



DATASET2050

“Data driven approach for a Seamless Efficient Travelling in 2050”

Coordination and Support Action funded by the European Commission

H2020, Mobility for Growth 2014-2015: MG.1.7-2015, T.1

"Aviation Research and Innovation Policy"

Grant Agreement no: 640353

Deliverable 3.1

“Current Passenger Demand Profile”

- Work-package: 3
- Deliverable number within work-package: 1
- Delivery date: M19, July 2016
- Dissemination level: PU
- Status: Final version
- Deliverable type: R
- Deliverable leader: Bauhaus Luftfahrt e.V.
- Reviewed by: DATASET2050 consortium
- Approved by: The Innaxis Foundation and Research Institute

ABSTRACT

The Flightpath2050 goal of enabling 90 per cent of European passengers to complete their door-to-door journey within four hours is a very challenging task. A major objective of the DATASET2050 project is to deliver insight into both current and future processes relating to the European transport system. In this regard, the deliverable D3.1 "Current Passenger Demand Profile" focuses on the demand side of European (air) transport with the specific goal to develop a range of passenger profiles and respective archetype journeys. For this purpose, a variety of passenger characteristics including demographic, geographic, socio-economic and behavioural aspects as well as particular mobility patterns are analysed using available European data.

Based on the analysis of this passenger related data and specific mobility behaviour of the different member states (EU28 and EFTA), six different passenger profiles and five different archetype journeys have been developed. The six different traveller profiles include two groups travelling for business purposes and four groups that have a private focus. Various characteristics including the length of stay at the destination, the amount of luggage taken along, or the level of technological affinity is assigned to each passenger group. The generalised journeys are based on specific types of destinations as well as respective route lengths. These are matched with the passenger profiles and hence each passenger group is associated with at least one particular journey type.

Pairing these demand profiles with the current supply of the European transport system helps to identify potential for improvement. The focus in this report has been placed on high density routes both in terms of air traffic and population density in order to capture a high share of potential passengers for the current demand profile. Based on these profiles and journey times, metrics will be developed which deliver specific input for the model. Hence, there is close alignment with the respective work packages WP2 and WP5.

TABLE OF CONTENTS

Abstract	1
1 Introduction	4
2 Passenger characteristics.....	6
2.1 Demographical aspects.....	6
2.1.1 Population and age structure	6
2.1.2 Gender	9
2.2 Geographical aspects.....	11
2.2.1 Country size, population density and urbanization.....	11
2.3 Socio-economic aspects.....	15
2.3.1 Gross domestic product and ease of doing business	15
2.3.2 Household structure	16
2.3.3 Education level.....	18
2.4 Behavioural aspects.....	21
2.4.1 Information and communications technology	21
2.4.2 Environmental awareness	24
2.4.3 Safety and security.....	25
3 Mobility behaviour	28
3.1 All transport modes.....	28
3.2 Air travel	31
3.2.1 Investigation of journey types	35
3.2.2 Passenger luggage.....	39
3.2.3 Value of travel time, price and income elasticities.....	41
4 Passenger profiles within DATASET2050.....	44
4.1 Description of passenger profiles.....	44
4.2 Definition of generalized journeys	47

5	Summary and next steps	55
6	Appendix	58
7	References.....	64
8	List of figures	69
9	List of tables	70

1 INTRODUCTION

The Flightpath2050 goal of enabling 90 per cent of European passengers to complete their door-to-door journey within four hours is a very challenging task. A major objective of the DATASET2050 project is to deliver insight into both current and future processes relating to the European transport system. In this regard, the deliverable D3.1 "Current Passenger Demand Profile" focuses on the demand side of European (air) transport with the specific goal to develop a range of passenger profiles and respective archetype journeys. It is important to include a variety of characteristics describing the demand for mobility in general and for air transport in particular. The data driven approach taken here focuses on the current transport system and will deliver input for the model developed in WP2 and implemented in WP5. Together with the results from the supply side analysis (WP4) current bottlenecks and areas of improvement regarding the European transport system can be identified. Within this discussion, the report concentrates on the EU28 and EFTA countries outlined in Table 1.

Table 1: Countries included in the DATASET2050 analysis

EU28 and EFTA countries considered in DATASET2050			
Austria (S)	Finland (S)	Lithuania (S)	Slovenia (S)
Belgium (S)	France (S)	Luxembourg (S)	Spain (S)
Bulgaria	Germany (S)	Malta (S)	Sweden (S)
Croatia	Greece (S)	Netherlands (S)	United Kingdom
Cyprus	Hungary (S)	Poland (S)	Iceland (EFTA; S)
Czech Republic (S)	Ireland	Portugal (S)	Liechtenstein (EFTA; S)
Denmark (S)	Italy (S)	Romania	Norway (EFTA; S)
Estonia (S)	Latvia (S)	Slovakia (S)	Switzerland (EFTA; S)

EFTA: European Free Trade Association countries, S: Schengen Agreement countries

Passengers' travel behaviour, their preferences regarding holiday destinations, their travel budget and experience sought are influenced by various factors such as gender, the country of origin of a traveller, age, the educational level or the usage of information and communication technologies. There are also interdependencies between the different factors as outlined in Figure 1 below. For example, the usage of information and communication technology during a journey may be interlinked with a person's age. In order to gain a better understanding of today's passenger behaviour and resulting expectations towards the European transport system, a range of factors is analysed, both quantitatively and qualitatively. Figure 1 depicts those parameters which are discussed in more detail in section 3. At the end of each section the implications for transport demand and for the characterization of different passenger groups will be outlined. Following that,

section 4 outlines passenger mobility behaviour in general and with regard to air travel in particular.

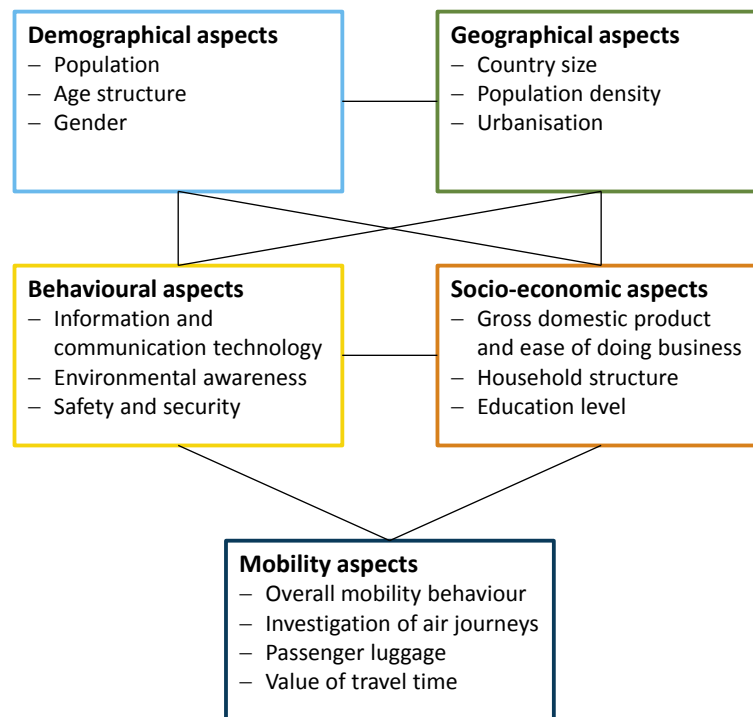


Figure 1: Factors influencing passenger demand for mobility (own depiction)

Following that, passenger profiles are generated using existing data on European passengers as well as different studies concerned with the analysis of passenger behaviour and demand. In addition to this, a set of generalised journey types is described in order to determine trip characteristics such as preferred destinations, access modes to the airport, or trip booking behaviour (section 5). The combination of passenger profiles and journey types provides one pillar for the assessment of the four hour door-to-door goal within this project. Section 6 summarizes and outlines the next steps.

2 PASSENGER CHARACTERISTICS

2.1 Demographical aspects

The population size affects the demand for air travel since a larger demand basis automatically increases the demand for mobility. Hence, the population of a country has to be taken into consideration when estimating and differentiating the demand for air travel.

2.1.1 Population and age structure

The absolute population for each of the EU28 and EFTA countries is outlined in Figure 2 and the countries are displayed in descending order of their total population.

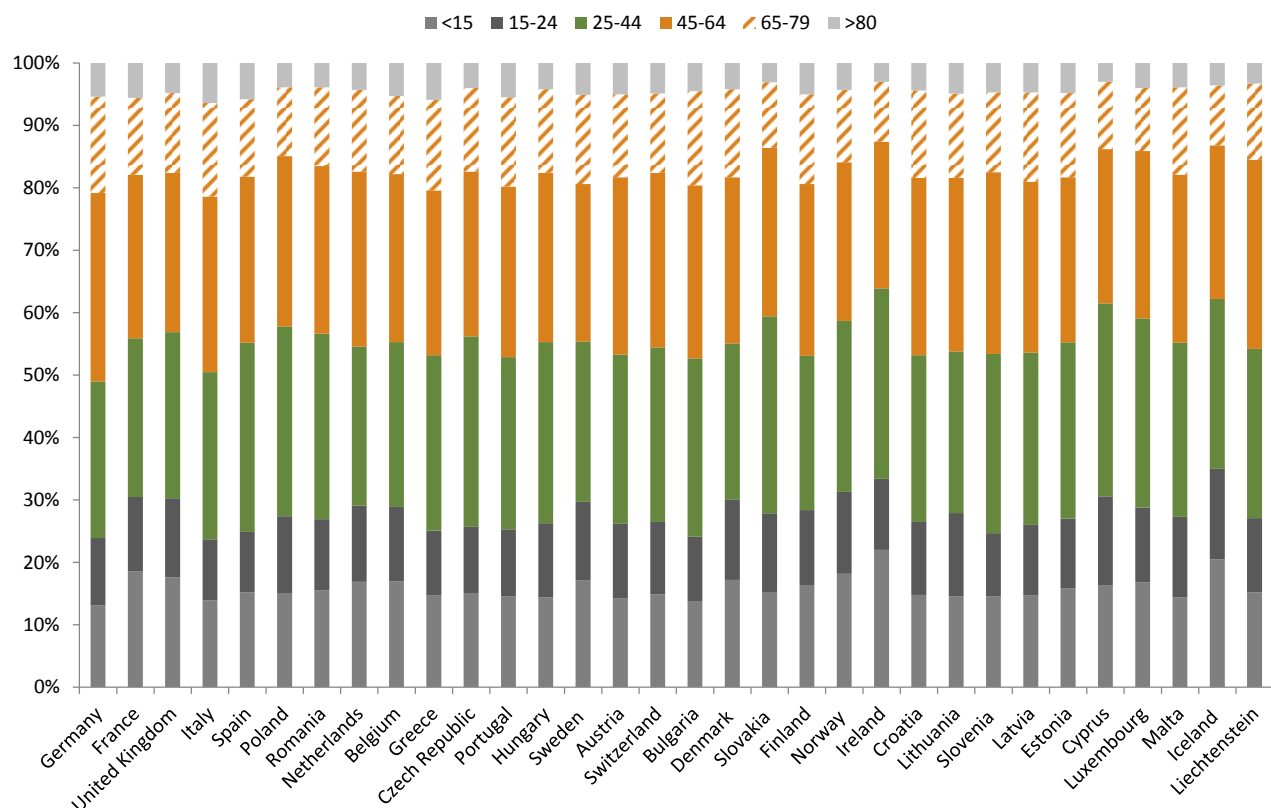


Figure 2: Population in EU28 and EFTA countries by age group (data: Eurostat, 2014a)

The six largest countries – Germany, France, the United Kingdom, Italy, Spain and Poland – already make up almost 70 per cent of the population within this country sample. Hence, a high share of mobility demand will be generated within these countries alone. This will be elaborated on in more

detail in section 4. Germany and Italy have a high share of population over 45 years of age, with 51 and 50 per cent respectively. Iceland and Ireland, on the contrary, have the highest share of population in the age cohort of under 15 year olds (about 20 per cent) and slightly more than 60 per cent of the population being below 45 years of age.

Figure 2 and Figure 3 outline the distribution of the overall European population across predefined age groups. More than 50 per cent of Europeans belong to the age groups between 25 and 44 years as well as 45 and 64 years. These two groups also reflect the majority of the working age population.

