images of sustainable forms of travel e.g. change the logo of the internationalisation strategic goal 2 (see annex 14, p. 112). Like UGent, UHasselt could develop a sticker; to be wielded when staff travelled using sustainable modes. Then, UHasselt should also design posters; to be distributed internally via email and to be hung all around the campuses. These posters should be visually attractive and contain some relevant figures from this thesis to raise awareness.
  - UHasselt could also personally target its staff with information on its individual business travel. Emails, containing detailed information of one’s business trips and associated CO<sub>2</sub> emissions should be sent annually. Also, the price of compensation for these CO<sub>2</sub> emissions should be communicated. This email should also contain comparative information, this way, staff members can interpret and compare their business trips and respective impacts with that of other staff.
  - UHasselt could develop a reward mechanism for staff members who actively seek to minimise the environmental impact of their business trips (e.g. financial bonuses, Greenpoints system NMBS, a system wherein the faculty that reduces its carbon emissions from travelling per head the most wins...). This while being cautious not to stigmatise staff that fly regularly.
  
- 3) UHasselt could adopt an intuitive, centralised platform for booking business trips.
  - Preferably, this platform is to be set up together with Omniatravel since UHasselt already has a framework agreement with them. Use of this platform should be mandatory in order to keep track of every business trip. Eventually (after some time), non-use of the platform should be charged with an administration penalty (to be determined), to be collected in the UHasselt Climate Fund. The platform should be intuitive, it should offer multi-modal

transport options and always suggest the route with the least lay-overs. Overnight stay could also be put forward as a preferred option. Also, it should compare travel time, travel cost & environmental impacts of every mode. The platform should also include awareness-raising elements.

- 4) UHasselt could set up an UHasselt Climate Fund and offset all (travel-related) CO<sub>2</sub> emissions.
  - UHasselt could compensate for CO<sub>2</sub> emissions from business travel of all modes, not only air travel. The compensation must at least be the price of a ton of CO<sub>2</sub> according to ETS (€26.81 on May 12th 2019). However, to be seen as progressive and ambitious, UHasselt could go for a higher amount. According to Brouwer et al. (2008), travellers generally have a higher willingness-to-pay than assumed... (see 2.2.5.5)
  - In a first instance, it is recommendable to keep the compensation voluntary; raising awareness is more important. Therefore, it is also recommendable that the Climate Fund account is public. This way, staff can overview their own contributions as well as the total collected compensation, which can work as a trigger for awareness-raising.
  - The Fund revenues should exclusively be used for projects or programmes with a net environmental benefit: finance videoconferencing infrastructure, reforestation programmes, sustainability and climate research projects, sustainable non-profits.
  
- 5) UHasselt could designate a sustainability officer.
  - Just like UHasselt has a staff office, finance office or IT, it could erect a 'sustainability' body, here the sustainability officer. This staff member monitors and evaluates the environmental performance of UHasselt activities. He / she could further investigate other UH activities that also have an environmental impact and then develop a strategic UHasselt sustainability plan. This plan should of course contain a section on business travel, but can also contain items such as energy consumption, water usage, emissions due to heating, isolation, green campus improvements...
  
- 6) UHasselt could regulate and reduce flying to nearby cities
  - The survey results point out that staff are significantly more in favour of the previous recommendations than to restrictive measures. The survey also pointed out that 'travel time' is considered the single most important factor in travel mode choice. However, travel time can be useful if spent efficiently: especially train travel allows to continue working e.g. checking emails while travelling. Then, even though 'environmental considerations' is the least important factor in travel mode choice among the 184 respondents, something must be undertaken in order to eradicate the air travel emissions of the shortest flights.
  - Like other universities, UHasselt could develop two lists of cities. One of cities that can be reached by high-speed train in 6 hours (or less) and one of cities that can be reached by (high-speed) train in 8 hours (or less). Bus travel should also be possible.  
Train travel should be the default option for 6-hour-list cities. As a rule, flying to these cities should be prohibited. However, it should still be possible to request an air travel option after a valid justification.  
Train or bus travel to 8-hour-list cities should be highly advised. A pop-up message in the central booking platform should appear, indicating that this city is on the 8-hour-list and also the message must show CO<sub>2</sub> emissions of all modes. By requiring the trip-booker to

actively ignore a bus or train ride and click 'flight, the booker is triggered to reflect on his choice. Flying is however not strictly prohibited since reflection and raising awareness are also important.

- 7) UHasselt could cooperate with universities, governments, industry and society
  - Additionally, UHasselt could cooperate together with other universities to make universities the frontrunners of sustainable business travel. Also, it could lobby for more sustainable Erasmus development at the European Commission.



## 5 References

- Akgüç, M., Beblavý, M., & Simonelli, F. (2018). *Low-Cost Airlines Bringing the EU closer together* [CEPS Research Report]. Retrieved from CEPS website: <https://www.ceps.eu/system/files/LowCost%20Airlines%20Bringing%20the%20EU%20closer%20together.pdf>
- Albalade, D., Bel, G., & Fageda, X. (2015). Competition and cooperation between high-speed rail and air transportation services in Europe. *Journal of Transport Geography*, *42*, 166–174. <https://doi.org/10.1016/j.jtrangeo.2014.07.003>
- Anastasiadou, I. (2012). *Constructing Iron Europe: Transnationalism and Railways in the Interbellum*. Retrieved from <http://ebookcentral.proquest.com/lib/ubhasselt/detail.action?docID=1773752>
- Becken, S., & Mackey, B. (2017). What role for offsetting aviation greenhouse gas emissions in a deep-cut carbon world? *Journal of Air Transport Management*, *63*, 71–83. <https://doi.org/10.1016/j.jairtraman.2017.05.009>
- Bestuurscollege UGent. (2018, May 18). *Eerste stappen naar een duurzaam reisbeleid*. Retrieved from III/DBZ/x.
- Bienick, M. (2014). *Gaps in the European long-distance rail network*. 44.
- Bigazzi, A. (2019). Comparison of marginal and average emission factors for passenger transportation modes. *Applied Energy*, *242*, 1460–1466. <https://doi.org/10.1016/j.apenergy.2019.03.172>
- Biofuelsflightpath. (2019). Jet Fuel Derived from Ethanol Now Eligible for Commercial Flights. Retrieved 8 January 2019, from <https://www.biofuelsflightpath.eu/news/56-jet-fuel-derived-from-ethanol-now-eligible-for-commercial-flights>
- Blauwens, G., De Baere, P., & Van de Voorde, E. (2016). *Transport economics* (6th ed.). De Boeck nv.
- Brouwer, R., Brander, L., & Van Beukering, P. (2008). “A convenient truth”: air travel passengers’ willingness to pay to offset their CO2 emissions. *Climatic Change*, *90*(3), 299–313. <https://doi.org/10.1007/s10584-008-9414-0>
- Brubacher, J. S. (1982). *On the Philosophy of Higher Education. Revised Edition. The Jossey-Bass Series in Higher Education*. Jossey-Bass Inc.
- Bueno, G., Hoyos, D., & Capellán-Pérez, I. (2017). Evaluating the environmental performance of the high speed rail project in the Basque Country, Spain. *Research in Transportation Economics*, *62*, 44–56. <https://doi.org/10.1016/j.retrec.2017.02.004>
- Burghouwt, G., Mendes de Leon, P., & de Wit, J. (2015). *EU air transport liberalisation process, impacts and future considerations*. Retrieved from <https://dare.uva.nl/search?identifier=2224bed3-2788-4c63-b9b1-72cc5d1fbaad>
- Burghouwt, Guillaume, & de Wit, J. G. (2015). In the wake of liberalisation: long-term developments in the EU air transport market. *Transport Policy*, *43*, 104–113. <https://doi.org/10.1016/j.tranpol.2015.05.006>

- Butcher, L. (2010). *Aviation: European liberalisation, 1986-2002*. Retrieved from <https://researchbriefings.parliament.uk/ResearchBriefing/Summary/SN00182>
- Cabuzel, T. (2018, May 18). Emissions trading: emissions have slightly increased in 2017 [Text]. Retrieved 6 January 2019, from Climate Action - European Commission website: [https://ec.europa.eu/clima/news/emissions-trading-emissions-have-slightly-increased-2017\\_en](https://ec.europa.eu/clima/news/emissions-trading-emissions-have-slightly-increased-2017_en)
- CE Delft. (2003). To shift or not to shift, that's the question. Retrieved 2 January 2019, from CE Delft website: <https://www.cedelft.eu/en/publications/249/to-shift-or-not-to-shift-thats-the-question>
- Cento, A. (Ed.). (2009). Characteristics of the Airline Industry. In *The Airline Industry: Challenges in the 21st Century* (pp. 13–44). [https://doi.org/10.1007/978-3-7908-2088-1\\_2](https://doi.org/10.1007/978-3-7908-2088-1_2)
- Chang, B., & Kendall, A. (2011). Life cycle greenhouse gas assessment of infrastructure construction for California's high-speed rail system. *Transportation Research Part D: Transport and Environment*, 16(6), 429–434. <https://doi.org/10.1016/j.trd.2011.04.004>
- Chester, M., & Horvath, A. (2010). Life-cycle assessment of high-speed rail: the case of California. *Environmental Research Letters*, 5(1), 014003. <https://doi.org/10.1088/1748-9326/5/1/014003>
- Clewlou, R. R., Sussman, J. M., & Balakrishnan, H. (2014). The impact of high-speed rail and low-cost carriers on European air passenger traffic. *Transport Policy*, 33, 136–143. <https://doi.org/10.1016/j.tranpol.2014.01.015>
- COST. (1998). *Interactions between high-speed rail and air passenger transport: final report on the Action Cost 318*. Luxembourg : Lanham, Md: Office for Official Publications of the European Communities ; Bernan Associates [distributor].
- Crozet, Y., Chèze, C., Guihéry, L., Reichenbach, M., Desmaris, C., Anderton, K., ... Hrebicek, Z. (2015). *TRANSFORuM - Transforming European Transport through an Active Actors Forum*. 52.
- D'Alfonso, T., Jiang, C., & Bracaglia, V. (2014). *The effects of competition between air transport and high speed rail on environment* (Sapienza Università di Roma). Retrieved from [https://editorialexpress.com/cgi-bin/conference/download.cgi?db\\_name=ITEA2014&paper\\_id=89](https://editorialexpress.com/cgi-bin/conference/download.cgi?db_name=ITEA2014&paper_id=89)
- D'Alfonso, T., Jiang, C., & Bracaglia, V. (2016). Air transport and high-speed rail competition: Environmental implications and mitigation strategies. *Transportation Research Part A: Policy and Practice*, 92, 261–276. <https://doi.org/10.1016/j.tra.2016.06.009>
- Den Boon, T. (2018). vliedschaamte – Taalbank. Retrieved 5 December 2018, from <https://www.taalbank.nl/2018/11/20/vliedschaamte/>
- Derwent, R., Collins, W., Johnson, C., & Stevenson, D. (2002). Peer Reviewed: Global Ozone Concentrations and Regional Air Quality. *Environmental Science & Technology*, 36(19), 379A-382A. <https://doi.org/10.1021/es022419q>
- Dessens, O., Köhler, M. O., Rogers, H. L., Jones, R. L., & Pyle, J. A. (2014). Aviation and climate change. *Transport Policy*, 34, 14–20. <https://doi.org/10.1016/j.tranpol.2014.02.014>
- Dobruszkes, F. (2010). *Airline and high-speed rail competition in Europe*: 22.