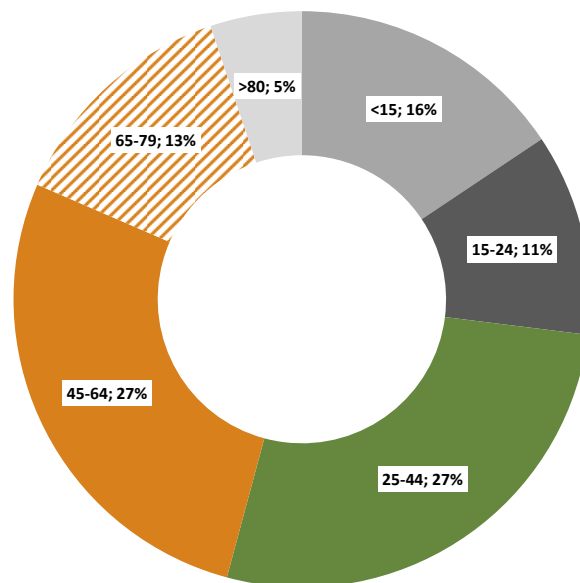


Figure 3: Accumulated distribution of different age groups (data: Eurostat, 2014a)

Figure 3 depicts the population by the different age groups for the base year 2014 accumulated for all considered countries. The distribution of population across the different age groups is similar for all countries. A distinction among age groups is important since travel behaviour may differ by age group, such as in terms of travel activity in general, trip duration, disposable income, expectations along the journey and other factors.

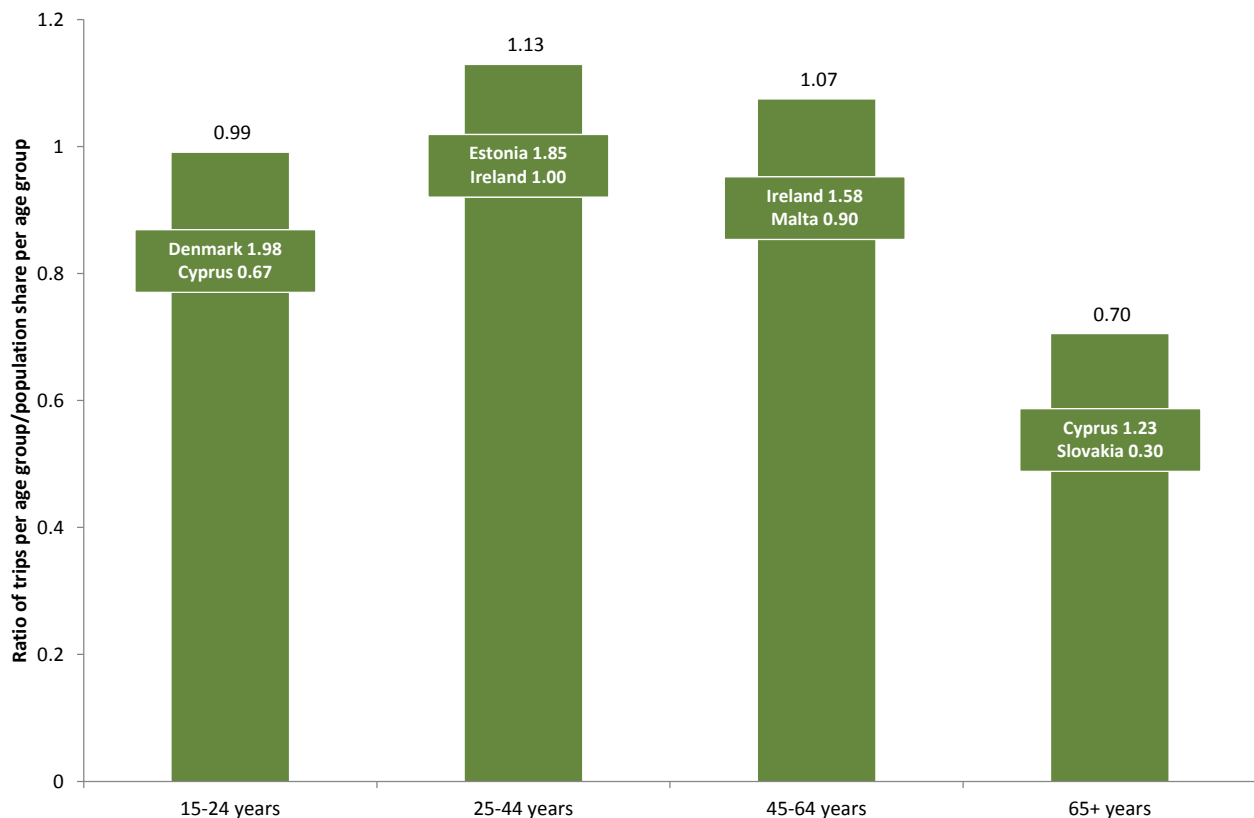


Figure 4: Travel activity of different age groups (data: Eurostat, 2014b)

The accumulated data for all EU28 and EFTA countries shows that the group of 25 to 44 year olds, on average, is the most active one in terms of trips taken per year, followed by the age group of 45 to 64 year old. The least active citizens are those of 65 years and older. Within each age range those countries with the highest and lowest travel activity are outlined. The relationship between age cohort and demand for travel has been investigated in different studies. Alsnih and Hensher (2003) analyse the travel behaviour of the elderly population with particular focus on private car use versus public transportation. They find that retirees are likely to conduct trip chains, meaning they combine multiple purposes and destinations within one trip in order to minimize the effort of driving. Public transportation is increasing among those being 75 year old and above in densely populated urban areas. Reasons for this might be the mere availability of respective infrastructure and frequencies of public transport services within these areas compared to rural ones.

Möller et al. (2007) give a good overview of different studies and outline factors that drive the demand for travel among seniors including higher life expectancy, high disposable income (also due to savings) or good state of health. The study considers three different groups of senior travellers: (1) empty nesters including the age group 55 to 64, (2) young seniors with adults from 65 to 79, and (3) seniors including the age group 80 and over. The amount of trips per year is higher for the empty nesters since these citizens are still in employment whereas trip amount is

decreasing for the latter two groups. However, trip duration is increasing with age. Reasons for not travelling include the lack of financial means as well as deteriorating health status. The authors also use a focus group approach in order to get a more detailed insight of the travel behaviour of elderly passengers in Austria. Both approaches imply that elderly passengers tend to travel during off-peak seasons and prefer longer stays. Sakai et al. (2000) focus on the travel demand among older Japanese citizens taking into account different effects including age, cohort and time. All studies show that the group of senior travellers is very prone to travel, a development continuing in the future since travel behaviour is likely to manifest over time, i.e. travelling can be considered as "learned behaviour" (Möller et al., 2007). This means that today's 30 year olds, for example, pursue their particular travel patterns to a high degree when they get older.

Regarding the behaviour of youth travellers, studies by the World Tourism Organization (UNWTO) (2016) as well as a report by the International Student Travel Confederation together with the Association of Tourism and Leisure Education (2003) investigate the travel planning, expectations and trip duration, amongst others, of this particular group. The UNWTO report looks at travellers between the ages 15 to 29 which account for approximately 23 per cent of all global travellers. The major motivation for this group is the experience of new cultures, getting to know local people and to "live local". Furthermore, with more students enrolling in higher education, studying abroad becomes increasingly important. Although student or young travellers often only have a low budget, i.e. being money poor but time rich, their travel expenditures within a country or region are not necessarily lower than those of a tourist with a higher income. This can be accrued to the longer trips young travellers often conduct; hence their expenditures accumulate to a high level as well. In addition, some of these travellers combine their travelling with work in the respective destination in order to enhance their budget. The latter report is based on a detailed survey among global travellers aged mostly below 26 and confirms a lot of those aspects of the UNWTO study. Main reasons for travelling here are getting to know new cultures, the pleasure of travelling itself as well as enhancing one's knowledge. Already in 2002, the year of the survey, the internet was the predominant mode for young travellers to plan and book their trip. Considering that a high share of this group travels to long-distance destinations, air transport is the mode used the most. Furthermore, as stated in the studies about senior travellers, young travellers also experience some kind of travel learning or "travel career", which means building up experience and accumulating knowledge regarding travel itself and different destinations. Also, the group of young travellers is not homogeneous but differs according to travel destinations, age, income level, or experience sought.

2.1.2 Gender

Another important aspect in defining different passenger profiles is the gender of traveller. The share of female population is around 50 per cent in each of the considered EU states. These figures

roughly translate to the share of females travelling for either personal or business reasons (Figure 5). However, in a majority of the countries the amount of male business travellers still exceeds that of female ones with the latter expected to increase in the future.

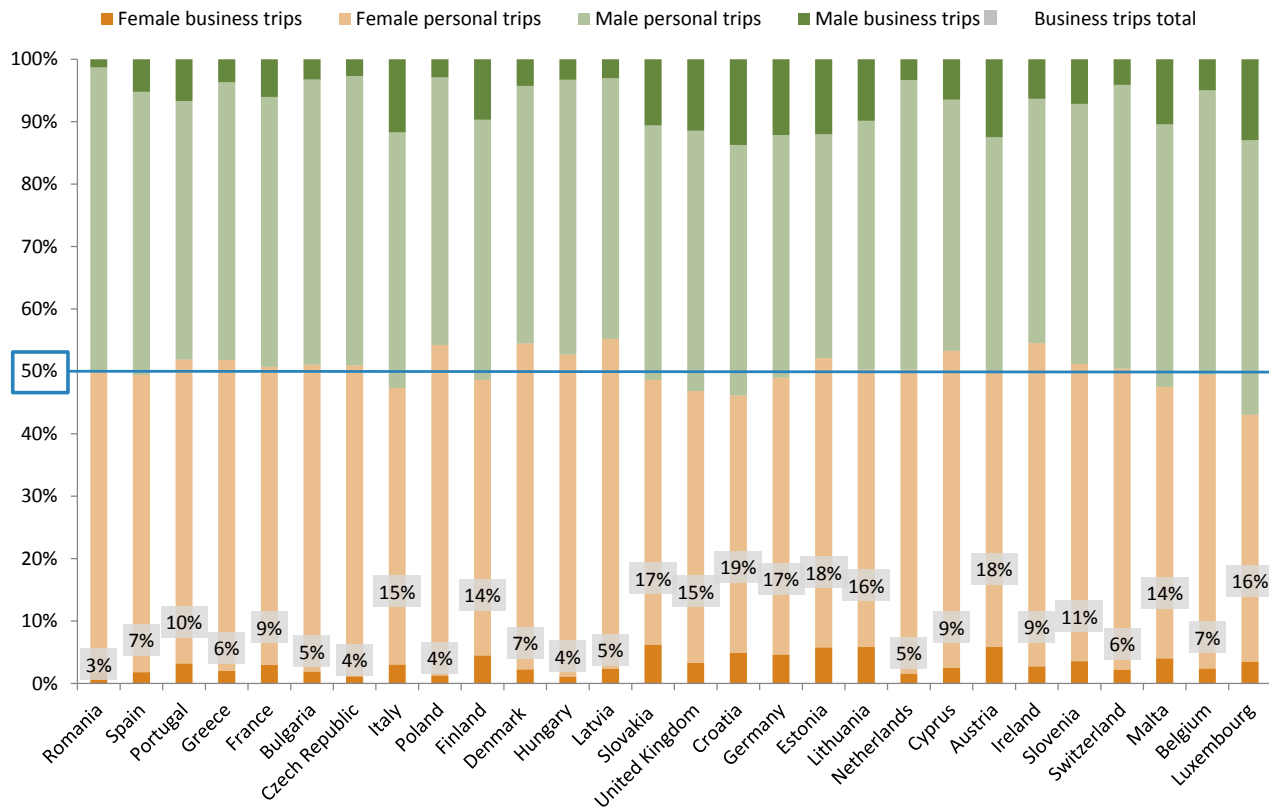


Figure 5: Share of female and male travellers (data: Eurostat, 2014b)

Travel behaviour and expectations differ by gender and hence have to be catered for accordingly. A recent survey by HolidayIQ (2016) investigated the expectations of female Indian travellers along the trip (BusinessWire, 2016). Amongst others, safety and improved accessibility of remote destinations were named as being important aspects. Furthermore, a high share demands more female service providers such as tour guides or women-only transport. Moreover, in the last decades the labour market participation of women as well as the female education level have strongly been increasing. Both factors contributed to more financially independent women and changing family structures. A range of studies show that the gender gap in terms of mobility behaviour has been closing over last decades. Especially in regard to automobility, i.e. the amount of licences obtained, daily trips made by car as well as kilometres driven in a year, women have been catching up with men. More women entering the workforce also contributes to an increase in female business trips as well as different types of holiday destinations (Kalter et al., 2011; McGuckin and Murakami, 1995).

Implications
Distinction by age group : The share of population within the age groups differs, age influences travel behaviour in regard to required services and type of trips taken.
Distinction by gender : Travel expectations and behaviour differ by gender; women play a decisive role in determining holiday locations and make up an increasing share of business travellers.

2.2 Geographical aspects

Within this section, the distribution of population across the different countries in the considered sample is discussed. The analysis is important to understand the demand for transport and flows between different regions. Investigating the share of passengers originating in rural and urban regions with different levels of modal accessibility (to be analysed in work package 4 of the project) facilitates the assessment of the four hour door-to-door goal within Europe.

2.2.1 Country size, population density and urbanization

The overall share of urban population, according to World Bank (2016) data, accumulates to more than 70 per cent of the total population across the considered European countries.

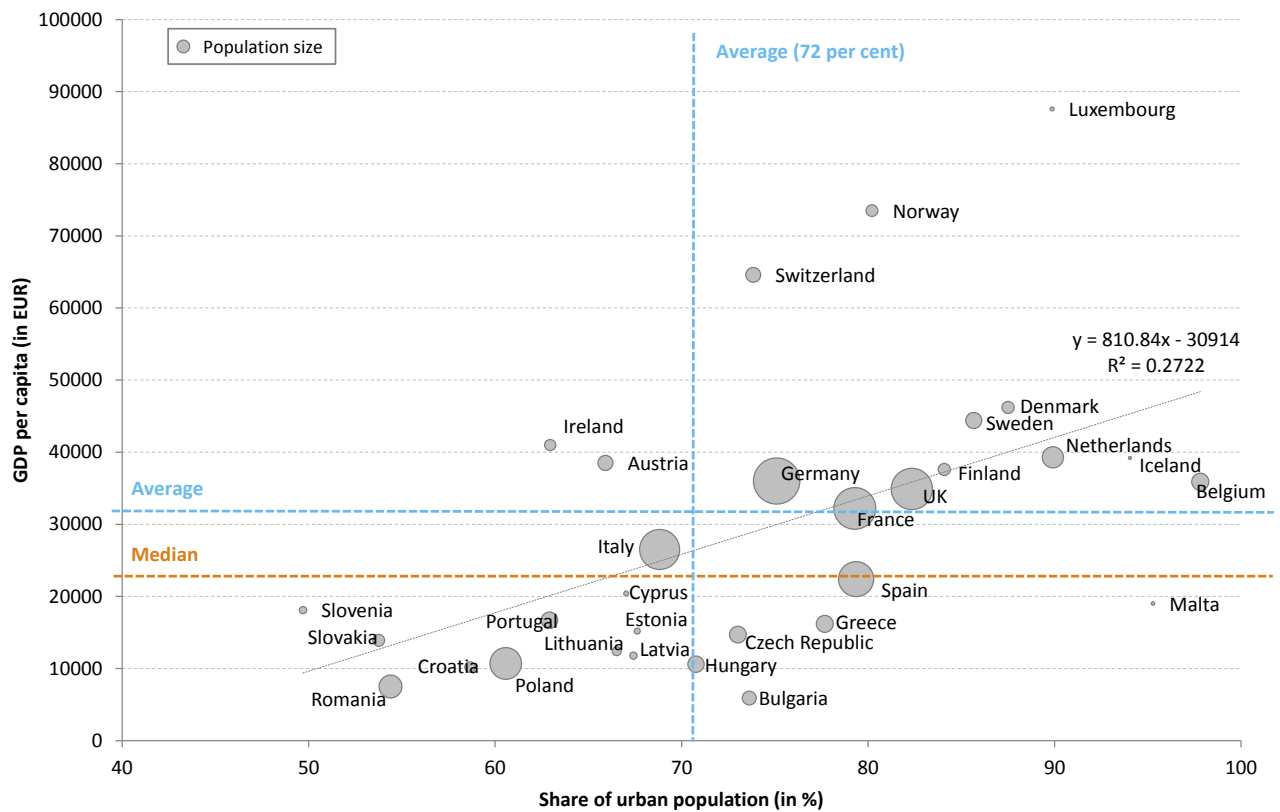


Figure 6: Correlation urbanization and GDP per capita (data: Eurostat, 2014c; World Bank, 2016)

Figure 6 shows that all these countries have an urbanization degree of at least 50 per cent and that the majority of countries have a share of above 65 per cent regarding their urban population. It also depicts the relationship between GDP per capita and the degree of urbanization for each country. However, the correlation between these two parameters is rather weak and both urbanization and GDP development are predominantly driven by other factors.

The overall share of urban population gives a first indication that a high share of (air) transport within Europe takes place between urban centres. In order to depict these flows the geographical distribution of urban agglomerations gives a further indication.

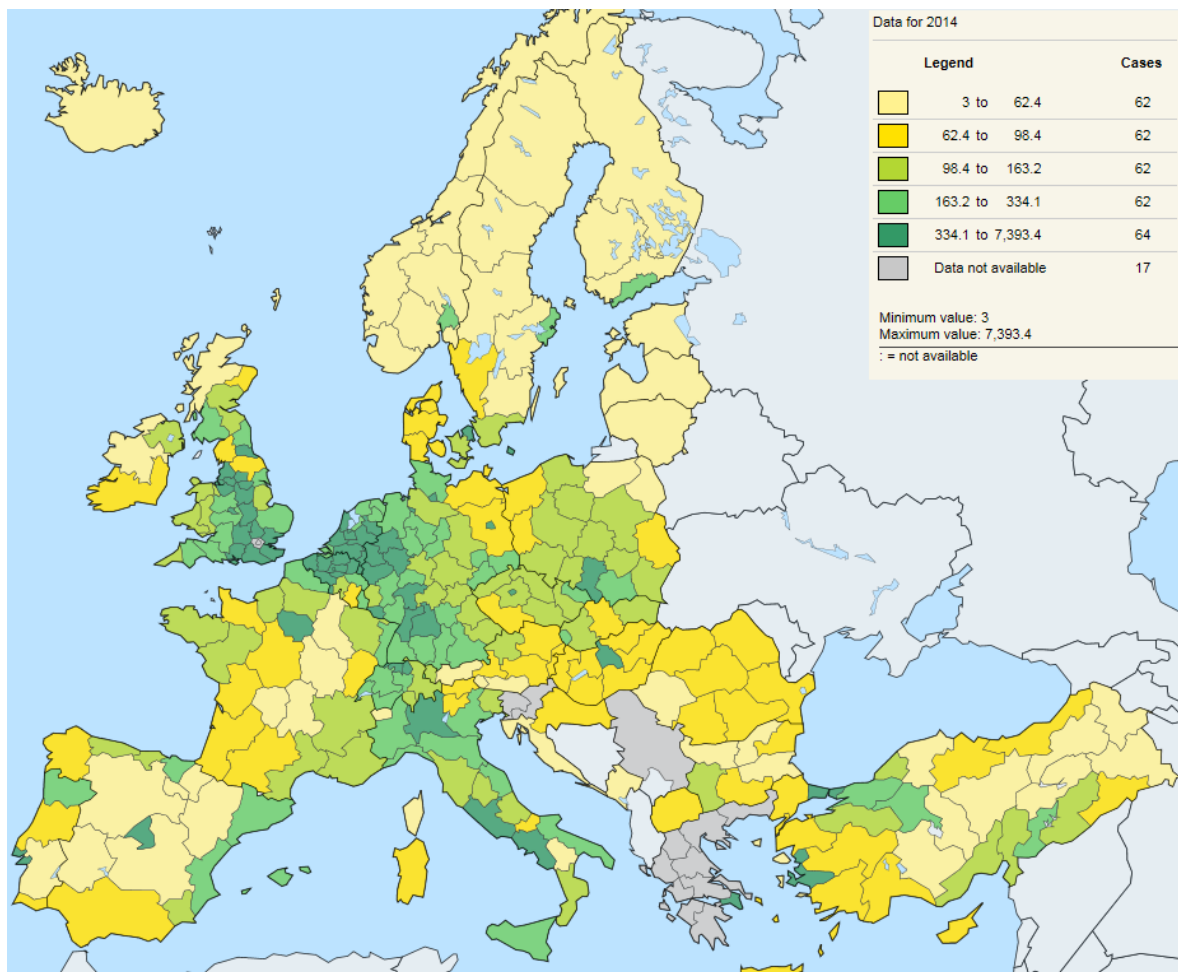


Figure 7: Population density by NUTS 2 region (data: Eurostat, 2014a)

Figure 7 hence shows a map by Eurostat (2014a) visualising population density on the NUTS 2 level. It can be seen that population density is usually highest in the areas surrounding European capitals and large cities (i.e. Paris, London, Rome, Berlin) or large urban agglomerations (e.g. German Ruhrgebiet). Since DATASET2050 addresses the four hour door-to-door goal including air traffic, the availability of airports as well as access modes within the different regions (to be investigated in WP4 of the project) has to be matched with the demand for air travel in the respective regions. It can hence be differentiated between different types of journeys, i.e. passengers starting in a rural region travelling to an urban agglomeration and back; travellers travelling between two large urban centres; or suburban dwellers travelling to a coastal region less densely populated than the major urban centres.

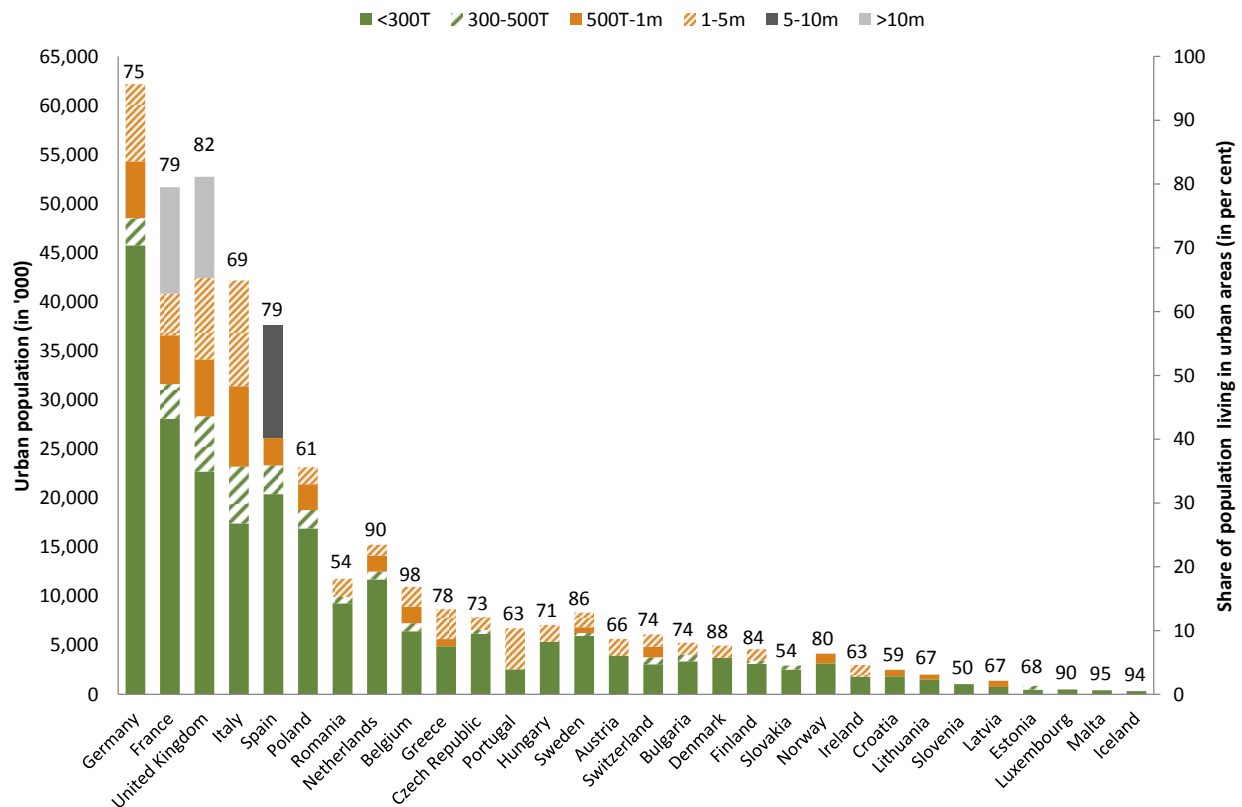


Figure 8: Urban agglomerations across European countries (data: World Bank, 2015)

In addition, Figure 8 shows the distribution of urban population across differently sized urban agglomerations. Within almost all countries, more than 50 per cent of the urban population lives in cities with up to 500,000 inhabitants. In Portugal, for example, the urban population is highly concentrated geographically. More than 60 per cent of the urban population lives within two large urban centres and the remaining share is distributed across smaller urban agglomerations with less than 300,000 inhabitants. Compared to other European countries, Spain, France, and the United Kingdom are characterized by very large urban agglomerations with at least more than five million inhabitants. The analysis of the distribution of population gives a first indication to potential demand for air transport services.