- Dobruszkes, F. (2011). High-speed rail and air transport competition in Western Europe: A supply-oriented perspective. *Transport Policy*, 18(6), 870–879. <https://doi.org/10.1016/j.tranpol.2011.06.002>
- Dobruszkes, F., Dehon, C., & Givoni, M. (2014). Does European high-speed rail affect the current level of air services? An EU-wide analysis. *Transportation Research Part A: Policy and Practice*, 69, 461–475. <https://doi.org/10.1016/j.tra.2014.09.004>
- Dresner, M., & Tretheway, M. W. (2002). Modelling and testing the effect of market structure on price: the case of international air transport. In: Air transport. *Classics in Transport Analysis*, (2). Retrieved from <https://trid.trb.org/view/663232>
- EC. (2018). Internal market - Mobility and Transport - European Commission. Retrieved 15 December 2018, from Mobility and Transport website: [/transport/modes/air/internal-market\\_et](/transport/modes/air/internal-market_et)
- EIA. (2018). Greenhouse Gases' Effect on the Climate - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration. Retrieved 3 December 2018, from [https://www.eia.gov/energyexplained/index.php?page=environment\\_how\\_ghg\\_affect\\_climate](https://www.eia.gov/energyexplained/index.php?page=environment_how_ghg_affect_climate)
- ERAA, E. R. A. A. (2011). *Air and rail: Setting the record straight environment, investment, mobility and political bias*. Retrieved from <https://www.eraa.org/sites/default/files/FINAL%20AMENDED%20copy.pdf>
- Euregiomr. (2019). Euregio Maas-Rhein . De Euregio Maas-Rijn wordt een Europese Groepering voor Territoriale Samenwerking (EGTS). Retrieved 7 May 2019, from <https://euregiomr.info/nl/aktuelles/meldungen/Neue-Struktur-EVTZ.php>
- EUROCONTROL. (2005). *Glossary for flight statistics & forecasts*. Retrieved from <https://www.eurocontrol.int/sites/default/files/article/attachments/eurocontrol-glossary-for-flight-statistics-and-forecasts.pdf>
- European Aviation Safety Agency. (2018a). SESAR | European Aviation Environmental Report. Retrieved 4 January 2019, from <https://www.easa.europa.eu/eaer/topics/air-traffic-management-and-operations/sesar>
- European Aviation Safety Agency. (2018b). The Agency. Retrieved 19 December 2018, from EASA website: <https://www.easa.europa.eu/the-agency/the-agency>
- European Aviation Safety Agency, European Union, & European Environment Agency. (2016a). *European aviation environmental report 2016*. Retrieved from <http://bookshop.europa.eu/uri?target=EUB:NOTICE:TO0115323:EN:HTML>
- European Aviation Safety Agency, European Union, & European Environment Agency. (2016b). *European aviation environmental report 2016*. Retrieved from <http://bookshop.europa.eu/uri?target=EUB:NOTICE:TO0115323:EN:HTML>
- European Commission. (2010a). High-speed Europe – A sustainable link between citizens - Mobility and Transport - European Commission. Retrieved 31 December 2018, from Mobility and Transport website: [/transport/node/4517\\_hr](/transport/node/4517_hr)
- European Commission (Ed.). (2010b). *High-speed Europe: a sustainable link between citizens*.



Luxembourg: Publications Office of the European Union.

European Commission. (2011, March 23). WHITE PAPER Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. Retrieved 23 May 2019, from <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52011DC0144>

European Commission. *An Aviation Strategy for Europe.*, Pub. L. No. COM/2015/0598 (2015).

European Commission. (2015b, July 14). Single European Sky to cut aviation emissions [Text]. Retrieved 6 January 2019, from Eco-innovation Action Plan - European Commission website: [https://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/eu/496\\_en](https://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/eu/496_en)

European Commission. (2016a, January 7). The implementation of the 2011 White Paper on Transport ‘Roadmap to a Single European Transport Area – towards a competitive and resource-efficient transport system’ five years after its publication: achievements and challenges. Retrieved 20 November 2018, from <http://ec.europa.eu/transparency/regdoc/?fuseaction=list&cotelId=10102&year=2016&number=226&version=ALL&language=nl>

European Commission. (2016b, November 23). EU Emissions Trading System (EU ETS) [Text]. Retrieved 6 January 2019, from Climate Action - European Commission website: [https://ec.europa.eu/clima/policies/ets\\_en](https://ec.europa.eu/clima/policies/ets_en)

European Commission. (2017a). *Alternative Fuels -Expert group report* (No. EUR KI-02-17-940-EN-N). Retrieved from <http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=34592&no=1>

European Commission. (2017b). Delivering the Trans-European Transport Network: fact and figures 2017 - Mobility and Transport - European Commission. Retrieved 4 January 2019, from Mobility and Transport website: [/transport/themes/infrastructure/news/2017-11-28-delivering-trans-european-transport-network-fact-and-figures\\_en](/transport/themes/infrastructure/news/2017-11-28-delivering-trans-european-transport-network-fact-and-figures_en)

European Commission. (2017c). European Deployment Plan and National Implementation Plans - Mobility and Transport - European Commission. Retrieved 4 January 2019, from Mobility and Transport website: [/transport/modes/rail/ertms/ertms\\_deployment\\_en](/transport/modes/rail/ertms/ertms_deployment_en)

European Commission. (2018a). Allocation to aviation [Text]. Retrieved 6 January 2019, from Climate Action - European Commission website: [https://ec.europa.eu/clima/policies/ets/allowances/aviation\\_en](https://ec.europa.eu/clima/policies/ets/allowances/aviation_en)

European Commission. (2018b). Functional airspace blocks (FABs) - Mobility and Transport - European Commission. Retrieved 19 December 2018, from Mobility and Transport website: [/transport/modes/air/single-european-sky/functional-airspace-blocks-fabs\\_en](/transport/modes/air/single-european-sky/functional-airspace-blocks-fabs_en)

European Commission. (2018c). Infrastructure - TEN-T - Connecting Europe - Mobility and Transport - European Commission. Retrieved 21 November 2018, from Mobility and Transport website: [/transport/themes/infrastructure\\_en](/transport/themes/infrastructure_en)

European Court of Auditors. (2017). Special report No 18/2017: Single European Sky: a changed culture but not a single sky. Retrieved 19 December 2018, from <https://www.eca.europa.eu/en/Pages/DocItem.aspx?did=43538>

- European Court of Auditors. (2018). *A European high-speed rail network: not a reality but an ineffective patchwork*. 103.
- European Union. (2011, August 3). Communication from the commission to the European Parliament, the Council, the European economic and social committee of the regions - A Roadmap for moving to a competitive low carbon economy in 2050. Retrieved 15 November 2018, from <https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52011DC0112>
- European Union. (n.d.). First railway package of 2001 - Mobility and Transport - European Commission. Retrieved 14 November 2018, from Mobility and Transport website: [/transport/modes/rail/packages/2001\\_en](/transport/modes/rail/packages/2001_en)
- Fiorello, D., & Zani, L. (2015). *EU Survey on issues related to transport and mobility*. Retrieved from European Commission website: [http://publications.jrc.ec.europa.eu/repository/bitstream/JRC96151/jrc96151\\_final%20version%202nd%20correction.pdf](http://publications.jrc.ec.europa.eu/repository/bitstream/JRC96151/jrc96151_final%20version%202nd%20correction.pdf)
- Fox, H. E., Kareiva, P., Silliman, B., Hitt, J., Lytle, D. A., Halpern, B. S., ... Tallis, H. (2009). Why do we fly? Ecologists' sins of emission. *Frontiers in Ecology and the Environment*, 7(6), 294–296. <https://doi.org/10.1890/09.WB.019>
- Fridell, E., Ferm, M., & Ekberg, A. (2010). Emissions of particulate matters from railways – Emission factors and condition monitoring. *Transportation Research Part D: Transport and Environment*, 15(4), 240–245. <https://doi.org/10.1016/j.trd.2010.02.006>
- Givoni, M. (2005). *Aircraft and high speed train substitution: the case for airline and railway integration*. (Doctoral, University of London). Retrieved from <http://discovery.ucl.ac.uk/1383598/>
- Givoni, Moshe. (2006). Development and Impact of the Modern High-speed Train: A Review. *Transport Reviews*, 26(5), 593–611. <https://doi.org/10.1080/01441640600589319>
- Givoni, Moshe. (2007). Environmental Benefits from Mode Substitution: Comparison of the Environmental Impact from Aircraft and High-Speed Train Operations. *International Journal of Sustainable Transportation*, 1(4), 209–230. <https://doi.org/10.1080/15568310601060044>
- Givoni, Moshe, & Dobruszkes, F. (2013). A Review of Ex-Post Evidence for Mode Substitution and Induced Demand Following the Introduction of High-Speed Rail. *Transport Reviews*, 33(6), 720–742. <https://doi.org/10.1080/01441647.2013.853707>
- Gössling, S., Fichert, F., & Forsyth, P. (2017). Subsidies in Aviation. *Sustainability*, 9(8), 1295. <https://doi.org/10.3390/su9081295>
- Govtrack. (2011). Text of S. 1956 (112th): European Union Emissions Trading Scheme Prohibition Act of 2011 (Passed Congress version). Retrieved 6 January 2019, from GovTrack.us website: <https://www.govtrack.us/congress/bills/112/s1956/text>
- GOV.UK. (2018). Government emission conversion factors for greenhouse gas company reporting. Retrieved 21 March 2019, from GOV.UK website: <https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting>
- GOV.UK. (2019). Environmental reporting guidelines: including Streamlined Energy and Carbon

- Reporting requirements. Retrieved 21 March 2019, from GOV.UK website: <https://www.gov.uk/government/publications/environmental-reporting-guidelines-including-mandatory-greenhouse-gas-emissions-reporting-guidance>
- Heymsfield, A. J., Krämer, M., Luebke, A., Brown, P., Cziczo, D. J., Franklin, C., ... Van Tricht, K. (2017). Cirrus Clouds. *Meteorological Monographs*, 58, 2.1-2.26. <https://doi.org/10.1175/AMSMONOGRAPHS-D-16-0010.1>
- Holler, M., Knieps, G., & Niskanen, E. (1997). *Standardization in Transportation Markets: a European Perspective* (Vol. 14).
- Hoyos, D., Bueno, G., & Capellàn-Pérez, I. (2016). Environmental assessment of high-speed rail. In *Evaluating High-Speed Rail*. Retrieved from [https://www.researchgate.net/publication/307607420\\_Environmental\\_assessment\\_of\\_high-speed\\_rail](https://www.researchgate.net/publication/307607420_Environmental_assessment_of_high-speed_rail)
- Hyams, K., & Fawcett, T. (2013). The ethics of carbon offsetting: Ethics of carbon offsetting. *Wiley Interdisciplinary Reviews: Climate Change*, 4(2), 91–98. <https://doi.org/10.1002/wcc.207>
- idre. (2019). Factor Analysis | SPSS Annotated Output. Retrieved 19 March 2019, from <https://stats.idre.ucla.edu/spss/output/factor-analysis/>
- International Energy Agency, & International Union of Railways. (2012). *Railway Handbook 2012*. Retrieved from [https://www.uic.org/com/IMG/pdf/iea-uic\\_2012final-lr.pdf](https://www.uic.org/com/IMG/pdf/iea-uic_2012final-lr.pdf)
- International Air Transport Agency. (2016). IATA Carbon Offset Program. Retrieved 29 December 2018, from <https://www.iata.org/whatwedo/environment/pages/carbon-offset.aspx>
- International Air Transport Agency. (n.d.). Growth and Development. Retrieved 2 November 2018, from <https://www.iata.org/about/pages/history-growth-and-development.aspx>
- International Civil Aviation Organisation. (2014). *Sustainable alternative fuels for aviation*. 17.
- International Civil Aviation Organisation. (n.d.). Convention on International Civil Aviation - Doc 7300. Retrieved 6 November 2018, from <https://www.icao.int/publications/pages/doc7300.aspx>
- International Panel on Climate Change. (2007). 2.2 Concept of Radiative Forcing - AR4 WGI Chapter 2: Changes in Atmospheric Constituents and in Radiative Forcing. Retrieved 3 December 2018, from [https://www.ipcc.ch/publications\\_and\\_data/ar4/wg1/en/ch2s2-2.html](https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-2.html)
- International Panel on Climate Change. (2018). Global Warming of 1.5 °C —. Retrieved 3 January 2019, from <https://www.ipcc.ch/sr15/>
- International Union of Railways. (2017). *High-speed traffic in the world*. Retrieved from [https://uic.org/IMG/pdf/high\\_speed\\_passenger-km\\_20171130\\_.pdf](https://uic.org/IMG/pdf/high_speed_passenger-km_20171130_.pdf)
- International Union of Railways. (2018). *High-speed rail*. Retrieved from UIC website: [https://uic.org/IMG/pdf/uic\\_high\\_speed\\_2018\\_ph08\\_web.pdf](https://uic.org/IMG/pdf/uic_high_speed_2018_ph08_web.pdf)
- IPCC. (1999). Aviation and the Global Atmosphere. Retrieved 30 November 2018, from <https://www.ipcc.ch/ipccreports/sres/aviation/>
- Janić, M. (2003). High-speed rail and air passenger transport: A comparison of the operational environmental performance. *Proceedings of the Institution of Mechanical Engineers, Part F*:

- Journal of Rail and Rapid Transit*, 217(4), 259–269.  
<https://doi.org/10.1243/095440903322712865>
- Janić, M. (2018a). An assessment of the potential of alternative fuels for “greening” commercial air transportation. *Journal of Air Transport Management*, 69, 235–247.  
<https://doi.org/10.1016/j.jairtraman.2017.09.002>
- Janić, M. (2018b). An assessment of the potential of alternative fuels for “greening” commercial air transportation. *Journal of Air Transport Management*, 69, 235–247.  
<https://doi.org/10.1016/j.jairtraman.2017.09.002>
- Janisch, T., & Hilty, L. (2017). *Changing University Culture Towards Reduced Air Travel – Background Report for the 2017 Virtual Conference on University Air Miles Reduction ETH Sustainability Content*.
- Jones, H., Moura, F., & Domingos, T. (2017). Life cycle assessment of high-speed rail: a case study in Portugal. *The International Journal of Life Cycle Assessment*, 22(3), 410–422.  
<https://doi.org/10.1007/s11367-016-1177-7>
- JRC-EC. (2008). JRC IPTS - Transtools. Retrieved 20 May 2019, from <http://energy.jrc.ec.europa.eu/transtools/FTP.html>
- Kärcher, B. (2016). The importance of contrail ice formation for mitigating the climate impact of aviation. *Journal of Geophysical Research: Atmospheres*, 121(7), 3497–3505.  
<https://doi.org/10.1002/2015JD024696>
- Kärcher, B., Möhler, O., DeMott, P. J., Pechtl, S., & Yu, F. (2007). Insights into the role of soot aerosols in cirrus cloud formation. *Atmospheric Chemistry and Physics*, 7(16), 4203–4227.  
<https://doi.org/10.5194/acp-7-4203-2007>
- Kennisinstituut voor Mobiliteitsbeleid. (2018, June 21). Substitutiemogelijkheden van luchtvaart naar spoor - Document (onderzoekpublicatie) - Kennisinstituut voor Mobiliteitsbeleid [Rapport]. Retrieved 30 December 2018, from <https://www.kimnet.nl/publicaties/rapporten/2018/06/21/substitutiemogelijkheden-van-luchtvaart-naar-spoor>
- Knight, J. (2003). *Updating the Definition of Internationalization*. 2.
- Krenek, A., & Schratzenstaller, M. (2016). *Sustainability-oriented EU Taxes: The Example of a European Carbon-based Flight Ticket Tax*.
- KU Leuven. (2018). KU Leuven lanceert vrijwillige compensatie voor vliegpreizen. Retrieved 30 December 2018, from <https://nieuws.kuleuven.be/nl/2018/ku-leuven-lanceert-vrijwillige-compensatie-voor-vliegpreizen>
- Lee, D. S., Fahey, D. W., Forster, P. M., Newton, P. J., Wit, R. C. N., Lim, L. L., ... Sausen, R. (2009). Aviation and global climate change in the 21st century. *Atmospheric Environment*, 43(22), 3520–3537. <https://doi.org/10.1016/j.atmosenv.2009.04.024>
- Lenoir, S. (2018, May 6). De UGent gaat minder vliegen: eerste stappen naar een duurzaam reisbeleid [Nieuwsbericht]. Retrieved 28 November 2018, from Universiteit Gent website: <https://www.ugent.be/nl/actueel/vliegtuig-reis-duurzaam-minder-co2-compensatie.htm>

- Lewis, B., & Volcovici, V. (2012, December 10). Insight: U.S., China turned EU powers against airline pollution law. *Reuters*. Retrieved from <https://www.reuters.com/article/us-eu-airlines-climate-idUSBRE8B801H20121210>
- Martí-Henneberg, J. (2013). European integration and national models for railway networks (1840–2010). *Journal of Transport Geography*, 26, 126–138. <https://doi.org/10.1016/j.jtrangeo.2012.09.004>
- Mauchly, J. W. (1940). Significance Test for Sphericity of a Normal  $\$n\$$ -Variate Distribution. *The Annals of Mathematical Statistics*, 11(2), 204–209. <https://doi.org/10.1214/aoms/1177731915>
- McLennan, C. J., Becken, S., Battye, R., & So, K. K. F. (2014). Voluntary carbon offsetting: Who does it? *Tourism Management*, 45, 194–198. <https://doi.org/10.1016/j.tourman.2014.04.009>
- Mihetec, T., Vidović, A., & Rezo, Z. (2017). Assessment of Single European Sky Implementation in the Functional Airspace Block Central Europe. *PROMET - Traffic&Transportation*, 29, 643. <https://doi.org/10.7307/ptt.v29i6.2499>
- Mitchell, D. E., & Nielsen, S. Y. (2012). Internationalization and Globalization in Higher Education. In H. Cuadra-Montiel (Ed.), *Globalization - Education and Management Agendas*. <https://doi.org/10.5772/48702>
- NASA. (2008). Water Vapor Confirmed As Major Player In Climate Change. Retrieved 3 December 2018, from ScienceDaily website: <https://www.sciencedaily.com/releases/2008/11/081117193013.htm>
- Nelldal, B.-L., & Andersson, E. (2012). Mode Shift as a Measure to Reduce Greenhouse Gas Emissions. *Procedia - Social and Behavioral Sciences*, 48, 3187–3197. <https://doi.org/10.1016/j.sbspro.2012.06.1285>
- O'Brien, P. (1983). *Railways and the Economic Development of Western Europe, 1830–1914*. Oxford: The Macmillan Press LTD.
- Pellegrini, P., & Rodriguez, J. (2013). Single European Sky and Single European Railway Area: A system level analysis of air and rail transportation. *Transportation Research Part A: Policy and Practice*, 57, 64–86. <https://doi.org/10.1016/j.tra.2013.09.004>
- Petr, M. (2016). Fourth Railway Package (Almost) Adopted. *European Networks Law and Regulation Quarterly (ENLR)*, 4, 88.
- Prescott-Allen, R. (2001). *The wellbeing of nations : a country-by-country index of quality of life and the environment*. Retrieved from <https://portals.iucn.org/library/node/7942>
- Preston, H., Lee, D. S., & Hooper, P. D. (2012). The inclusion of the aviation sector within the European Union's Emissions Trading Scheme: What are the prospects for a more sustainable aviation industry? *Environmental Development*, 2, 48–56. <https://doi.org/10.1016/j.envdev.2012.03.008>
- Projectguru. (2015, February 5). Interpretation of factor analysis using SPSS. Retrieved 19 March 2019, from Knowledge Tank website: <https://www.projectguru.in/publications/interpretation-of-factor-analysis-using-spss/>
- Prussi, M., & Lonza, L. (2018). Passenger Aviation and High Speed Rail: A Comparison of Emissions

- Profiles on Selected European Routes [Research article].  
<https://doi.org/10.1155/2018/6205714>
- Puffert, D. J. (2002). Path Dependence in Spatial Networks: The Standardization of Railway Track Gauge. *Explorations in Economic History*, 39(3), 282–314.  
<https://doi.org/10.1006/exeh.2002.0786>
- Robertson, S. (2016). The potential mitigation of CO2 emissions via modal substitution of high-speed rail for short-haul air travel from a life cycle perspective – An Australian case study. *Transportation Research Part D: Transport and Environment*, 46, 365–380.  
<https://doi.org/10.1016/j.trd.2016.04.015>
- Rodrigue, J.-P. (2017). High Speed Rail Systems. Retrieved 28 December 2018, from The Geography of Transport Systems website: [https://transportgeography.org/?page\\_id=7457](https://transportgeography.org/?page_id=7457)
- Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, 1(1), 7–59. <https://doi.org/10.1007/BF00055564>
- Schrever, R. (2010). Desiderius Erasmus (ca. 1466-1536) - Humanist uit Rotterdam. Retrieved 27 November 2018, from Historiek website: <https://historiek.net/desiderius-erasmus-humanist-uit-rotterdam/9511/>
- Scott, J. C. (2006). The Mission of the University: Medieval to Postmodern Transformations. *Journal of Higher Education*, 77(1), 1–39. <https://doi.org/10.1353/jhe.2006.0007>
- Staples, M. D., Malina, R., Suresh, P., Hileman, J. I., & Barrett, S. R. H. (2018). Aviation CO2 emissions reductions from the use of alternative jet fuels. *Energy Policy*, 114, 342–354.  
<https://doi.org/10.1016/j.enpol.2017.12.007>
- Stockholm University. (2017). Documents - Sustainable Campus. Retrieved 14 January 2019, from <https://www.su.se/sustainablecampus/management/documents>
- T&E, E. F. for T. and E., & CAN, -Europe – Climate Action Network Europe. (2006). *Images in this publication appear courtesy of: 47.*
- Thalys. (2018). Alle feiten en kerncijfers van Thalys International. Retrieved 2 January 2019, from <https://www.thalys.com/be/nl/over-thalys/feiten-en-cijfers>
- Torenbeek, E., & Wittenberg, H. (Eds.). (2009). History of Aviation. In *Flight Physics: Essentials of Aeronautical Disciplines and Technology, with Historical Notes* (pp. 1–46).  
[https://doi.org/10.1007/978-1-4020-8664-9\\_1](https://doi.org/10.1007/978-1-4020-8664-9_1)
- Transport and Environment, & Climate Action Network Europe. (2006). *The Myth and Reality of Aviation and Climate Change*. Retrieved from [https://www.transportenvironment.org/sites/te/files/media/2006-06\\_aviation\\_clearing\\_the\\_air\\_myths\\_reality\\_0.pdf](https://www.transportenvironment.org/sites/te/files/media/2006-06_aviation_clearing_the_air_myths_reality_0.pdf)
- Transport Studies Unit. (2018). TRANSFORuM: Transport 2050 | Research | Transport Studies Unit | University of Oxford [TU Oxford]. Retrieved 15 November 2018, from Transport Studies Unit website: <https://www.tsu.ox.ac.uk/research/transforum/>
- UGent. (2018). Duurzaamheid aan de UGent — Universiteit Gent [Webpagina]. Retrieved 30 December 2018, from <https://www.ugent.be/nl/univgent/waarvoor-staat->

ugent/duurzaamheidsbeleid

- UHasselt. (n.d.). Internationalisation policy. Retrieved 28 November 2018, from <https://www.uhasselt.be/Internationalisation>
- UNFCCC. (2019). Global Warming Potentials | UNFCCC. Retrieved 20 May 2019, from <https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/greenhouse-gas-data-unfccc/global-warming-potentials>
- United Nations, & United Nations Economic Commission for Europe. (2017). *Trans-European railway high-speed master plan study*. Retrieved from <https://www.unece.org/index.php?id=47917>
- Universiteit Leiden. (2018, March 7). 2017 editions of annual report and sustainability report published. Retrieved 14 January 2019, from Leiden University website: <https://www.universiteitleiden.nl/en/news/2018/06/2017-annual-report-and-sustainability-report-published>
- University of Glasgow. (2018, March 15). *University Travel Policy UNIVERSITY OF GLASGOW TRAVEL STATEMENT*. Retrieved from [https://www.gla.ac.uk/media/media\\_278348\\_en.doc](https://www.gla.ac.uk/media/media_278348_en.doc)
- University of Gothenburg. (2018). *Action plan for the environment and sustainable development 2017-2019*. Retrieved from [https://medarbetarportalen.gu.se/digitalAssets/1697/1697075\\_actionplan\\_2017\\_2019\\_revise-d-august-2018.pdf](https://medarbetarportalen.gu.se/digitalAssets/1697/1697075_actionplan_2017_2019_revise-d-august-2018.pdf)
- US EPA, O. (2016, January 12). Understanding Global Warming Potentials [Overviews and Factsheets]. Retrieved 20 May 2019, from US EPA website: <https://www.epa.gov/ghgemissions/understanding-global-warming-potentials>
- WCED. (1988). The Brundtland report: 'Our common future'. *Medicine and War*, 4(1), 17–25. <https://doi.org/10.1080/07488008808408783>
- Widheden, J., & Ringström, E. (2007). Handbook for Cleaning/Decontamination of Surfaces | ScienceDirect. Retrieved 10 January 2019, from <https://www.sciencedirect.com/book/9780444516640/handbook-for-cleaning-decontamination-of-surfaces>
- Wilcox, L. J., Shine, K. P., & Hoskins, B. J. (2012). Radiative forcing due to aviation water vapour emissions. *Atmospheric Environment*, 63, 1–13. <https://doi.org/10.1016/j.atmosenv.2012.08.072>
- Wright, T. S. A. (2009). Sustainability, internationalization, and higher education. *New Directions for Teaching and Learning*, 2009(118), 105–115. <https://doi.org/10.1002/tl.357>
- Wu, Y. (2013). *The effect of the entry of low-cost airlines on price and passenger traffic* (Master thesis, Erasmus University Rotterdam). Retrieved from [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwi\\_7-LgpsjeAhXRxoUKHduCB9cQFjAAegQICRAC&url=https%3A%2F%2Fthesis.eur.nl%2Fpub%2F10307%2FMA-Thesis%2520Yaxian%2520Wu.docx&usq=AOvVaw30JLis-SMXaD9yDCnCjBQz](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwi_7-LgpsjeAhXRxoUKHduCB9cQFjAAegQICRAC&url=https%3A%2F%2Fthesis.eur.nl%2Fpub%2F10307%2FMA-Thesis%2520Yaxian%2520Wu.docx&usq=AOvVaw30JLis-SMXaD9yDCnCjBQz)

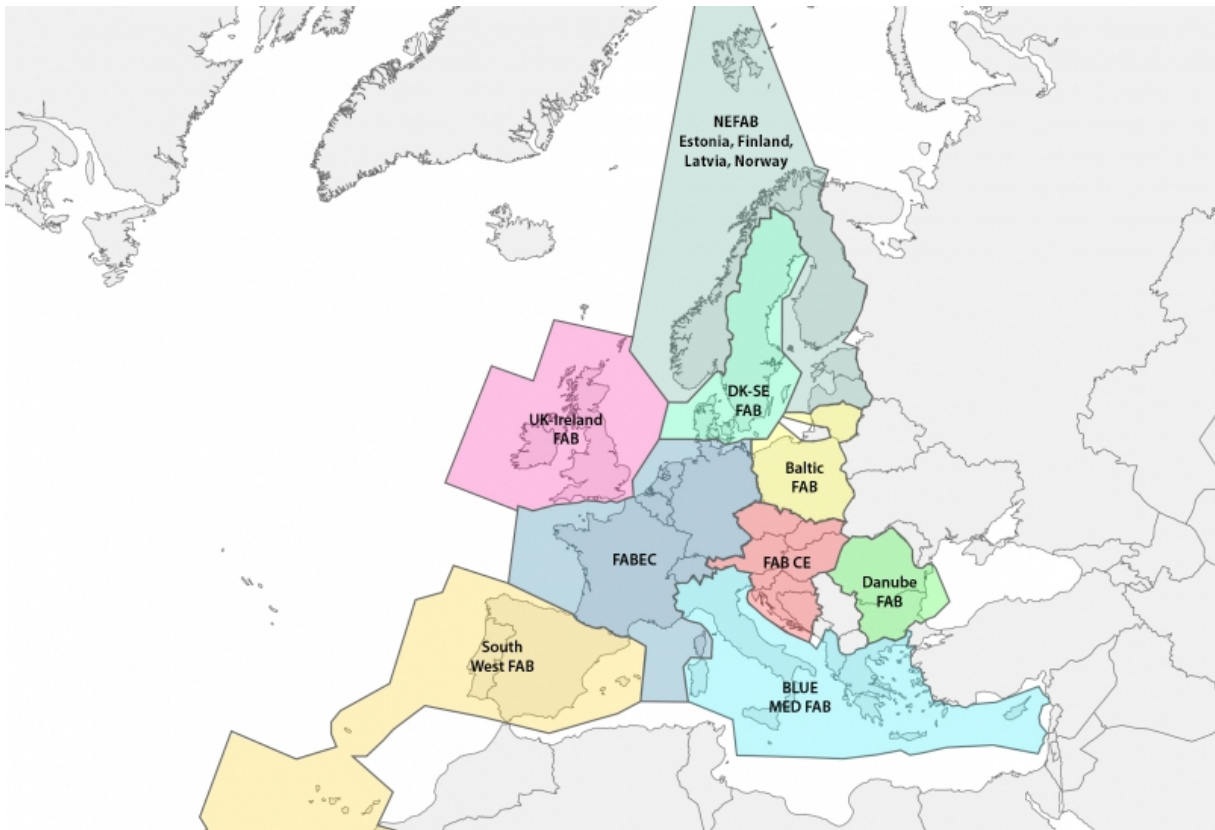
## 6 Attachments

Annex 1: Calculations on KiM figures

	A	B	C	D	E	F	G	H	I	J	K
1		Tot. reistijd trein h.m	Tot. reistijd lucht h.m	vliegen is % sneller	Freq. trein	Freq lucht	... keer meer	Tarief trein min.	tarief trein max	Tarief lucht min.	Tarief lucht max.
2	Londen	6,1	5	1,10	7	51	7	€ 112,00	€ 206,00	€ 69,00	€ 195,00
3	Berlijn	7,05	5,1	1,95	7	9	1	€ 80,00	€ 268,00	€ 94,00	€ 168,00
4	Kopenhagen	12,25	5,25	7,00	2	11	6	€ 100,00	€ 348,00	€ 97,00	€ 181,00
5	Parijs	4,15	5,15	-1,00	14	12	1	€ 110,00	€ 194,00	€ 75,00	€ 141,00
6	Birmingham	8	5,1	2,90	7	10	1	€ 140,00	€ 372,00	€ 98,00	€ 164,00
7	Basel	8,45	5,2	3,25	8	6	1	€ 80,00	€ 354,00	€ 143,00	€ 253,00
8	Bristol	8,55	5,2	3,35	7	5	1	€ 162,00	€ 340,00	€ 122,00	€ 186,00
9	Frankfurt	4,5	5,05	-0,55	7	11	2	€ 80,00	€ 258,00	€ 94,00	€ 158,00
10	Hamburg	6,05	5	1,05	7	6	1	€ 80,00	€ 203,00	€ 80,00	€ 183,00
11	München	8,25	5,2	3,05	6	12	2	€ 120,00	€ 343,00	€ 87,00	€ 154,00
12	Hannover	5,2	4,55	0,65	7	4	1	€ 60,00	€ 163,00	€ 126,00	€ 175,00
13	Brussel	2,5	4,45	-1,95	14	5	0	€ 58,00	€ 91,00	€ 94,00	€ 131,00
14	Dusseldorf	3,05	4,45	-1,40	7	5	1	€ 40,00	€ 123,00	€ 125,00	€ 261,00
15								€ 94,00	€ 251,00	€ 100,31	€ 180,77
16											
17				<b>1,49</b>			<b>2</b>	gem. prijs trein	€ 172,50	gem. prijs lucht	€ 140,54



Annex 2: FAB Blocks



*Annex 3: UGent sustainability logo*



### Interviewvragen KUL

- In mijn thesis heb ik het KUL-dienstreizenbeleid als volgt samengevat\*.
    - Welke parameters zijn er gebruikt om tot dit cijfer te komen?
    - Welke maatregelen uit de twee strategieën (of onderdelen ervan) zijn reeds effectief van kracht?
  - Aan de UHasselt zijn er drie mogelijkheden om reizen te boeken: individueel, via Omniatravel of via het faculteitssecretariaat.

Kan u mij wat meer vertellen over de boekingsprocedure aan de KUL en over uw samenwerking met Omniatravel?
  - “Voor korte afstanden stimuleren we het gebruik van de trein, en voor zéér korte afstanden verplichten we het”<sup>22</sup>

Is dit reeds van kracht? Wat definieert KUL u als ‘zéér korte afstanden’? (UGent lijst groene/oranje steden?)
  - “Je hebt vergaderinfrastructuur nodig die gevoelig beter is dan wat we nu hebben”<sup>1</sup>

Welke kenmerken moet zulke infrastructuur hebben? Wat onderscheidt ze van Skype?
  - KUL heeft een vrijwillige bijdrage vastgelegd op €40 per ton CO<sub>2</sub><sup>23</sup>.
    - Op basis van Yale University en internationale berekeningen.
    - EU hanteert €21,50<sup>24</sup>.
    - Echter, wetenschappers bv. Stanford pleiten voor een prijs +200\$ / ton.

→ Vraag: denkt u dat €40/ ton CO<sub>2</sub> voldoende hoog is om een gedragsverandering teweeg te brengen?

→ Vraag: onderzoekers hebben bepaalde budgetten: is het de bedoeling dat deze vrijwillige bijdrage uit het gegeven budget komt, of eerder dat de persoon in kwestie met privé-middelen deze bijdrage levert?
  - In het intern klimaatfonds van de KUL worden de inkomsten van vrijwillige bijdrage bewaard. Welke andere inkomsten vullen deze schatkist?
  - Heeft de KUL/ is de KUL bezig met het ontwikkelen van draagvlak onder de medewerkers?
    - Hebt u al feedback, reacties etc. van medewerkers ontvangen? Zijn deze positief of negatief?
- 

<sup>22</sup> KUL website artikel 24/10/2018 (<https://nieuws.kuleuven.be/nl/2018/ku-leuven-lanceert-vrijwillige-compensatie-voor-vliegreizen>)

<sup>23</sup> Online document Decreasing the carbon footprint of KU Leuven staff mobility: How a Carbon Compensation Policy can support sustainable management (<https://www.kuleuven.be/issue/yourss/publications/ForeignTravel-TechnicalNote.pdf>)

<sup>24</sup> Bron: <https://www.finanzen.nl/grondstoffen/co2-emissionsrechte>

### **\*Stuk uit thesis**

The KUL has published its renewed strategic plan in 2018. It is founded on five pillars, including internationalisation and sustainability. The pillar 'sustainability' comprises three priorities regarding business trips. KUL also has document detailing how it aims at decreasing the carbon footprint of KUL staff. For 2013, it was calculated that 6.8% (6340 CO<sub>2</sub> / 22 298 CO<sub>2</sub>) of their carbon emissions come from plane travel. KUL already has the following rules in place:

- Obligatory information on carbon emissions for each flight
- All KUL travel data is centralised at Omniatravel
- Booking via Omniatravel is compulsory

The KUL wants to go towards a rationalisation of flying. The financial, temporal and climate costs should be weighed against the added benefit of a flight. Two main strategies are defined:

- Incentivize staff to seek alternatives for flying
  - Build robust video-conferencing infrastructure and training, partly paid by recovered expenses from flights.
  - Travelling by train (e.g. to Schiphol) will be compulsory
  - By setting up awareness campaigns
  - Communication of annual carbon emissions per staff member and comparison to university average
  - Encourage individual departments to pursue more ambitious policy
- Setting a correct price on flying
  - Internalise social cost of carbon
  - Levy on CO<sub>2</sub> emissions must be high enough to trigger behavioural change
  - Set up internal KU Leuven Climate Fund (reduce redundant flying and keep revenues internal will result in net savings for the University)
  - Carbon price of €40 per ton, following Yale University's Carbon-charge programme (KULeuven, 2018).

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### **Interview with Gerhard Rover (sustainability coordinator at KU Leuven) 08/03/2018**

#### **Maxime**

Welke parameters zijn er gebruikt om tot dit cijfer te komen?

#### **Mr. Govers**

Op basis van gefactuurde vlieguren, kijk je gewoon waar de mensen naartoe zijn gevlogen en kan je vrij gemakkelijk in idee krijgen van de uitstoot.

#### **Maxime**

En dit gebeurt allemaal samen met Omniatravel?

#### **Mr. Govers**

Ja, dus KULeuven werkt met een raamakkoord met Omnia en dus dat betekent dus eigenlijk dat onze mensen toch min of meer verplicht zijn om via Omnia hun reizen te boeken. Dat betekent dat de KUL een vrij goed zicht heeft op wie waar wanneer en hoe naartoe reist, dat klopt wel. Er wordt af en toe tegen gezondigd, dat weten wij ook wel, maar dat neemt niet weg dat we er toch een goed zicht hebben op de uitstoot van de KUL

dienstreizen.

**Maxime**

Aan de UHasselt bestaan er drie manieren om dienstreizen vast te leggen...

**Mr. Govers**

Ja, dus dat is een van de dingen waar je goed over moet nadenken. Als je een reisbeleid wil, dan kan je dat alleen doorvoeren als je inderdaad een zicht hebt op wat mensen doen. Zonder gestandaardiseerd boekingsstelsel is het inderdaad moeilijk om daarrond een beleid te voeren.

**Maxime**

Dus een eerste stap bestaat uit het centraliseren en standardiseren van de boekingsprocedure?

**Mr. Govers**

Dat zou ik toch wel aanraden ja...

**Maxime**

Hoe verloopt de samenwerking tussen KUL en Omnia?

**Mr. Govers**

Wij hebben een reisbeleid waarin we bij steden die je in minder dan drie uur kan bereiken, vragen om de trein te nemen in plaats van het vliegtuig.