Implications

Distinction by travel flows between **urban regions**: The depiction of passenger origin and destination according to distribution of population within Europe helps identify potential traffic flows, i.e. having a passenger from a large urban area travelling to another urban area vs. a passenger travelling from rural regions to urban centres or holiday locations (categorization of origin and destinations according to specific traffic flows).

2.3 Socio-economic aspects

Socio-economic aspects constitute major drivers of current and future demand for air transport. The first part of this section elaborates on the GDP level across EU28 and EFTA states as well as on the attractiveness of a country in terms of doing business. The household composition also contributes to the derivation of passenger profiles since it can be distinguished, for example, between families or singles travelling. The last part within this section addresses the educational attainment level.

2.3.1 Gross domestic product and ease of doing business

Figure 9 depicts the GDP per capita for the considered EU countries with Liechtenstein leading ranking first.

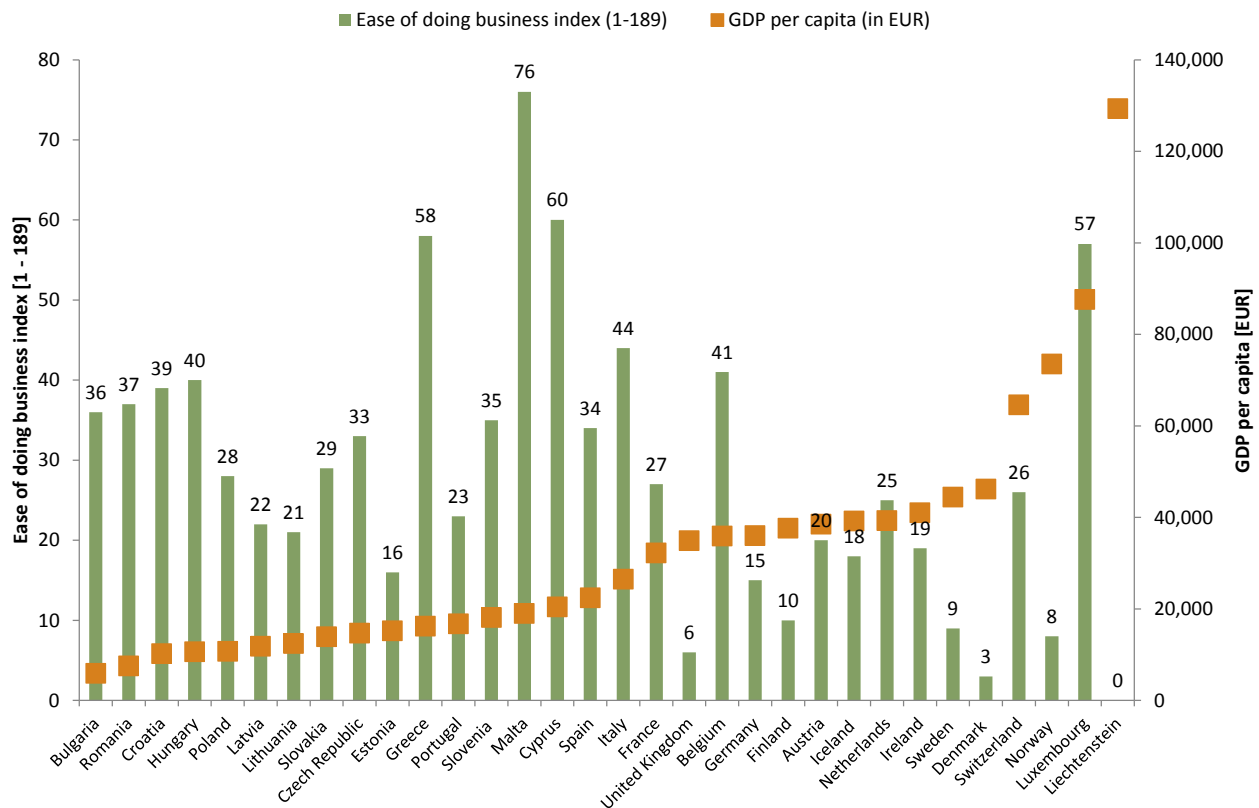


Figure 9: GDP per capita and ease of doing business index (data: Eurostat, 2014c; World Bank, 2014)

The Eastern European countries like Romania, Bulgaria or Lithuania have the lowest GDP per capita. The correlation between this indicator and the demand for air travel will be outlined in section 4. The business environment of a country is an important factor in determining the level of

GDP, the cooperation with other countries, or the attractiveness in terms of working conditions. This in turn affects the demand for mobility within and beyond a region.

Therefore, this parameter is included by considering the so called “ease of doing business” index. This index is established by the World Bank and includes 189 countries. The country in first place (rank 1) has the best business environment, hence, the lower the index number, the better. The index is composed of different indicators addressing the regulatory business environment and changes within these¹. According to this World Bank index, Denmark has the most attractive business environment within this country sample and another four countries are within the global top ten (the United Kingdom, Norway, Sweden, Finland). This indicator may be useful for the assessment of future economic development in particular regions, i.e. whether it is attractive for companies to locate subsidiaries or even headquarters within particular countries.

2.3.2 Household structure

The distribution of different household sizes can give an indication as to whether there is a high share of single travellers, either travelling alone or in groups, or families using transportation services. In Denmark, Finland, Norway, Germany, and Sweden the share of single person households accumulates to more than 40 per cent of total population. Further including two-person households, the figure rises to more than 70 per cent (Figure 10).

A high share of people might hence be travelling alone or in groups of two. In countries such as Romania, Poland, Slovakia, or Portugal, on the contrary, a rather large share of households consists of three persons or more. When considering (air) traffic flows between specific regions it is important to consider the household size within a country and the potential prevalence of a particular passenger group (as defined in the latter sections of this report).

¹ The indicator set includes: starting a business, dealing with construction permits, getting electricity, registering property, getting credit, protecting minority investors, paying taxes, trading across borders, enforcing contracts, resolving insolvency, labour market regulation (for a more detailed outline of each indicator see <http://www.doingbusiness.org/>)

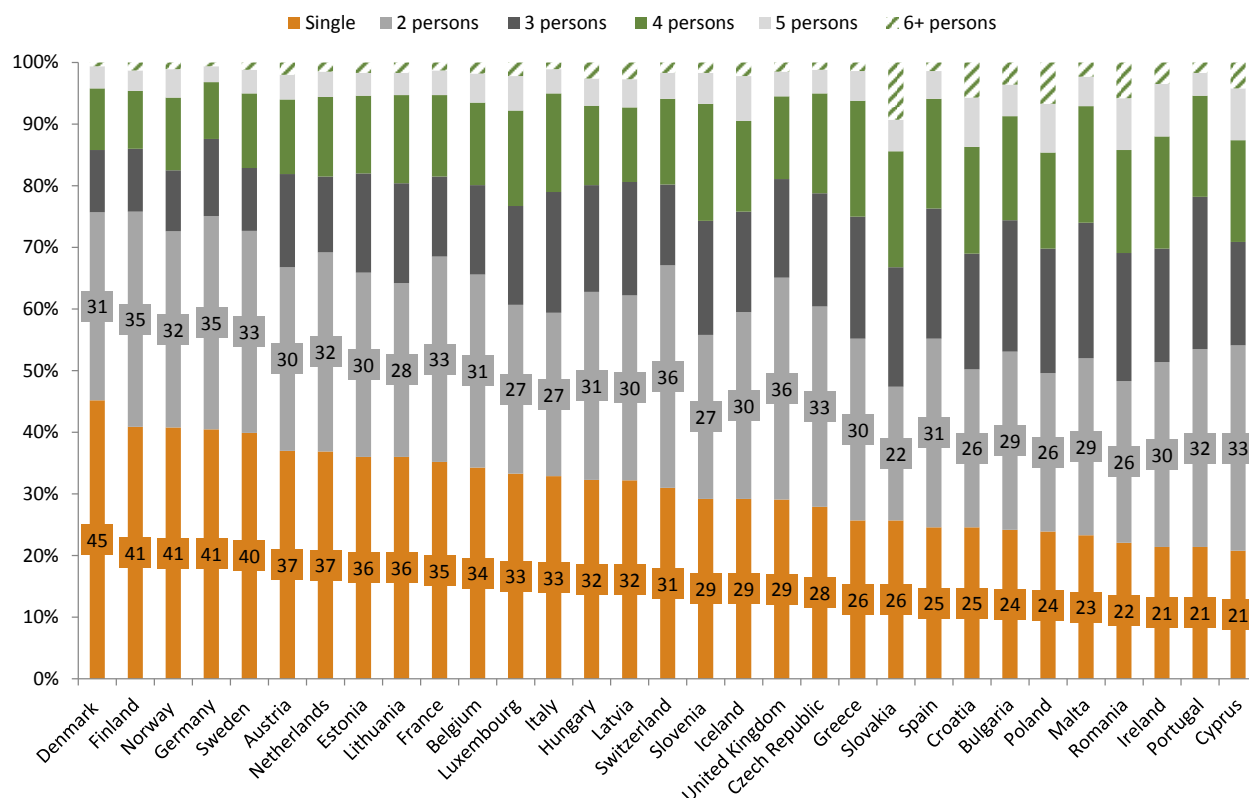


Figure 10: Household size across different European countries (data: Eurostat, 2014d)

Figure 11 shows the mean equivalenced income for different household types. According to Eurostat (2014d), the income which is attributed to each member of the household results from the division of the total disposable income of the household by a predefined equivalisation factor. The one used by Eurostat is based on the OECD-modified scale. Here, persons in the household are assigned a weight depending on their age: the first person aged 14 or more receives a weight of 1.0, the second one over 14 a weight of 0.5 and persons below the age of 14 obtain a weight of 0.3. In the figure, the disposable income of a single person household is normalized to 1 in order to compare the income level across different household compositions as well as the ratio across countries.