**Maxime**

Dat is dus verplicht?

**Mr. Govers**

Dat is eigenlijk quasi verplicht. De steden bereikbaar in minder dan drie uur staan bekend als de 'witte' stedenlijst. Voor steden met reistijden tot zeven uur bestaat er de 'grijze' lijst. Bij deze grijze lijst geven we ook altijd het alternatief van de trein mee. Mensen kunnen echter wel nog altijd zelf beslissen om toch met het vliegtuig te gaan. Het is niet zo eenvoudig om het vliegtuig volledig te verbieden; er kunnen redenen zijn waarom mensen toch met het vliegtuig willen gaan. Ze hebben bv. een gezinssituatie die het voor hen onmogelijk maakt om de dag voordien met de trein te vertrekken. Je raadt het sterk aan, maar verplicht het niet. Bij het boeken van tickets komt er pop-up te voorschijn die zegt: 'deze stad staat op de grijze lijst, we suggereren dus dat je de trein neemt, dit is het reisaanbod voor de trein'. De medewerker krijgt dan ook de informatie over CO2 uitstoot.

**Maxime**

Bestaat er dan ook zoiets als een 'zwarte' lijst?

**Mr. Govers**

De 'witte' lijst bevat de steden die binnen de drie uur met de trein bereikt kunnen worden. Op deze steden wordt normaal niet gevlogen. De 'grijze' lijst bevat steden bij welke we sterk aanraden dat je met de trein gaat.

**Maxime**

Dus vergelijkbaar met de 'groene' (6h) en 'oranje' (8h) lijsten van de UGent?

**Mr. Govers**

Ja, dat is een analoog systeem. De drie uur op de witte lijst komt van trips heel dichtbij gelegen grote steden zoals Parijs en Amsterdam. Als je zegt zes, ja, dan zeg je dus eigenlijk dat iemand moet kiezen voor de trein als die er in zes uur kan zijn. Het verschil tussen zes en acht uur lijkt me dan heel subtiel. Maar goed, UGent zal ook

wel haar argumenten hebben om het zo te doen. Verder is ons reisbeleid vrijwillig, dat houdt in dat mensen die kredieten (onderzoeksbudgetten?) moeten beheren, daar vrijwillig kunnen instappen en kunnen zeggen: ok ik wens te compenseren voor mijn vlucht(en). Deze mensen krijgen dan op het einde van het jaar een factuur met het bedrag dat te compenseren is.

**Maxime**

En de inkomsten van deze compensatie worden dan in het KUL klimaatfonds bewaard?

**Mr. Govers**

Ja, dat klopt. Ik denk dat dat ook verschilt, voor zover ik geïnformeerd ben, met wat UGent doet. Daar bewaart men het simpelweg centraal. Wij hebben voor dit systeem gekozen omdat we het eigenlijk wel belangrijk vinden dat dat debat in de hele universiteit en universitaire gemeenschap plaatsvindt, niet alleen op het allerhoogste niveau weg van de mensen. Het zou eigenlijk gemakkelijker geweest zijn om te zeggen: 'kijk, ongeveer 300 000 euro moeten we compenseren, we doen dat gewoon zelf'. Echter, op deze manier creër je geen discussie in de gemeenschap, en dat willen we er toch echt bijhebben.

**Maxime**

Zijn er buiten de compensatie voor vluchten nog andere inkomstbronnen die in dit klimaatfonds worden bewaard?

**Mr. Govers**

Neen, enkel dit. Verder hebben we vier mogelijke vormstellingen(?) geformuleerd. Ten eerste een reis vermijden door betere videoconferencing infrastructuur. Ten tweede bebossing. Een derde is klimaatcompensatie via een fonds zoals Carbon+Alt+Delete. Het vierde is onderzoeksprojecten inzake klimaat.

**Maxime**

Onderzoekers zijn gebonden door onderzoeksbudgetten. Komt de compensatie uit dit onderzoeksbudget of eerder uit de privé van de onderzoeker?

**Mr. Govers**

Neen, je kan niet zomaar in de privézakken van de mensen zitten. De onderzoekers voelen van deze compensatie zelf niet veel, dat klopt. In een van je vragen stel je ook: denkt u dat €40/ ton CO2 voldoende hoog is om een gedragsverandering teweeg te brengen? Je kan over die kost of prijs lang discussiëren; binnen het ETS staat op dit ogenblik de prijs op 21,50 euro zoals je vermeldt in je vraag. Maar goed, we hebben eens rondgekeken en als je dat doet dan stel je vast dat de kost eerder geschat wordt tussen 60 euro, sommigen zeggen zelfs 200 euro. Maar goed, het ETS stelt de prijs op dit moment iets hoger dan 20 euro. Die 40 euro ligt daar tussenin, en veel meer kan ik daar niet over zeggen. Het is niet zo dat wij over harde data beschikken die zou verantwoorden waarom het 40 moet zijn en geen 50 of 30.

**Maxime**

Ik denk dan dat 40 euro per ton CO2 eerder te weinig is om een echte gedragsverandering te veroorzaken.

**Mr. Govers**

Dan kom je op een andere vraag, die ook belangrijk is: wat wil je bereiken? Wij willen dat op korte afstanden mensen niet meer vliegen. Ik denk ook dat we daar wel in gaan slagen. We gaan zien dat voor dienstreizen met reistijden tot zeven uur waarop vroeger gevlogen werd, er een sterke terugloop van het aantal vluchten zal zijn. Er zijn veel mensen die dat ernstig opnemen. Voor de langere vluchten denk ik niet dat je het moet zien als een mechanisme dat ertoe gaat leiden dat mensen geweldig minder gaan vliegen. Dat geloof ik ook niet. Onafhankelijk van de koolstofprijs die je daarop plakt trouwens. Tenzij misschien een aantal jongere

onderzoekers, zitten de meeste professoren niet te wachten op heel strenge maatregelen. Zij vliegen, omdat zij vinden dat voor hun onderzoek of onderwijs de verplaatsing nodig is. Het is natuurlijk ook een essentieel onderdeel van wat een universiteit als KUL of ook UHasselt is. Jezelf bijvoorbeeld als doelstelling vooropstellen: 'er moet 10% minder gevlogen worden aan de KUL', vind ik een moeilijke. Ik zie het eerder als een mechanisme waarbij we als instelling eigenlijk zeggen: 'we vliegen, we weten ook dat dat vervuilt en we zijn ook bereid om daar iets voor te betalen'. Als we dat als mindset kunnen introduceren aan de KUL, dan zal ik al tevreden zijn. Voor de korte afstanden geloof ik dat we zeker in dit principe zullen slagen: als ik naar Rennes of naar Lyon zou moeten, dan zal ik de trein nemen. Tenzij dat er echt iets waardoor dat niet kan. Maar als ik naar een stad moet die vanuit Brussel op een redelijke manier te bereiken is, zoals Berlijn, wil ik daar rustig over denken. Waarom ook, ja ik kan in de trein rustig werken of lezen, ik zit op mijn gemak. Het is een veel relaxtere en comfortabele manier van reizen. Op lange afstanden gaat dat niet lukken zullen voor het grootste gedeelte met het vliegtuig blijven. Daar gaat misschien een paar procent af omdat sommigen zullen bedenken: 'eigenlijk kan ik dit nu toch wel per Skype oplossen' of 'moeten we nu echt met drie collega's naar dit congres, we kunnen dat ook met slechts twee of één'. Dat zullen we ook tegenkomen, maar in beperktere mate. Mij is het vooral te doen om het opstarten van het debat daarrond, de discussie op gang brengen binnen de KUL gemeenschap over 'wat is ons gedrag, wat zijn de implicaties van dit gedrag en wat kunnen wij daar aan doen'. Niet zozeer het aantal kilometers dat niet gevlogen is aanvinken.

#### **Maxime**

In hun professionele leven voelen onderzoekers deze compensatie niet, zo'n compensatie zouden ze natuurlijk wel voelen in hun privé leven, ondanks ze niet heel hoog is. Dan is een gedragsverandering al sneller aan de orde me dunkt.

#### **Mr. Govers**

Dit werkt natuurlijk alleen voor het professionele gedeelte. We hebben geen impact op wat mensen doen in hun privéleven. Dat willen we ook niet, dat is wel duidelijk. De universiteit moet blijven draaien, dat is ook een realiteit. Er zal dus altijd worden gevlogen.

#### **Maxime**

In een online artikel van de KUL staat: 'Je hebt vergaderinfrastructuur nodig die gevoelig beter is dan wat we nu hebben'

Welke kenmerken moet zulke infrastructuur hebben? Wat onderscheidt ze van Skype?

#### **Mr. Govers**

Dat is een goede vraag. Je vermeldt Skype, je zal Skype ongetwijfeld zelf ook al wel eens gebruikt hebben. Ten eerste, de mensen die de userinterfaces maken bij Microsoft, die moeten misschien ook wel eens nadenken over de gebruiksvriendelijkheid van hun software en diensten. Wat je eigenlijk nodig hebt zijn investeringen in vergaderzalen waarin alles automatisch opstart vanaf het ogenblik dat je de code van je vergadering ingeeft. Alle systemen waarbij je eerst camera's moet opstellen, pc's moet opstarten, connecties moet maken werken eigenlijk niet.

#### **Maxime**

Moeten dit dan specifiek daarvoor bestemde videoconferencing lokalen zijn?

#### **Mr. Govers**

Neen, de lokalen hoeven niet speciaal te worden ingericht. Dat kan in elk lokaal. Je hebt al een videocamera en een scherm, wat je dan nog nodig hebt is een kleine console, die aan het internet verbonden is. Vervolgens voer ik dan mijn vergadernummer in en dan worden de camera en het geluid automatisch opgestart. Zo heb je een automatische verbinding, zonder dat je daaraan een pc moet aanhangen.

**Maxime**

En wat met het uitwisselen van bestanden?

**Mr. Govers**

Dat is minder essentieel. Vooral belangrijk is dat mensen op voorhand niet moeten prutsen met kabels, camera's, pc's en niet alles 3-4 keer moeten opstarten. Dat is volgens mij de essentie. Collega's moeten elkaar goed zien en goed horen. Zulke zalen bestaan al op de KUL. Dat moet dus geen specifieke infrastructuur zijn, want hoe specifieker hoe duurder en hoe waarschijnlijker dat je ook technisch personeel nodig hebt. Goede, gebruiksvriendelijke apparatuur, dat is heel belangrijk.

**Maxime**

Wat is er dan concreet al van kracht?

**Mr. Govers**

Op dit ogenblik zitten we in een fase die vrijwillig is, m.a.w. ik kan nog altijd kiezen om niet mee te doen. We hebben dat op die manier gedaan omdat we binnen de KUL draagvlak willen genereren. We hopen dan ook om binnen ongeveer een jaar onze maatregelen te veralgemenen (zeer korte afstand en infrastructuur). Zoals gezegd, het is niet arbitrair, maar het is ook niet zo dat we een gedetailleerde analyse hebben gedaan om te bepalen of het 30 euro, dan wel 40 of 50 euro moet zijn. Wij denken dat het bedrag op dit moment realistisch is. Gaat het tot gedragsverandering leiden, ja en neen. Op korte afstanden ja, op lange afstanden allicht in beperkte mate. Het brengt wel bewustzijn met zich mee, het wordt een dialoog, mensen zijn er mee bezig en gaan reflecteren over hun verplaatsingsgedrag. De fondsen komen inderdaad uit de onderzoeksbudgetten. Er zijn op dit ogenblik geen andere inkomsten voor het KUL klimaatfonds.

**Maxime**

Hoe zit het met draagvlak onder de medewerkers?

**Mr. Govers**

Draagvlak proberen we te ontwikkelen. Vanmiddag nog ga ik naar de faculteit rechten, waar ik het hele systeem, zoals ik bij jou heb gedaan, toelicht. Op het einde van de rit organiseer ik ook een stemming met als vraag: 'zien jullie dat nu zitten ja of neen'. Op die manier, we doen dat in alle faculteiten, genereren we draagvlak en kunnen we naar de academische raad gaan en zeggen: 'kijk, er is echt wel in de verschillende faculteiten draagvlak om iets dergelijks uit te rollen dus laten we dat doen'. Dus ja, er wordt veel tijd en energie in gestoken.

**Maxime**

En hoe gebeurt de bewustmaking? Posters in vergaderzalen enz.?