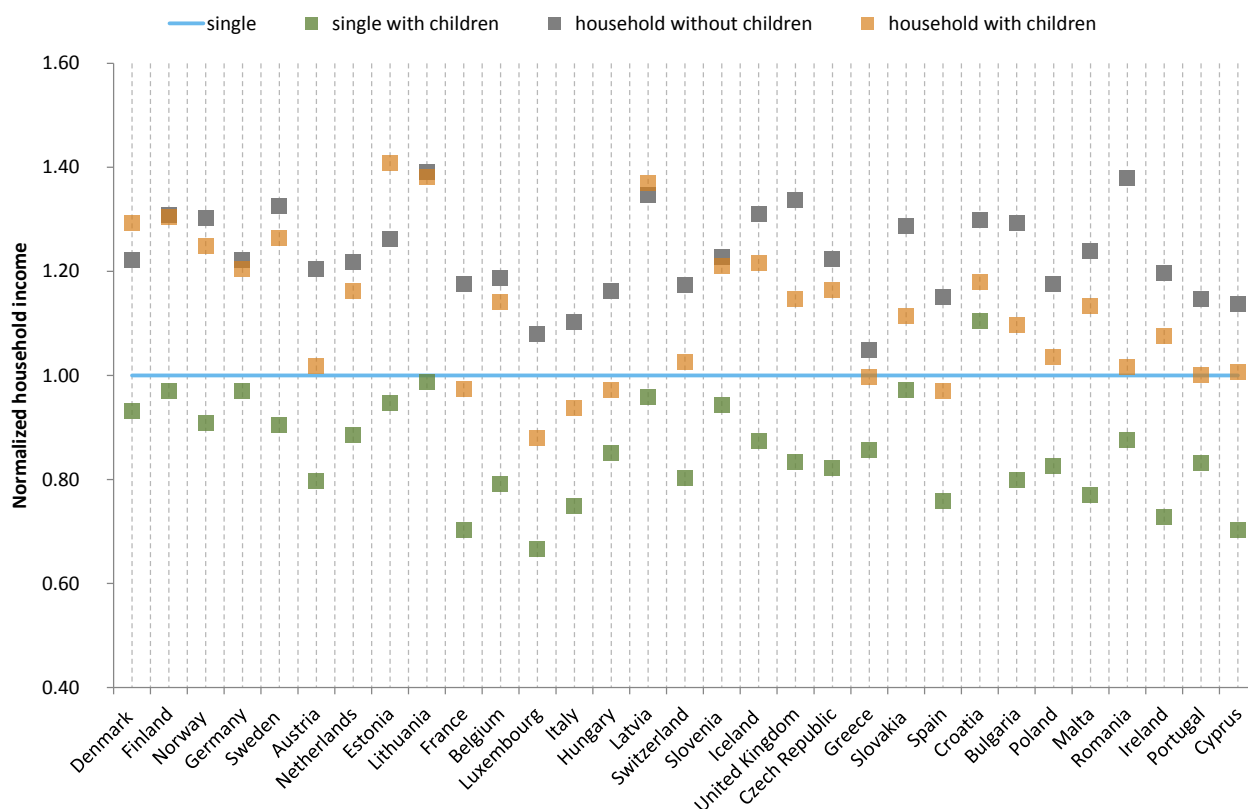


Figure 11: Income distribution across different household types (data: Eurostat, 2014 d)

In all countries in the sample, the disposable income of a household consisting of a single parent with children is lowest. In most countries but France, Luxembourg, Italy, Hungary, and Spain, single households rank second lowest in regard to disposable income. Households without children (and more than one person) are those with the highest disposable income (except Latvia). This distribution of disposable income across household types has implications for the demand for air travel by particular groups since those groups with a higher income level might be more likely to use air transport in general and on a more frequent basis than those at the lower end of the income scale.

2.3.3 Education level

The level of tertiary education differs significantly across considered countries, as can be seen in Figure 12, with Luxembourg having the highest share of population with tertiary education (40 per cent) and Romania at the lowest end with 14 per cent.

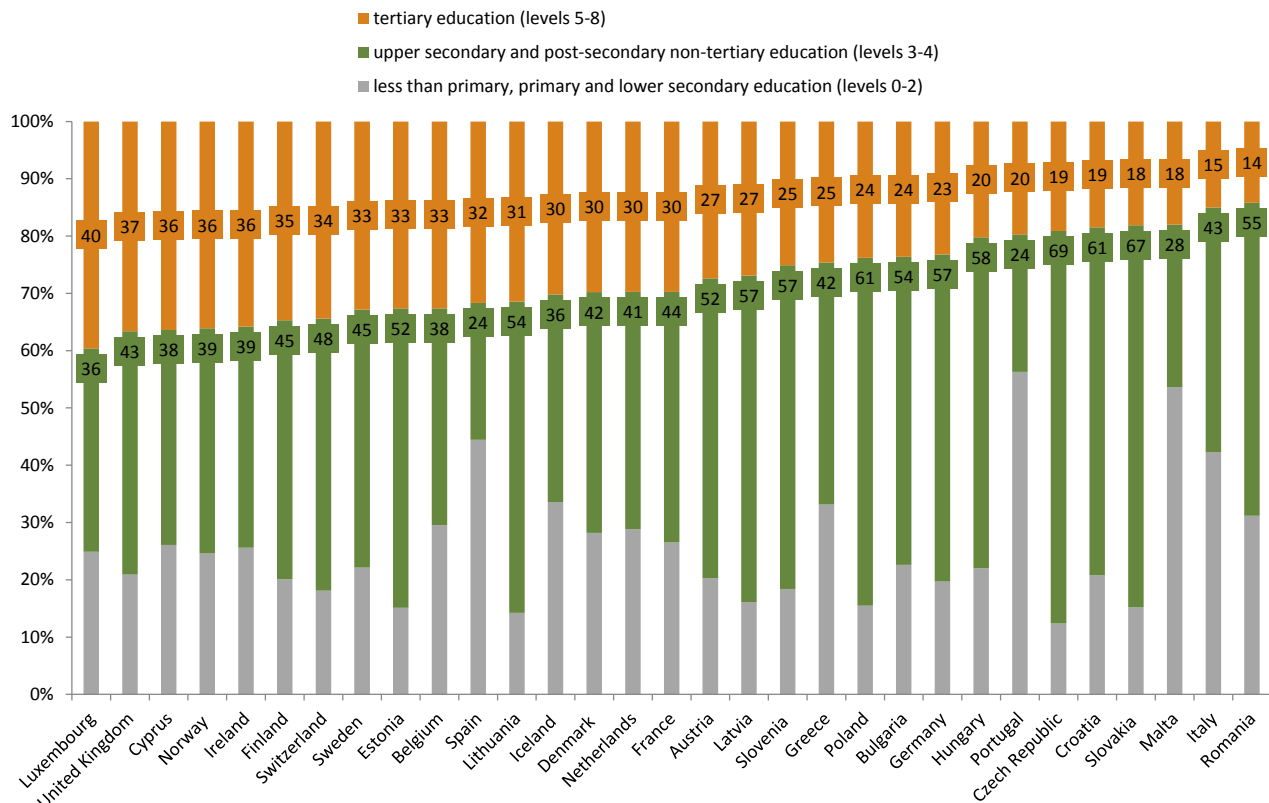


Figure 12: Educational attainment level by country (data: Eurostat, 2014e)

A study by the Global Business Travel Association (GBTA) (2011) reveals that a high share of business travellers has a college education (71 per cent). In Luxembourg, for example, 17 per cent of all trips are business trips compared to only 3 per cent in Romania. Education and type of employment activity, however, are not the only determinants of business travel. Furthermore, a higher education level often correlates with a higher income level and hence a higher propensity to use air transport for leisure purposes as well.

Implications

Distinction by **GDP per capita (income level)**: The level of income positively correlates with the demand for (air) travel, this parameter hence gives an indication of the potential of different countries to participate in current and future air transport. The ease of doing business index gives an indication to potential economic development within a country.

Distinction by **household type and type of education**: The household type determines the level of travel activity as well as the number of persons travelling together, the level of education has an indirect influence on the level of air transport due to associated type of employment and income level.

2.4 Behavioural aspects

This section outlines behavioural aspects such as use of information and communication technology (ICT), consumers' attitude to environmental aspects, or the perception of safety and security with specific emphasis on transport services. Compared to the previous sections, the quantification of these behavioural aspects is either rather difficult or not available on a country level. Therefore, some aspects are depicted in a qualitative way to generate information for the different passenger clusters derived in section 4 of this report.

2.4.1 Information and communications technology

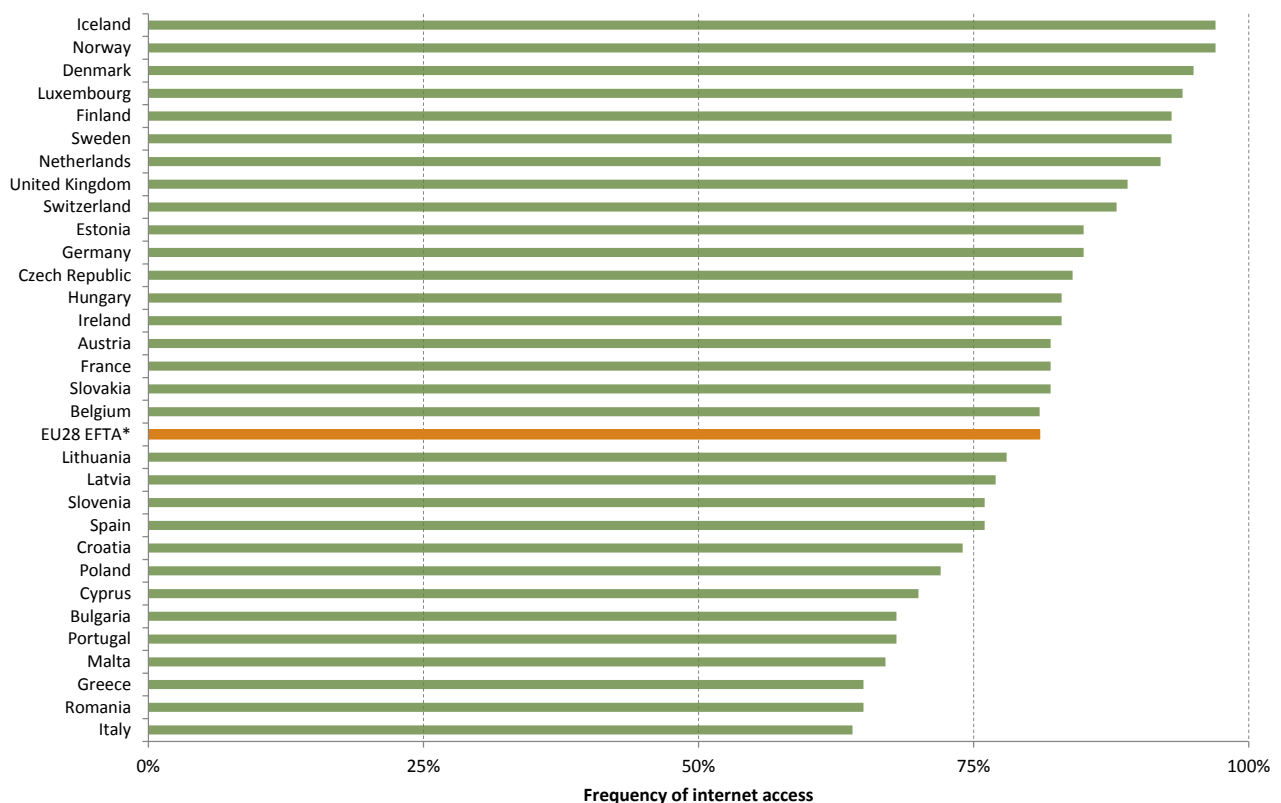


Figure 13: Frequency of internet access² (data: Eurostat, 2014f)

Information and communications technology (ICT) is an elementary component of everyday life in Europe, both at work and in private life (Eurostat, 2014f; World Economic Forum, 2016). Internet access has become widely available for the majority as seen in Figure 13 with a high frequency of average internet access of 81 per cent for the base year 2014.

² Once a week (including every day) in per cent of individuals in 2014

Although there is a very high internet penetration in Europe, differences can be found when looking at the usage of ICT across different generations, such as for digital media usage. Within the survey by the World Economic Forum (2016) "Digital Media and Society - Implications in a Hyperconnected Era" different user groups are defined as well their digital media consumption levels.

Table 2: Digital media consumption levels (World Economic Forum, 2016)

	Sporadic users (%)	Frequent users (%)	Total sample (%)
Millennials (born in 1980s and 1990s)	34	47	40
Generation X (born in 1960s and 1970s)	30	31	31
Baby Boomers (born in 1940s to early 1960s)	36	23	29
Male	46	58	52
Female	54	42	48
(Under) graduate degree	45	57	45
No children	54	34	43
1 child	26	44	35
> 1 child	21	22	22

The Millennials (also called Generation Y) include those people born in the 1980s and 1990s whereas Generation X denotes people born in the late 1960s and 1970s, and Baby Boomers include the late 1940s to early 1960s. These groups differ in their frequency of use, such as using digital media for chat- and messaging, online entertainment, or for seeking information. Millennials are more likely to be frequent users whereas Baby Boomers are more likely to be sporadic users.

ICT is also essential for air transportation passengers. Almost all of them (97 per cent) carry their own mobile device during their journey; with 81 per cent alone carrying a smartphone (SITA, 2015a).

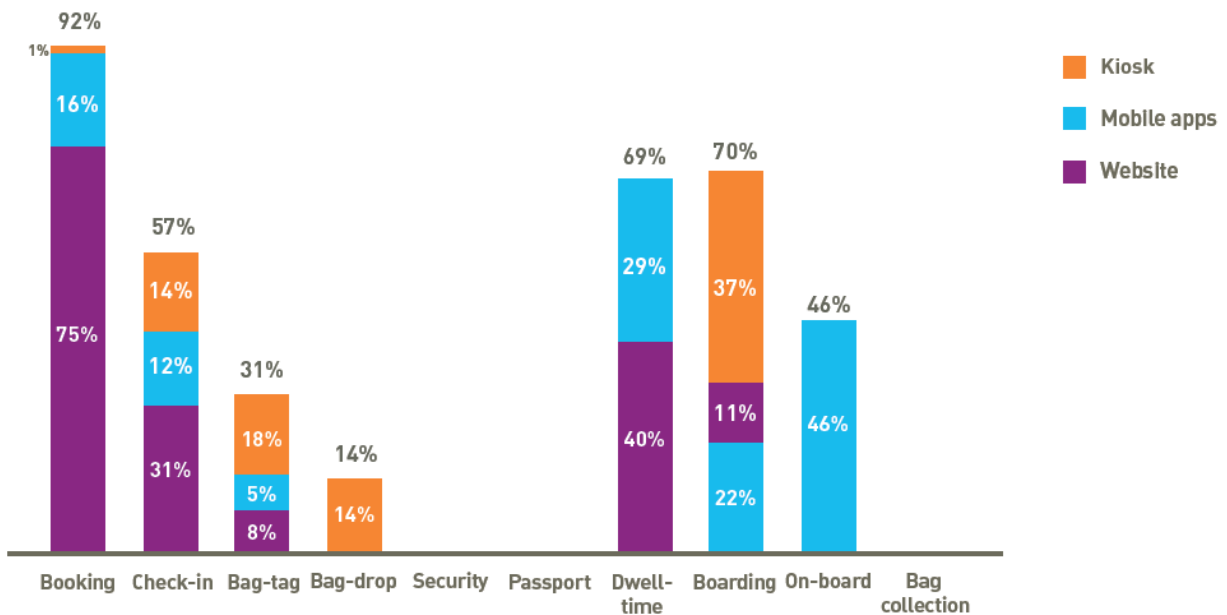


Figure 14: Passengers' usage of self-technology during travel (data: SITA, 2016)

As seen in the Figure 14, passengers also use technology for many parts during their journey at the airport and off airport. For instance, 92 per cent of flights are booked online using self-technology (of these, 75 per cent use websites and 16 per cent mobile apps). The remaining eight per cent use human contact (call centre or travel agent). 43 per cent check in using web or mobile check-in off airport (SITA, 2016). After the security and passport control, the usage of technology among passengers increases again. Around 3/4 use mobile apps or websites during dwell time and 1/3 for boarding (SITA, 2016). These numbers show a clear preference to use own technological devices for booking and preparing flights, even before arriving at the airport. According to SITA (2016), passengers welcome that ICT enables them to be free by a specific time and place as they can prepare for their flight at own pace, which leads to a positive travel experience at the beginning of the journey. Not having to queue and incurring time savings are two other main advantages (Castillo-Manzano and López-Valpuesta, 2013). The SITA survey also indicates that passengers wish to complete even more off-airport options so they can arrive at the airport relaxed and enjoy the time before they board. Such additional off-airport options could be, for instance, home bag-tag printing. IATA (2015a) revealed that 34 per cent of passengers checking-in from home would like their luggage to be tagged at the same time. Summarised, the more duties of the journey are completed off airport, the more seamless the overall journey (IATA, 2015b).

When it comes to receiving notifications, 79 per cent of passengers would like to receive mobile updates on the current luggage status, 67 per cent on potentially mishandled baggage and 65 per cent information on baggage collection (SITA, 2016). A slightly different view can be found looking at data from IATA (2015a): the top three notifications passengers want are: flight status (93 per

cent); baggage status as well as delivery waiting time (74 per cent); and information on regulations (e.g. visa or customs) (68 per cent). However, more than 50 per cent of surveyed participants prefer short messaging services (SMS) for notifications over other communication channels. Additionally, ICT could also enable "smart travel", an approach which integrates visa applications, check-in, security and border control in order to decrease passengers' waiting time and create efficiency as well as greater security through sharing and cross-checking of passengers' data (World Economic Forum, 2014).

Socio-demographic characteristics, such as age, education and gender, influence the usage of technology during the journey as well. In comparison to passengers over 65 years, passengers younger than 30 years are 11.5 per cent more likely to use online check-in. This result underpins the fact that Millennials use digital media most frequently and are very likely to be digitally savvy. Moreover, female passengers and passengers with a high level of education prefer self-check-in, either via a kiosk or online, i.e. passengers holding a university degree are also 11.5 per cent more likely to check-in online. Business travellers show a slight tendency to check-in at the traditional desk as well. Travelling often on business class fares, check-in desks might offer numerous privileges and hence be equally time-saving as online check-in. In contrast, frequent fliers are more likely to choose online check-in. Flying more than twelve times per year decreases the likelihood of choosing a check-in desk than passengers flying occasionally. Flying with low cost carriers (LCCs) such as Ryanair, some airlines charge a penalty for checking-in at the desk and consequently passengers have a financial incentive to check-in online (Castillo-Manzano and López-Valpuesta, 2013).

2.4.2 Environmental awareness

Air transportation emits greenhouse gases (GHG) and hence has a potential impact on the environment. Passengers contribute to this effect by their choice of means of transport, their choice of holiday destinations and kilometres travelled (Cohen and Higham, 2011; Brouwer et al., 2008).

Around 90 per cent of all trips in Europe have a personal background (Eurostat, 2014b). Hence, it is not surprising that tourism is a focus of research regarding environmental awareness and resulting travel behaviour. According to a study from Hares et al. (2009) on UK tourists, there is a basic understanding of tourists on climate change and flying was named among the top three personal contributions towards climate change. However, environmental concerns do not seem to be part of the attitudinal set of participants' decisions and do not influence their behaviour when planning a holiday, choosing a destination and deciding on the type of transportation. The three main barriers towards pro-environmental behaviour change are a lack of alternative transport systems (particularly in the UK); the high value of holidays with the freedom to travel to every destination one wants; and the lack of feeling personal responsibility for climate change. Hares et al. (2009)

derive an awareness-attitude gap among tourists with further research required why such awareness does not lead to pro-environmental travel behaviour. These results are supported by a study of among Germans conducted by Böhler et al. (2006). In this research, all four identified travel groups (non-traveller, local-traveller, mid-distance traveller, and long-haul traveller) have pro-environmental values which does not result in behaviour changes, though. Conducted in-depth interviews show that participants do not see a connection between their travel and holiday behaviour and an impact on the environment.

However, within some recent studies, evidence emerged showing an increasingly pro-environmental awareness in tourists' mind-set and a willingness to actually change air travel behaviour in the future (Cohen and Higham, 2011; Gössling et al., 2009). For instance, within a study on Swedish passengers (both business and leisure travellers), 25 per cent of surveyed participants would be willing change their future travel behaviour and fly less in order to mitigate emissions (Gössling et al., 2009). Environmental awareness among passengers seems to be already present, however, does not lead to behaviour change at the moment but might do so in the future.

Next to changing travel behaviour, voluntary carbon offsetting schemes can provide another solution to neutralize emissions generated by one's own journey without compromising the means of transport or influencing the decision on holiday destinations. Beside one study by Brouwer et al. (2008), research reveals that the willingness of passengers to pay (WTP) for carbon offsets is low (Eijgelaar, 2009; Mair, 2011). 75 per cent of passengers are not even aware of such schemes at all (Gössling et al., 2009). Frequency of flying (Brouwer et al., 2008), the disposable income, and education (Eijgelaar, 2009) influence the willingness to pay for carbon offsetting positively.

2.4.3 Safety and security

Perceived safety is a top priority for passengers contributing to the overall customer satisfaction and, thus, should also be considered when looking at behavioural aspects of passenger characteristics (Gilbert and Wong, 2003; Ringle et al., 2011). The relationship between safety and satisfaction is significantly higher for passengers travelling for leisure (Ringle et al., 2011). The overall passenger satisfaction, both for passengers with business and leisure background, is strongly and positively linked to customer loyalty (Ringle et al., 2011). Socio-demographic characteristics can influence the perceived risk of passengers regarding flying as well (Boksberger et al., 2007).

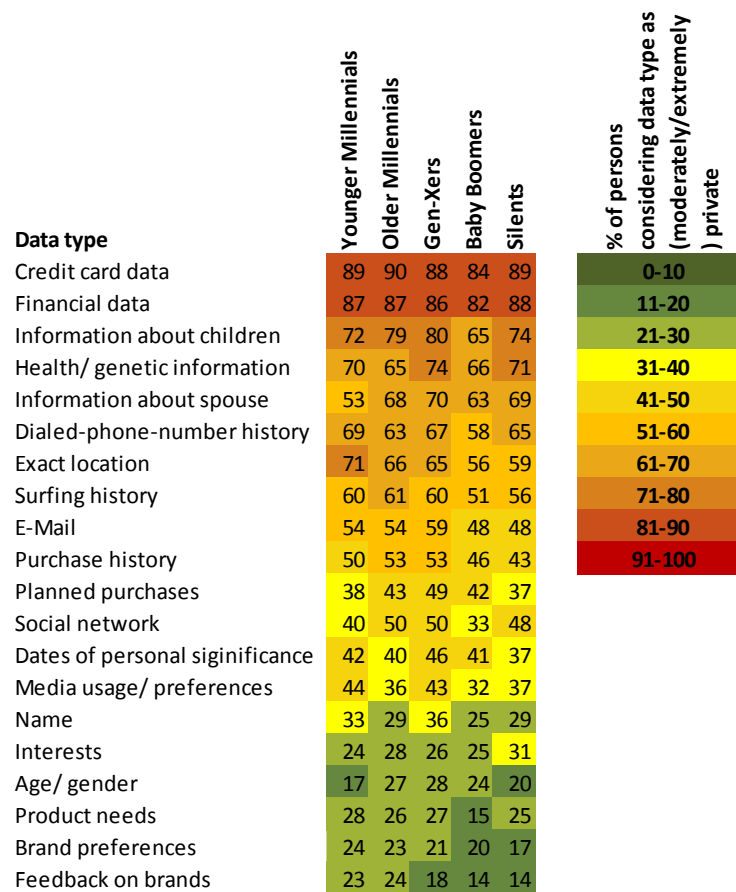


Figure 15: Privacy issues across different age groups in the US (data: BCG, 2013)

When it comes to the privacy of own data, the Boston Consulting Group "Global Consumer Sentiment Survey" (2013) reveals how different generations consider the various types of data. The results are depicted by age group in Figure 15. Here, younger Millennials are persons from 18 to 24, older Millennials from 25 to 34, Gen-Xers include people from the ages between 35 to 48, Baby Boomers are those people aged 49 to 67, and Silents are participants aged 68 and above. The figure also shows that all generations share the same concerns: financial data, family data and healthcare data are seen as most private among all age groups (BCG, 2013). A lot of this data can be generated before and during a flight, such as credit card information, booking tickets for relatives, requiring assistance at the airport or special meals due to health problems.

Implications

Distinction by **ICT**: Demand for notifications with information on current journey, demand for additional off-airport service options. Socio-demographic factors influence usage of ICT.

Distinction by **environmental awareness**: This might influence (air) travel behaviour in the future (change in personal choice of transportation); and the willingness to pay for carbon offsetting is positively influenced by frequency of flying, disposable income and education.

Distinction by **safety and security**: Perceived safety is a top priority for passengers. Financial data, family data and healthcare data are seen as most private.

3 MOBILITY BEHAVIOUR

Within this section, special emphasis is placed on the mobility behaviour of European passengers, both for all transport modes and for the air travel sector in particular. Starting with demand for transport in general, the following section outlines the annual trips per capita by country as well as the share of private and business trips.