**Mr. Govers**

Neen, zo ver zijn we niet gegaan. Dat is delicaat en moeilijk, omdat je altijd een evenwicht moet vinden tussen enerzijds mensen aanzetten om te reflecteren, maar anderzijds niet aanzien worden als een soort duurzaamheidspolitie. En dus wat hebben we gedaan, we hebben geen posters etc. gebruikt, maar we hebben wel de mensen allemaal persoonlijk aanschreven die kredieten beheren (onderzoekers etc.?) met hun vliegverbruik van het afgelopen jaar. We hebben ook uitgelegd wat dat betekent en ook wat de compensatie zou kosten. Zodanig zijn onze medewerkers mee in dit verhaal. We betrekken onze mensen dus eerder via persoonlijke communicatie dan via bv. een grote postercampagne aan de KU Leuven. Op die manier maken we de mensen dus bewust.



**Maxime**

Aan de UGent heeft men deze 'I DIDN'T FLY' ingevoerd. Dit kunnen medewerkers gebruiken als ze een duurzamer alternatief voor hun verplaatsing naar een congres of een vergadering in het buitenland vinden. Ze kunnen het bijvoorbeeld in een presentatie of document verwerken. Ziet u een mogelijkheid voor zulks aan de KULeuven?

**Mr. Govers**

Ik zou aarzelen, op zich kan ik wel begrijpen dat mensen die een inspanning doen daar ook een zekere erkenning voor krijgen en dus deze sticker gebruiken. Anderzijds moet je wel oppassen dat je mensen om welke reden dan ook toch moeten vliegen niet stigmatiserd. Dat is ook een moeilijke: het ligt tussen bepaalde signalen aantonen dat je werkt rond duurzaamheid en anderzijds een evenwicht waarbij je zegt we moeten mensen niet bruskeren maar draagvlak creëren om ze mee te krijgen. Er is dus geen 'one size fits all' oplossing hé Maxime. Ik denk, hier in Leuven, zeker die struisvogel die erbovenop staat, dat zou hier niet pakken. Denk je nu de struisvogel weg, en eigenlijk ook het vliegtuig, maar het vliegtuig werkt natuurlijk niet zonder de struisvogel. Als je beschouwt: 'The sky is not the limit, our planet is' dat vind ik iets waar onze mensen achter zouden kunnen staan. Maar nogmaals, altijd delicaat.

**Maxime**

Hartelijk bedankt Mijnheer Govers, we hebben alle puntjes behandeld! (Zijn naam mag in de thesis vermeld worden en hij wil ook graag de thesis (of het hem betreffende stuk?) ontvangen op het einde, hij zal dit vertrouwelijk behandelen.

## Survey: Sustainable business travel at UHasselt

Q1 Welcome! My name is Maxime Walczynski and I am a master student in Transportation Sciences (specialisation Mobility Management).

This academic year, I write my master thesis on how UHasselt can make its international business travel (more) environmentally friendly. In this respect, I designed a short survey in order to identify the **characteristics of business travel behaviour** of UHasselt staff members within Europe and their **opinion** about sustainable business travel measures. I would like to ask you, UHasselt staff, to fill in my survey, which takes between 5 and 10 minutes. Please note that this survey not only complements my thesis research, but will also help the UHasselt to develop a strategic sustainability plan like several other universities already have. Hence, your input will serve a higher purpose! Your answers will be dealt with anonymously. Would you have any question or remark, please contact me on the following e-mail address: maxime.walczynski@student.uhasselt.be Thank you for your cooperation!

Q2 I am a ...

Professor (1)

Postdoc (2)

PhD student (3)

Other researcher (4)

Member of the central administrative services e.g. Finances, Student facilities... (5)

*Skip To: Q4 If I am a ... = Member of the central administrative services e.g. Finances, Student facilities...*

Q3 I am affiliated with the faculty of... (main faculty)

Architecture and arts (1)

Business economics (2)

Life sciences (3)

Engineering technology (4)

Transportation sciences (5)

Rehabilitation sciences (6)

Sciences (7)

Law (8)

Educational sciences (9)

Q4 Did you **travel abroad** for university related purposes in 2018? e.g. seminar, conference, teaching...

Yes (1)

No (2)

*Skip To: Q7 If Did you travel abroad for university related purposes in 2018? e.g. seminar, conference, teaching... = No*

Q5 How many **international** business trips did you undertake in 2018 (1 trip is defined as Belgium-destination(s)-Belgium)

Q6 Did you travel **within Europe** for university related purposes in 2018?

Yes (1)

No (2)

*Skip To: Q7 If Did you travel within Europe for university related purposes in 2018? = No*  
*Skip To: Q23 If Did you travel within Europe for university related purposes in 2018? = Yes*

Q7 What is **your opinion** about the following possible rules, guidelines or policy measures to reduce the ecological footprint of UHasselt? UHasselt should... 1 = strongly disagree, 5 = strongly agree

	(1)	(2)	(3)	(4)	(5)
Hire 'sustainability staff members' that monitor and evaluate the climate impact of UHasselt activities (1)					
Invest in qualitative videoconferencing infrastructure and train UHasselt staff to use it as to avoid travelling (2)					
Build an intuitive, centralised UHasselt platform for booking business trips which compares travel time, travel costs & environmental impacts (3)					
Set up an UHasselt Climate Fund and use its revenues for sustainable project at UHasselt or elsewhere (4)					
Compensate for the climate cost of UHasselt air travel (e.g. this adds €10 to a flight to Madrid) and collect the revenue in the UHasselt Climate Fund (5)					
Restrict flying to cities that can be reached in (6)					
Restrict flying to cities that can be reached in (7)					
Prohibit flying to destinations located less than 500 km from Hasselt e.g. flying to cities like Hamburg, Stuttgart, Leipzig, Zürich, Tours, Dijon would be prohibited (8)					
Develop a reward mechanism for staff members who actively seek to minimize the environmental impact of their business trips (e.g. financial bonuses) (9)					
Set up awareness campaigns that make you reflect on your travel behaviour (10)					
Set up a platform which compares business CO2 emissions from all staff members to the university average (analog to how some universities keep track of printing paper consumption by staff) (11)					

Q8 THANK YOU FOR TAKING PART IN MY SURVEY

Would the subject interest you; I am looking for professors or staff members who would like to give a short interview in order to ask some more profound questions. Especially staff members who specialise in environmental studies are relevant, as I would like to hear their opinions on this topic.

Please contact me on the following e-mail address if you would like to participate: maxime.walczynski@student.uhasselt.be

Press the arrow to end the survey.

*Skip To: End of Survey If THANK YOU FOR TAKING PART IN MY SURVEY Would the subject interest you; I am looking for profess...() Is Displayed*

Q23 How do you usually arrange your business trips?

Individually (1)

Via Omniatravel (2)

Via the (faculty)secretariat (3)

Q9 Which **European country / countries** did you travel to in 2018?

Albania (1)

Andorra (2)

Armenia (3)

Austria (4)

Belarus (5)

Bosnia and Herzegovina (6)

Bulgaria (7)

Croatia (8)

Cyprus (9)

Czech Republic (10)

Denmark (11)

Estonia (12)

Finland (13)

France (14)

Georgia (15)

Germany (16)

Greece (17)

Hungary (18)

Iceland (19)

Ireland (20)

Italy (21)

Kosovo (22)

Latvia (23)

Liechtenstein (24)

Lithuania (25)

Luxemburg (26)

Macedonia (FYROM) (27)

Malta (28)

Moldova (29)

Monaco (30)  
Montenegro (31)  
The Netherlands (32)  
Norway (33)  
Poland (34)  
Portugal (35)  
Romania (36)  
Russia (37)  
San Marino (38)  
Serbia (39)  
Slovakia (40)  
Slovenia (41)  
Spain (42)  
Sweden (43)  
Switzerland (44)  
Turkey (45)  
Ukraine (46)  
The United Kingdom (47)

Q10 How many business trips did you undertake to...?

- Albania : \_\_\_\_\_ (1)
- Andorra : \_\_\_\_\_ (2)
- Armenia : \_\_\_\_\_ (3)
- Austria : \_\_\_\_\_ (4)
- Belarus : \_\_\_\_\_ (5)
- Bosnia and Herzegovina : \_\_\_\_\_ (6)
- Bulgaria : \_\_\_\_\_ (7)
- Croatia : \_\_\_\_\_ (8)
- Cyprus : \_\_\_\_\_ (9)
- Czech Republic : \_\_\_\_\_ (10)
- Denmark : \_\_\_\_\_ (11)
- Estonia : \_\_\_\_\_ (12)
- Finland : \_\_\_\_\_ (13)
- France : \_\_\_\_\_ (14)
- Georgia : \_\_\_\_\_ (15)
- Germany : \_\_\_\_\_ (16)
- Greece : \_\_\_\_\_ (17)
- Hungary : \_\_\_\_\_ (18)
- Iceland : \_\_\_\_\_ (19)
- Ireland : \_\_\_\_\_ (20)
- Italy : \_\_\_\_\_ (21)
- Kosovo : \_\_\_\_\_ (22)
- Latvia : \_\_\_\_\_ (23)
- Liechtenstein : \_\_\_\_\_ (24)
- Lithuania : \_\_\_\_\_ (25)
- Luxemburg : \_\_\_\_\_ (26)
- Macedonia (FYROM) : \_\_\_\_\_ (27)
- Malta : \_\_\_\_\_ (28)
- Moldova : \_\_\_\_\_ (29)
- Monaco : \_\_\_\_\_ (30)
- Montenegro : \_\_\_\_\_ (31)
- The Netherlands : \_\_\_\_\_ (32)
- Norway : \_\_\_\_\_ (33)
- Poland : \_\_\_\_\_ (34)
- Portugal : \_\_\_\_\_ (35)
- Romania : \_\_\_\_\_ (36)
- Russia : \_\_\_\_\_ (37)
- San Marino : \_\_\_\_\_ (38)
- Serbia : \_\_\_\_\_ (39)
- Slovakia : \_\_\_\_\_ (40)
- Slovenia : \_\_\_\_\_ (41)
- Spain : \_\_\_\_\_ (42)
- Sweden : \_\_\_\_\_ (43)
- Switzerland : \_\_\_\_\_ (44)
- Turkey : \_\_\_\_\_ (45)
- Ukraine : \_\_\_\_\_ (46)

The United Kingdom : \_\_\_\_\_ (47)

Total : \_\_\_\_\_

Q11 **Which city / cities** did you travel to in...? Please fill in.  
List with countries

Q13 For which **purpose(s)** did you travel to...?  
Multiple answers are possible.

	Confer ence, semina r (1)	Lecturi ng & teachi ng (2)	Resear ch purpos es (3)	Meetin g with fellow profes sors, staff... (4)	Meetin g with a govern ment body (5)	Meetin g with a private compa ny (6)	Other (7)
Albania (x1)							
Andorra (x2)							
Armenia (x3)							
Austria (x4)							
Belarus (x5)							
Bosnia and Herzegovina (x6)							
Bulgaria (x7)							
Croatia (x8)							
Cyprus (x9)							
Czech Republic (x10)							
Denmark (x11)							
Estonia (x12)							
Finland (x13)							
France (x14)							
Georgia (x15)							
Germany (x16)							
Greece (x17)							
Hungary (x18)							
Iceland (x19)							
Ireland (x20)							

Italy (x21)  
Kosovo (x22)  
Latvia (x23)  
Liechtenstein (x24)  
Lithuania (x25)  
Luxemburg (x26)  
Macedonia (FYROM) (x27)  
Malta (x28)  
Moldova (x29)  
Monaco (x30)  
Montenegro (x31)  
The Netherlands (x32)  
Norway (x33)  
Poland (x34)  
Portugal (x35)  
  
Romania (x36)  
  
Russia (x37)  
San Marino (x38)  
Serbia (x39)  
Slovakia (x40)  
Slovenia (x41)  
Spain (x42)  
Sweden (x43)  
Switzerland (x44)  
Turkey (x45)  
Ukraine (x46)  
The United Kingdom (x47)



Carry Forward Selected Choices from "Which European country / countries did you travel to in 2018?"

Q14 Was your latest trip in 2018 a day-trip or did you stay overnight?

	Day-trip (1)	Overnight (2)
--	--------------	---------------

Carry Forward Selected Choices from "Which European country / countries did you travel to in 2018?"

Q16 What was the main transport mode during your latest trip in 2018 to...? (e.g. if you travel by taxi to Brussels South Railway Station and then by ICE train to Frankfurt, only select high-speed train)

	Coach / bus (1)	Car(pooling) (2)	Train (3)	High-speed train (4)	Airplane (5)
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List of countries

Q19 How do the following factors affect your transport mode choice when you **travel for business purposes**?