3.1 All transport modes

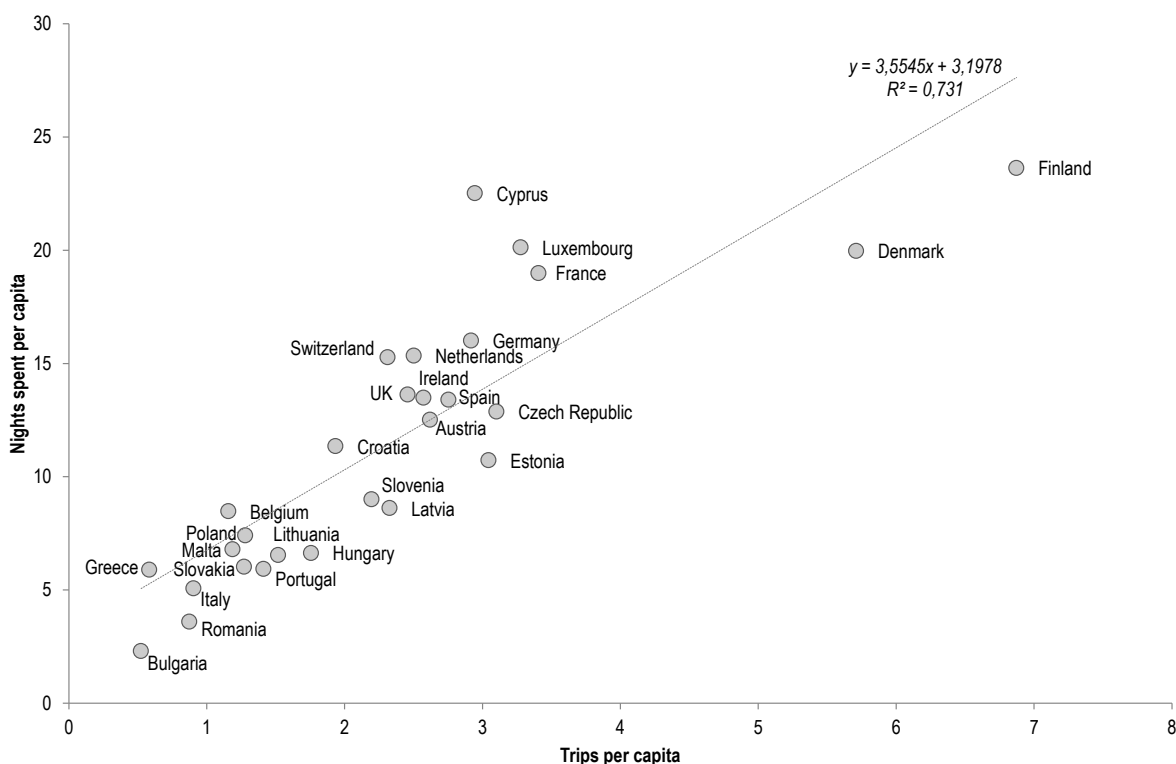


Figure 16: Trips per capita (all modes) and nights spent per capita (data: Eurostat, 2014 b)

Figure 16 shows the total amount of trips taken per person per year and the correlation to the annual nights per person. Trips within the Eurostat database include those journeys with at least one night over stay, i.e. return trips taken on a single day are not included in the data. At the top end, the Finnish take the most trips on average per year, about seven, and stay for three to four nights on average. At the bottom, Bulgarians and Greeks take less than one trip per capita per year. This particular figure gives a first overview of travel activity within the different countries. For future demand, it is important to consider the growth potential for each country and the resulting demand for (air) transport services.

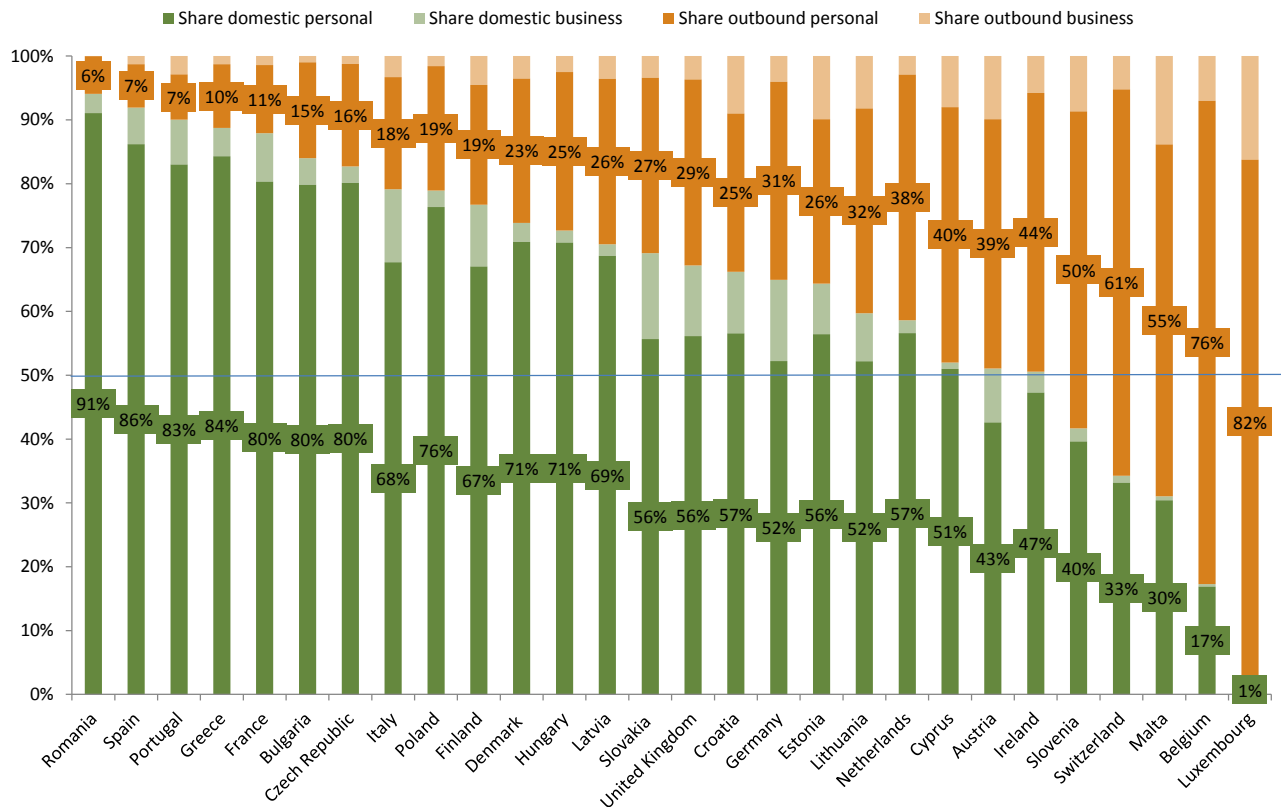


Figure 17: Distribution of domestic and outbound trips (data: Eurostat, 2014b)

Figure 17 shows the inbound and outbound trips for the considered set of countries. Those countries with a very high share of outbound trips – Luxembourg, Belgium, Malta, Switzerland, or Slovenia – are very small in terms of geographical size or an island state like Malta. However, these two aspects do not constitute a general rule considering the share of outbound and inbound traffic flows. Other factors such as income level or degree of urbanization also influence the type of trips taken on a country basis.

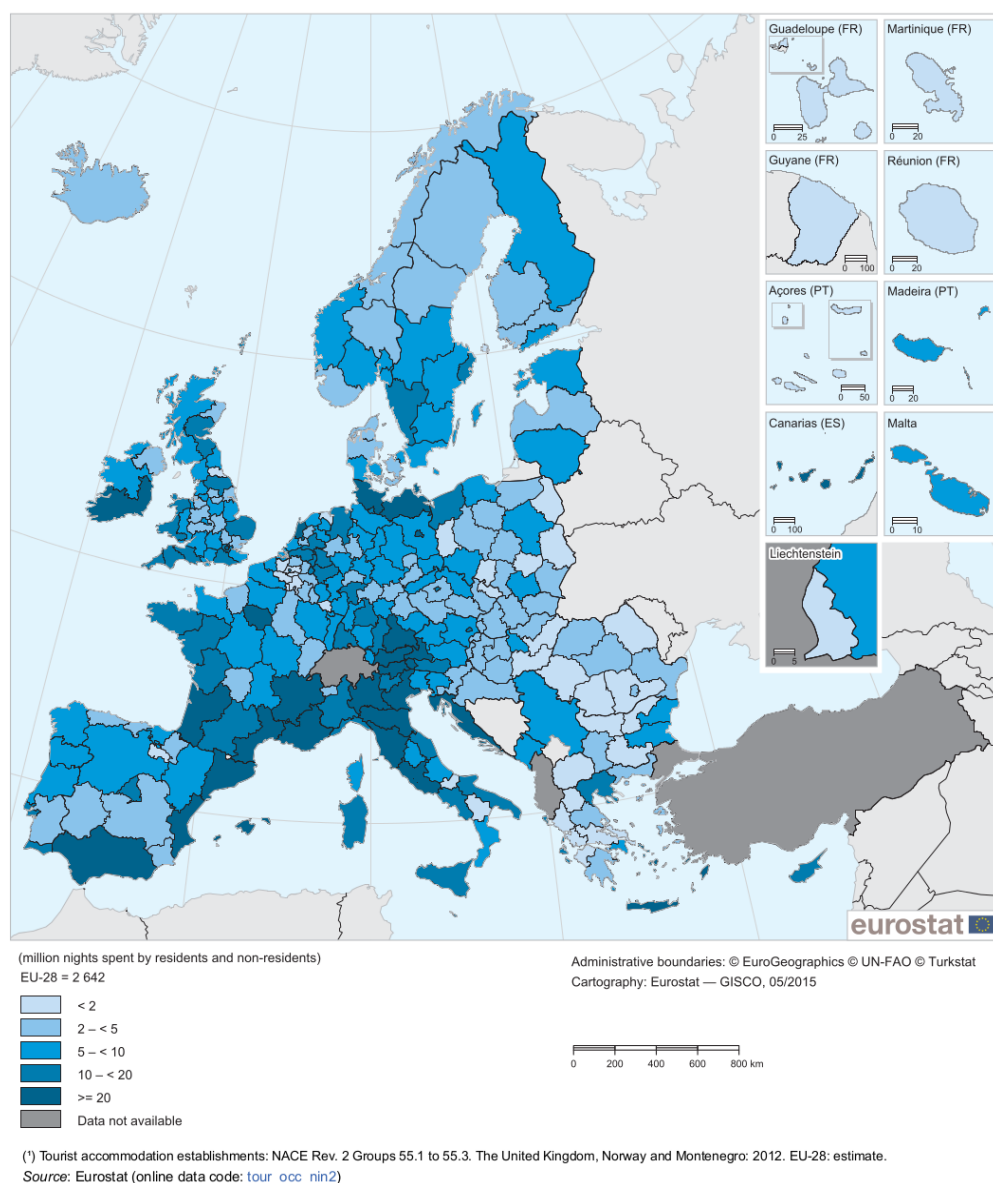


Figure 18: Nights spent in tourist accommodations (NUTS2, data: Eurostat, 2013)

Figure 18 shows the number of nights spent on a NUTS 2 level for European countries. At first view, the Southern coastal regions are those where people spent the most nights as well as those NUTS 2 regions of the European capitals. This data gives a good indication as to where people are travelling and which areas are rather neglected considering tourism flows. Furthermore, for the derivation of passenger profiles it is important to understand in which regions travellers spend their vacation and which regions are visited for business purposes. Traffic flows between regions and countries, especially in terms of air transport, will be outlined in more detail further below.