	Not at all important (1)	Slightly important (2)	Moderately important (3)	Very important (4)	Extremely important (5)
Price (1)					
Travel time (2)					
Comfort (3)					
Environmental considerations (4)					
Safety (5)					

Q21 Do you **feel responsible** for your contribution to **climate change**?

1 = not at all 10 = extremely responsible ( )	
---	--

Q24 What is **your opinion** about the following possible rules, guidelines or policy measures to reduce the ecological footprint of UHasselt? UHasselt should... 1 = strongly disagree, 5 = strongly agree

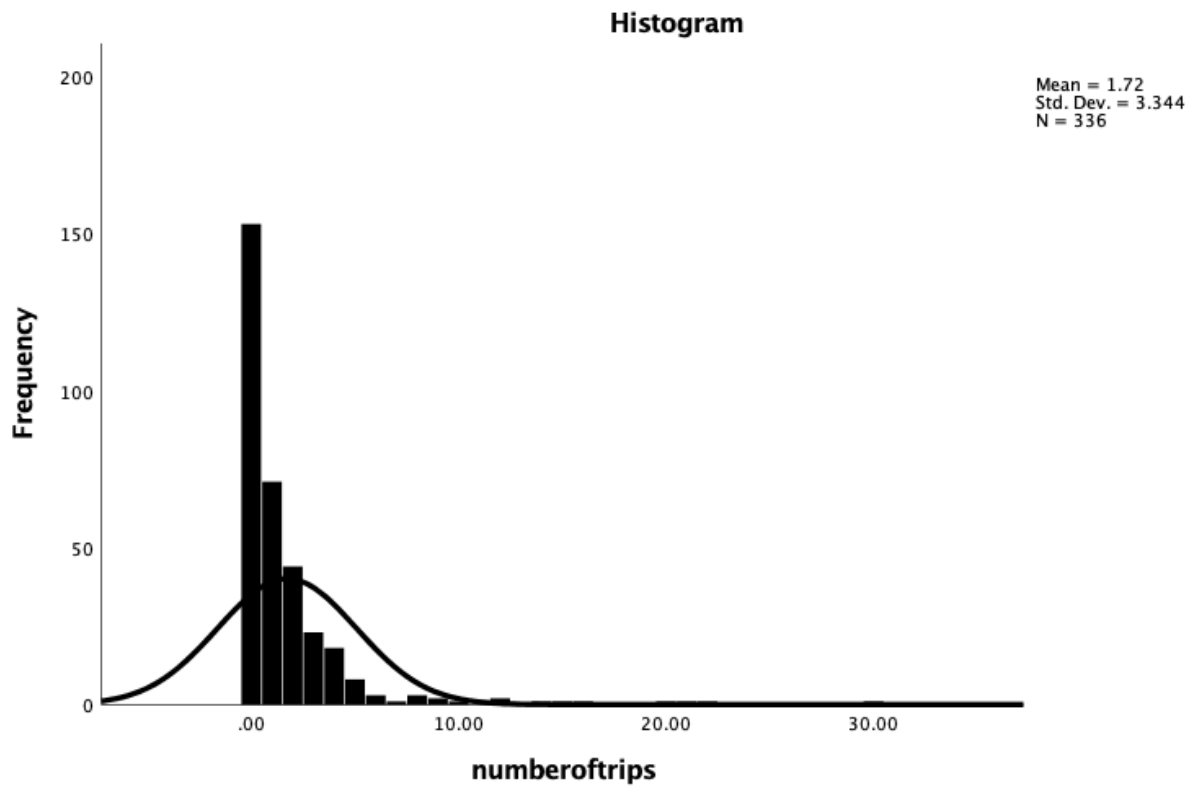
	(1)	(2)	(3)	(4)	(5)
Hire 'sustainability staff members' that monitor and evaluate the climate impact of UHasselt activities (1)					
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Build an intuitive, centralised UHasselt platform for booking business trips which compares travel time, travel costs & environmental impacts (3)					
Set up an UHasselt Climate Fund and use its revenues for sustainable project at UHasselt or elsewhere (4)					
Compensate for the climate cost of UHasselt air travel (e.g. this adds €10 to a flight to Madrid) and collect the revenue in the UHasselt Climate Fund (5)					
Restrict air travel to cities that can be reached in (6)					
Restrict air travel to cities that can be reached in (7)					
Prohibit flying to destinations located less than 500 km from Hasselt (8)					
Develop a reward mechanism for staff members who actively seek to minimize the environmental impact of their business trips (e.g. financial bonuses) (9)					
Set up awareness campaigns that make you reflect on your travel behaviour (10)					
Set up a platform which compares business CO2 emissions from all staff members to the university average (analog to how some universities keep track of printing paper consumption by staff) (11)					

Q25      THANK      YOU      FOR      TAKING      PART      IN      MY      SURVEY

Would the subject interest you; I am looking for professors or staff members who would like to give a short interview in order to ask some more profound questions. Especially staff members who specialise in environmental studies are relevant, as I would like to hear their opinion on this topic. Please contact me on the following e-mail address if you would like to participate: [maxime.walczynski@student.uhasselt.be](mailto:maxime.walczynski@student.uhasselt.be)

Press the arrow to end the survey.

Annex 6: Histogram of number of trips



*Annex 7: Country frequencies*

Country	Number of trips				
Albania	0	Greece	4	Poland	5
Andorra	0	Hungary	3	Portugal	7
Armenia	1	Iceland	2	Romania	2
Austria	20	Ireland	7	Russia	1
Belarus	1	Italy	35	San Marino	0
Bosnia and H.	0	Kosovo	0	Serbia	1
Bulgaria	1	Latvia	0	Slovakia	3
Croatia	5	Liechtenstein	0	Slovenia	4
Cyprus	1	Lithuania	4	Spain	32
Czech Republic	9	Luxemburg	3	Sweden	17
Denmark	8	Macedonia (FYROM)	0	Switzerland	9
Estonia	4	Malta	0	Turkey	1
Finland	1	Moldova	0	Ukraine	0
France	51	Monaco	0	The United Kingdom	55
Georgia	0	Montenegro	0	Total	580
Germany	89	The Netherlands	185		
		Norway	9		


*Annex 8: Excel spreadsheet containing the data for Tableau*

<b>Stad</b>	<b>Freq.</b>	<b>Latitude</b>	<b>Longitude</b>				
				Hamburg	3	53.551086	9.993682
Yerevan	1	40.179188	44.499104	Bremen	4	53.079296	8.801694
Vienna	13	48.208176	16.373819	Frankfurt	2	50.110924	8.682127
Linz	1	48.306938	14.285830	Mannheim	1	49.487457	8.466040
Hirschegg	1	47.020142	14.957820	Stuttgart	3	48.775845	9.182932
Graz	2	47.070713	15.439504	Julich	1	50.921009	6.361200
Salzburg	1	47.809490	13.055010	Hannover	1	52.375893	9.732010
Minsk	1	53.904541	27.561523	Aachen	6	50.775345	6.083887
Ruse	1	43.849579	25.955231	Wüppertal	1	51.264018	7.178037
Dubrovnik	2	42.650661	18.094423	München	4	48.139130	11.580220
Zagreb	1	45.815010	15.981919	Münster	1	51.960667	7.626135
Split	1	43.508133	16.440193	Mainz	1	49.992863	8.247253
Nicosia	1	35.185566	33.382275	Darmstadt	1	49.872826	8.651193
Prague	4	50.075539	14.437800	Düsseldorf	1	51.227741	6.773456
Ostrava	2	49.840790	18.290880	Dortmund	1	51.513588	7.465298
Aarhus	6	56.162937	10.203921	Bayreuth	1	49.94782	11.57893
Copenhagen	3	55.676098	12.568337	Bonn	1	50.73389	7.09972
Talin	4	59.436962	24.753574	Kaiserlautern	1	49.44472	7.76889
Helsinki	1	60.169857	24.938379	Göttingen	1	51.53389	9.93556
Paris	14	48.856613	2.352222	Verden	1	52.919444	9.238333
Lyon	5	45.764042	4.835659	Cologne	1	50.94222	6.95778
Nice	2	43.710175	7.261953	Dresden	1	51.03333	13.73333
Lille	1	50.629250	3.057256	Karlsruhe	1	49.01389	8.40417
Rennes	2	48.117268	-1.677793	Heidelberg	1	49.41222	8.71
Belfort	1	47.637960	6.862894	Zweibrücken	1	49.24944	7.36083
Strasbourg	5	48.582951	7.743750	Niederrhein	1	51.347015	6.337819
Nancy	2	36.871441	94.863281	Chemnitz	1	50.83333	12.91667
Marseille	2	43.296482	5.369780	Oberwolfach	1	48.31667	8.21667
Nantes	1	47.218372	1.553621	Wadern	1	49.51667	6.86667
Aix-en provence	1	43.524910	5.454140	Thessaloniki	1	40.63333	22.95
Bordeaux	1	44.837788	-0.579180	Corfu	1	39.607838	19.913836
Berlin	15	52.516.667	13.383.333	Volos	1	39.36667	22.93333

Athens	1	39.491253	26.336477	Leiden	1	52.15444	4.49472
Budapest	2	47.49833	19.04083	Heerlen	1	50.88333	5.98333
Koszeg	1	47.381944	16.552222	Groningen	3	53.2167	6.5667
Reykjavik	2	64.15	-21.88333	Amersfoort	1	52.15	5.38
Dublin	6	53.3425	-6.26583	Zwolle	1	52.51667	6.1
Parma	3	44.80147	10.328	Rattekaai	1	51.4164	4.1808
Rome	5	41.89306	12.48278	Vlissingen	1	51.45	3.58333
Como	2	-12.18333	44.23333	Den Haag	5	52.08417	4.3175
Milano	5	45.46416	9.19034	s	2	51.6892	5.3031
Venice	2	45.43972	12.33194	Hertogenbosch			
Baveno	1	45.9	8.5	Twente	1	41.06225	28.80635
Pescara	1	42.46428	14.21419	Lunteren	1	52.0872	5.6219
Genua	1	44.416667	8.933333	Egmond Aan Zee	1	52.6186	4.6242
Padova	1	45.40639	11.87778	Delft	1	52.01194	4.35944
Pisa	1	43.71667	10.4	Dordrecht	1	51.81	4.67
Bologna	2	44.49389	11.34278	Roermond	1	51.2	5.98333
Salerno	1	40.7	14.7	Horn	1	51.208333	5.947222
Sardinia	1	40.05	9.083333	Trondheim	1	63.4306	10.3952
Turin	3	45.06667	7.7	Bergen	1	60.3925	5.323333
Perugia	1	43.1121	12.3888	Oslo	5	59.91111	10.75278
Alghero	1	40.55778	8.32194	Stavanger	1	58.968	5.7325
Macugnaga / Ispra	1	45.816667	8.616667	Bodo	1	67.2839	14.3826
Vilnius	3	54.68333	25.28333	Krakow	2	50.06667	19.95
Kaunas	1	54.9	23.93333	Warsaw	1	52.21667	21.03333
Luxemburg	1	49.610556	6.132778	Katowice	2	50.25	19
Belvaux	1	49.51667	5.93333	Estoril	1	38.706667	-9.397778
Maastricht	12	50.86667	5.68333	Lisbbon	3	38.71667	9.16667
Rotterdam	5	51.95	4.41667	Porto	4	30.033	51.2305
Tilburg	3	51.57	5.07	Lasi	1	47.155556	27.591389
Breda	3	51.58333	4.78333	Bucharest	1	44.4	26.08333
Amsterdam	11	52.378	4.9	Yekaterinaburg	1	56.83333	60.58333
Eindhoven	15	51.43444	5.48417	Belgrado	1	44.820556	20.462222
Nijmegen	2	51.83333	5.85	Bratislava	2	48.14472	17.11278
Utrecht	7	52.08889	5.11556	Kosice	1	48.71667	21.25

Ljubljana	4	46.05	14.51667	Geneva	6	46.2	6.15
Barcelona	11	41.3825	2.17694	Zürich	3	47.37861	8.54
Madrid	7	40.41889	-3.69194	Basel	1	47.55056	7.59111
Tenerife	1	28.047922	-16.57754	Izmir	1	38.43333	27.15
Malaga	1	36.720476	-4.412525	Hull	2	53.74433	-0.3325
Valencia	2	39.46667	-0.375	Cambridge	4	52.20806	0.1225
Almeria	1	36.83333	-2.45	Edinburgh	2	55.95	-3.19889
A Coruna	1	43.36667	-8.38333	London	17	51.50722	-0.1275
Granada	1	37.17806	-3.60083	Shefflied	1	53.3825	-1.47194
Sevilla	1	37.38333	5.98333	Newcastle	1	54.97778	-1.61333
Lleida	1	41.61667	0.63333	Leeds	1	53.79972	-1.54917
Malmo	1	55.60556	13	Manchester	3	53.46667	-2.23333
Lund	4	55.7	13.2	Windsor	1	51.4791	-0.6095
Uppsala	2	59.85	17.65	Glasgow	3	55.87	-4.27
Stockholm	2	59.32944	18.06861	Lancester	1	54,100	-2,800
Halmstad	1	56.66667	12.85	St. Andrews	1	56.33889	-2.79889
Linköping	1	58.40833	15.625	Coventry	1	52.41667	-1.51667
Göteborg	3	57.70694	11.96667	Oxford	2	51.75194	-1.25778
Umea	2	63.83333	20.25	Belfast	1	54.59667	-5.93833
Wales	1	52.3496	-3.63785				

Annex 9: Excel spreadsheet of travel purposes

	A	B	C	D	E	F	G	H	I	J	K	L
2		conference	lecturing	research	fellow professors	government body	private company	other				
3	Albania										Albania	
4	Armenia		1						1		Andorra	
5	Andorra										Armenia	
6	Austria	13	2	7	9				31		Austria	
7	Belarus	1							1		Belarus	
8	Bosn. H								0		Bosnia and H.	
9	Bulgaria	1							1		Bulgaria	
10	Croatia	4		1					5		Croatia	
11	Cyprus	1							1		Cyprus	
12	Czech rep	4	1	3	3	1			12		Czech Republic	
13	denmark	7		1	2			1	11		Denmark	
14	Estosnia	4							4		Estonia	
15	Finland	1							1		Finland	
16	France	27	1	10	12			1	2	53	France	
17	Georgia								0		Georgia	
18	Germany	33	4	23	25	1	2	2	90		Germany	
19	Greece	3		1					4		Greece	
20	Hungary	1			1			1	3		Hungary	
21	Iceland	2		1	1				4		Iceland	
22	Ireland	5		1	2				8		Ireland	
23	Italy	24	2	9	7	2		2	46		Italy	
24	Kosovo								0		Kosovo	
25	Latvia								0		Latvia	
26	Liechtenstein								0		Liechtenstein	
27	Lithuania	1			2	2			5		Lithuania	
28	Luxemburg	1		1	1	1	2		6		Luxemburg	
29	Macedonia								0		Macedonia (FYROM)	
30	Malta								0		Malta	
31	Moldova								0		Moldova	
32	Monaco								0		Monaco	
33	Montenegro								0		Montenegro	
34	Netherlands	42	9	19	24	2	2	8	106		The Netherlands	
35	Norway	5	3	4	4				16		Norway	
36	Poland	3		3	5				11		Poland	
37	Portugal	6	1	1	1				9		Portugal	
38	Romania	2		1					3		Romania	
39	Russia	1			1				2		Russia	
40	San Marino								0		San Marino	
41	Serbia							1	1		Serbia	
42	Slovakia	2	1	1				1	5		Slovakia	
43	Slovenia	4			1				5		Slovenia	580
44	Spain	18	11	5	1	11		3	49		Spain	
45	Sweden	9			5			1	15		Sweden	
46	Switzerland	3	1	2	3	2	2		13		Switzerland	
47	Turkey	1						1	1	3	Turkey	
48	Ukraine								0		Ukraine	
49	UK	19	2	13	15		2	4	55		The United Kingdom	
50		248	39	107	125	22	14	25			Total	
51												
52		43%	7%	18%	22%	4%	2%	4%				



*Annex 10: Faculties*

Faculty	n	Mean	Standard deviation
Architecture and arts	23	1.312	1.149
Business economics	37	1.200	0.637
Life sciences	30	3.036	0.682
Engineering technology	26	2.024	1.093
Transportation sciences	16	1.500	0.994
Rehabilitation sciences	13	0.979	1.014
Sciences	87	2.118	0.447
Law	13	2.800	1.401
Educational sciences	2	2.000	2.565

*Annex 11: UGent stedenlijst*

**Groene steden:**

- met de trein bereikbaar in minder dan 6 uur of
- reistijd per trein is minder lang of gelijk aan de reistijd per vliegtuig (duur van vlucht + 2 uur, als standaardduur van de rit naar de luchthaven + inchecktijd + transfertijd)

Aken	Eindhoven	Nancy
Amersfoort	Enschede	Nantes
Amsterdam	Frankfurt	Nijmegen
Arras	Grenoble	Noordwijkerhout
Ashford	Groningen	Oxford
Birmingham	Heidelberg	Parijs
Bochum	Julich	Reims
Bonn	Keulen	Rennes
Bordeaux	Leeds	Rotterdam
Breda	Leiden	Sheffield
Brighton	Lille/Rijsel	Southampton
Bristol	London	Strasbourg
Calais	Luxembourg	Stuttgart
Cambridge	Lyon	Tilburg
Cardiff	Maastricht	Trier
Delft	Mainz	Tübingen
Den Haag	Marseille	Utrecht
Dortmund	Metz	Wageningen
Düsseldorf	Montpellier	York
Egmond aan Zee	Münster	

**Oranje steden:**

- met de trein bereikbaar in minder dan 8 uur of
- reistijd per trein is minder lang of gelijk aan de reistijd per vliegtuig (duur van vlucht + 2 uur, als standaardduur van de rit naar de luchthaven + inchecktijd + transfertijd)

Aix-en-Provence	Basel	Berlijn
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Bern

Bremen

Durham

Freiburg

Fribourg

Genève

Göttingen

Hamburg

Hannover

Karlsruhe

Lausanne

Leipzig

München

Newcastle

Nice

Nuremberg

Toulouse

Twente

Zürich

*Annex 12: Position*

UHasselt function	n	Mean	Standard deviation
Professor	84	2.411	0.577
Postdoc	50	1.526	0.849
PhD student	80	2.667	0.517
Other researcher	32	0.524	0.782
Central administrative services	90	2.000	3.628

Annex 14: Strategic Goal 2 UHasselt logo



Beste,

Ik richt me tot u omdat u alle drie als 'gespecialiseerd secretariaatsmedewerker' van de faculteit levenswetenschappen aangeduid staat op de UHasselt website.

Ik ben Maxime Walczynski, master student Mobiliteitswetenschappen en ik rond momenteel mijn thesis over internationale dienstreizen af. In mijn dataonderzoek ben ik op een merkwaardigheid gestoten.

In één van mijn analyses zocht ik een verband tussen het horen bij een bepaalde faculteit en / of het bekleden van een bepaalde functie (professor, postdoc, doctoraatsstudent etc.)

Citatie uit mijn thesis:

When looking for interaction effects between faculty and position, it is revealed that postdocs affiliated with the faculty of life sciences and with that of architecture & arts appear to travel significantly more than the professors of those faculties. Also, PhD students affiliated with the faculty of life sciences appear to travel significantly more than the professors of that same faculty. This might seem strange, yet a logical explanation, limited to the faculty of life sciences, is that professors cannot travel that much as they are often required to treat patients or perform surgeries etc. in Belgium. PhD students and postdocs might not be required to be present that often, therefore they can travel more often.

Lijkt dit u logisch? hebt u nog verdere verklaringen? Graag wil ik uw reactie kort in mijn thesis verwerken.

Vriendelijke groeten,

Maxime Walczynski

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Antw.: Toelichting over data

[Details](#)

Aan: Maxime Walczynski, Kopie: Veronique POUSSET, Kathleen UNGRICHT, Ilse HENKENS

Beste Maxime,

ik kreeg van mijn teamleden jouw mailtje doorgestuurd. Je stelt geen gemakkelijke vraag... Het is voor mezelf ook een verrassing om te zien dat dit blijkbaar facultair anders ligt.

Ook al ligt je uitleg voor de hand, toch denk ik niet dat het zo eenvoudig ligt. Het hangt er ook vanaf hoe je je analyse gedaan hebt.

De faculteit geneeskunde & levenswetenschappen (medicine & life sciences trouwens in het Engels, niet enkel life sciences) werkt wel met veel deeltijdse professoren-artsen. Zij zijn inderdaad als hoofdactiviteit in het ziekenhuis actief. Zij doen hun academisch onderzoek en onderwijs in een deelaanstelling aan de universiteit (bvb 10% van een voltijds mandaat) naast hun klinisch werk. Als je dus geteld hebt "per hoofd" is jouw uitleg waarschijnlijk een deel van de verklaring. Als je geteld hebt per totaal voltijds equivalenten is dat niet het geval, want dan compenseer je normaal voor de aanstelling in het ziekenhuis, al zijn er dan relatief gezien ook gewoon meer doctoraatsstudenten per voltijds prof (want elke deeltijdse prof heeft ook doctoraatsstudenten). Heb je dus rekening gehouden met het aantal doctoraatsstudenten en postdocs tov het aantal professoren?

Bijkomend zijn er echter ook veel professoren die actief zijn in het basis biomedisch (preklinisch) onderzoek en hier aan UHasselt dus een voltijdse aanstelling hebben. Zij zijn bvb geen artsen maar biomedici, biologen etc van opleiding. Zij zien dus geen patiënten. Daarvoor gaat je uitleg niet op.

Daarnaast nog enkele bedenkingen/mogelijke factoren:

Het is zo dat in de biomedische sector doctoraatsstudenten en post-docs ook sterk gestimuleerd worden om deel te nemen aan internationale congressen ed. Je zou bvb eens kunnen kijken of er een verschil is in het aantal toegekende FWO reisbeurzen tussen de faculteiten. Er is misschien een andere reis- of congrescultuur in de verschillende wetenschapsdomeinen (en dus faculteiten)? Gaat men bvb in de rechten minder naar internationale congressen omdat dit soms (zeker niet altijd) ook een sterk nationale (wetgevende) component heeft? Dat strookt dan weer niet echt met de faculteit wetenschappen, waar die nationale component er ook niet is. Anderzijds heeft men bij rechten ook deelaanstellingen van mensen die bvb de advocatuur combineren met een functie aan de universiteit. Daarvoor zou hetzelfde moeten gelden als de arts-professoren in jouw redenering.

Ook een belangrijke vraag is natuurlijk op welke tijdsperiode je je baseert, en of dit patroon elk jaar terug keert of dat het een "toevalstreffer" is.

Je stelt dus een moeilijke vraag waar ik ook niet zomaar pasklaar een antwoord op heb. Er zijn veel variabelen, waarvan ik er een paar in het antwoord hierboven wou aanstippen. Maar ik heb geen enkel argument om te zetten wát precies de "oorzaak" is van je vaststelling.

Steeds ter beschikking als je hierover nog verdere vragen hebt.

Mvg  
Roeland

Beste Maxime

Intussen werd jouw vraag voorgelegd op het faculteitsbureau.

Uitgaande van de volgende feiten:

- We beschikken niet over de definitie van "the professors of those faculties", met andere woorden, we kennen de parameters uit de noemer niet: Werd er rekening ghehouden met het aantal koppen of met de aanstellingspercentages, worden enkel ZAP - leden of ook gastprofessoren en de docenten uit het integratiekader meegerekend?
- De definitie van een "significant verschil" werd niet meegegeven; Men kan zich aldus afvragen: "Is dit statistisch significant verschil ook een betekenisvol verschil?"

zou de verklaring te vinden kunnen zijn in het volgende:

Gezien onze faculteit pas in 2013 ingekanteld is in UHasselt, is het aantal voltijdse ZAP - leden (professoren) nog zeer beperkt. Onze faculteit beschikt over meerdere zapeden met kleine aanstellingen. Ook zijn er gastprofessoren aangesteld, eveneens met zeer kleine aanstellingen (5% - 10%). Verder is er een groep docenten en hoofddocenten die nog steeds in het integratiekader aangesteld is en dus niet onder het statuut van UHasselt werkt. De opdracht van deze groep bestaat voor 100% uit onderwijs. Internationale reizen worden echter quasi steeds gedaan in het kader van onderzoek. Ook beseft onze faculteit - Hierin heet één van de onderzoekslijnen 'sustainability' - de bijdrage van iedere vlucht aan de CO2 - uitstoot en wil hiermee bewust rekening houden in haar daden.

Veel succes met de afronding van jouw thesis!

Christel

**Christel Heynickx**

Administratief Directeur Faculteit Architectuur en Kunst  
Head of the administration Faculty of Architecture and Arts