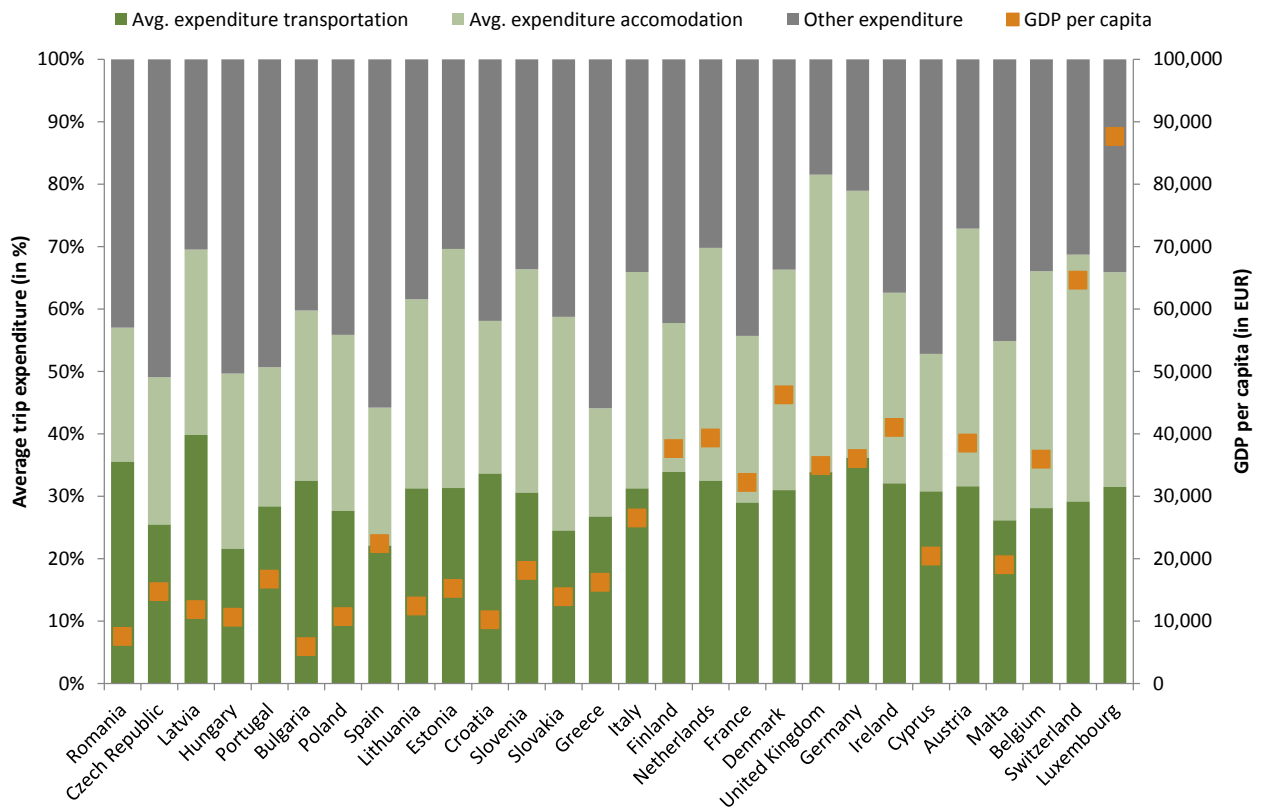


Figure 19: Average expenditure per trip by country (data: Eurostat, 2014b)

There seems to be a strong correlation between the GDP per capita and the absolute amount of transport costs by country, i.e. a higher GDP per capita implies a higher amount spent on transportation per trip. On average, travellers spend 30 per cent of their travel expenses on transport (Figure 19). Latvia has the highest share of expenditures spent on income with 40 per cent compared to Hungary with only 22 per cent.

3.2 Air travel

Since the objective of the DATASET2050 project contains the optimization and amendment of the passenger journey including air travel, this section places special emphasis on air traffic flows within Europe. Thus, highly frequented air routes can be identified as well those routes with growth potential in the future. First, there will be an overview of the prevalence of air travel within the EU28 and EFTA states as well as a first indication of the distribution of stage lengths and related air travel times. This gives an idea of how much time the air transport part is taking up in regard to achieving the four hours door-to-door goal within Europe. Furthermore, particular routes and countries of origin and destination will be identified. This approach will assist in defining

traveller profiles by defining specific passenger journeys within Europe. This may include a journey from a small airport such as Bremen Airport (Germany) to a large hub airport such as London Heathrow (UK) or to holiday destination such as Gran Canaria (Spain). Passengers travelling on these different routes will have different expectations and requirements. The analysis within the following section will elaborate on this in more detail.

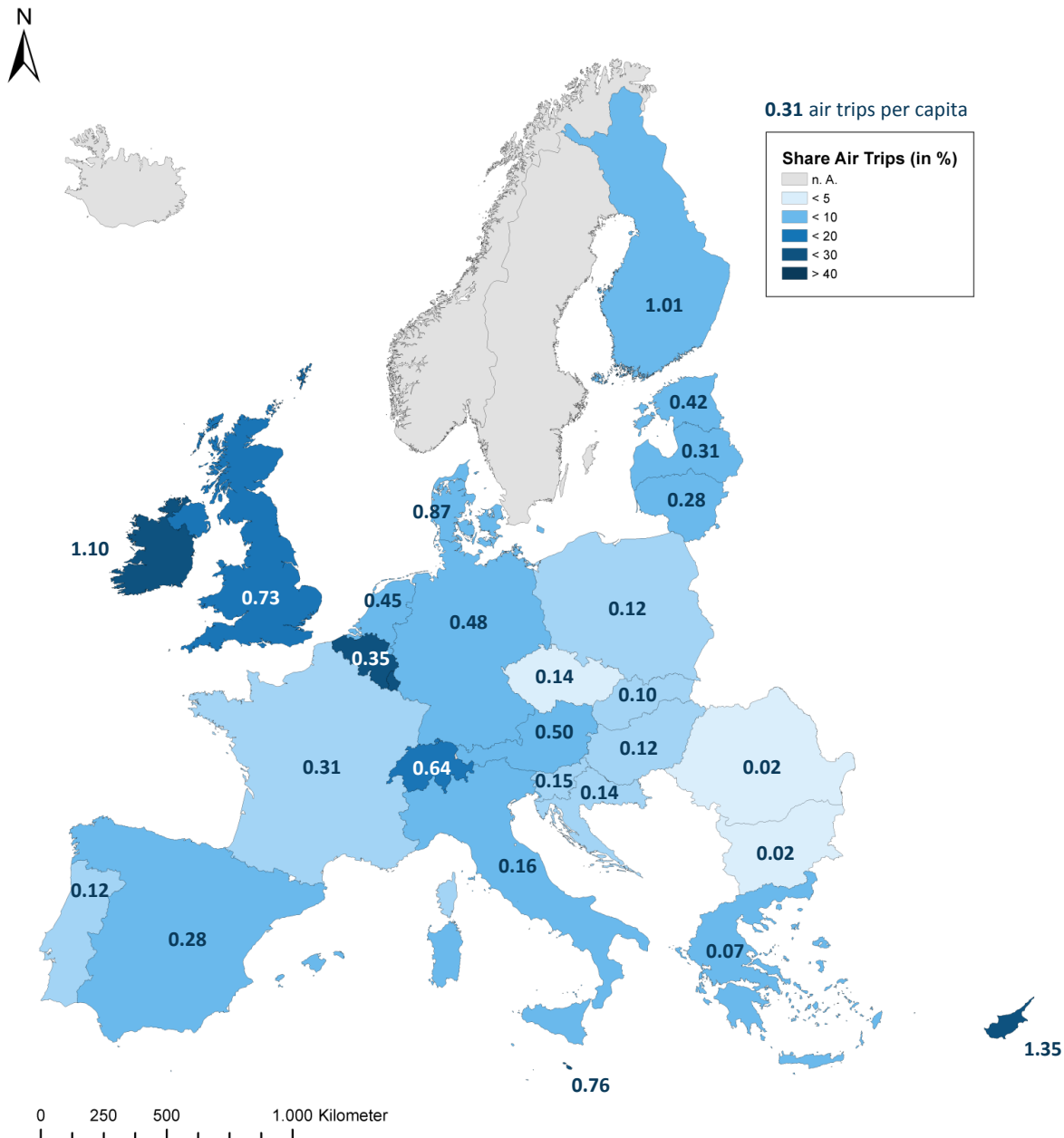


Figure 20: Prevalence of air travel in different European countries (data: Eurostat, 2014 b)

A first overview of the prevalence of air traffic by country is given in Figure 20. Malta with more than 60 per cent and both Cyprus and Ireland with more than 40 per cent have the highest share of air

trips in total trips taken in 2014, closely followed by the United Kingdom with a share of about 30 per cent. One of the main reasons for this is the countries' geographical size and island location. All three countries have a high share of outbound traffic, as depicted in Figure 17, since air travel is usually the most feasible option to access other European countries. Romania, Bulgaria and the Czech Republic have the lowest share of air trips in total transport trips compared to the other European countries. Portugal, France, Poland, Slovakia, Slovenia Hungary and Croatia all have a share of less than ten per cent. Most of these countries also have very high shares of domestic trips (see Figure 17), Romania with a share of about 95 per cent or France with almost 90 per cent. The distribution of air trips by national and intra-EU seats in each country can be seen in Figure 21.

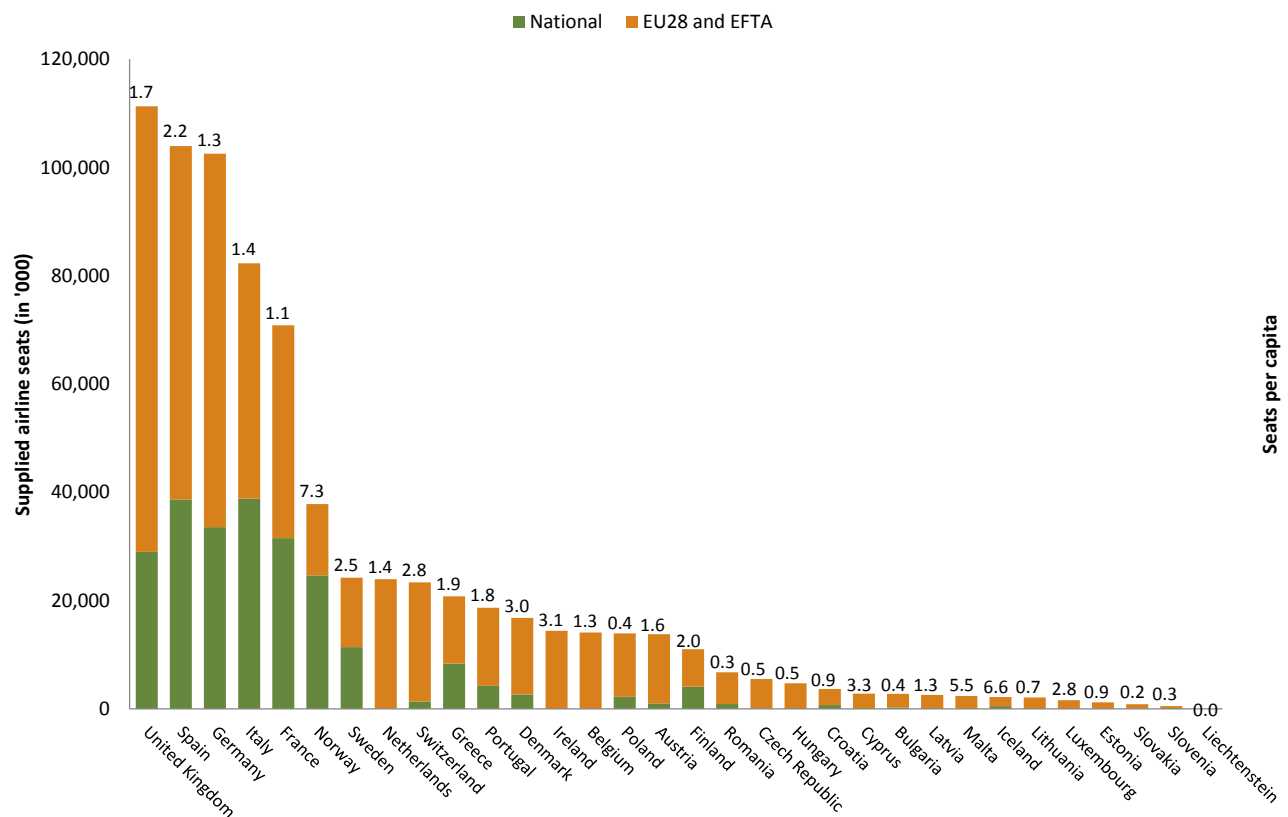


Figure 21: Supplied national and intra-EU airline seats by country (data: OAG, 2014a)

The supplied airline seats in Figure 21 correlate with the population size of a country, i.e. the more inhabitants in a country, the higher the absolute amount of offered seats to and from that country. Norway is the country with the highest share of national seats offered in relation to total seats, with 65 per cent. This might be due to the geography of this country with long distances and sparse population density. The same applies for Sweden and Finland with national seats accounting for 47 per cent and 37 per cent, respectively. Italy, France and Spain also have high shares of national air traffic with 47 per cent, 45 per cent and 37 per cent, respectively. These three countries also have a high share of domestic transport considering all transport modes (Figure 17). For Spain and

France, the large country size and the existence of few but large urban centres contribute to the high level of domestic traffic which serves as a fast connection alternative. Another correlation can be detected looking at the gross domestic product per capita and the number of air trips per capita (Figure 22).

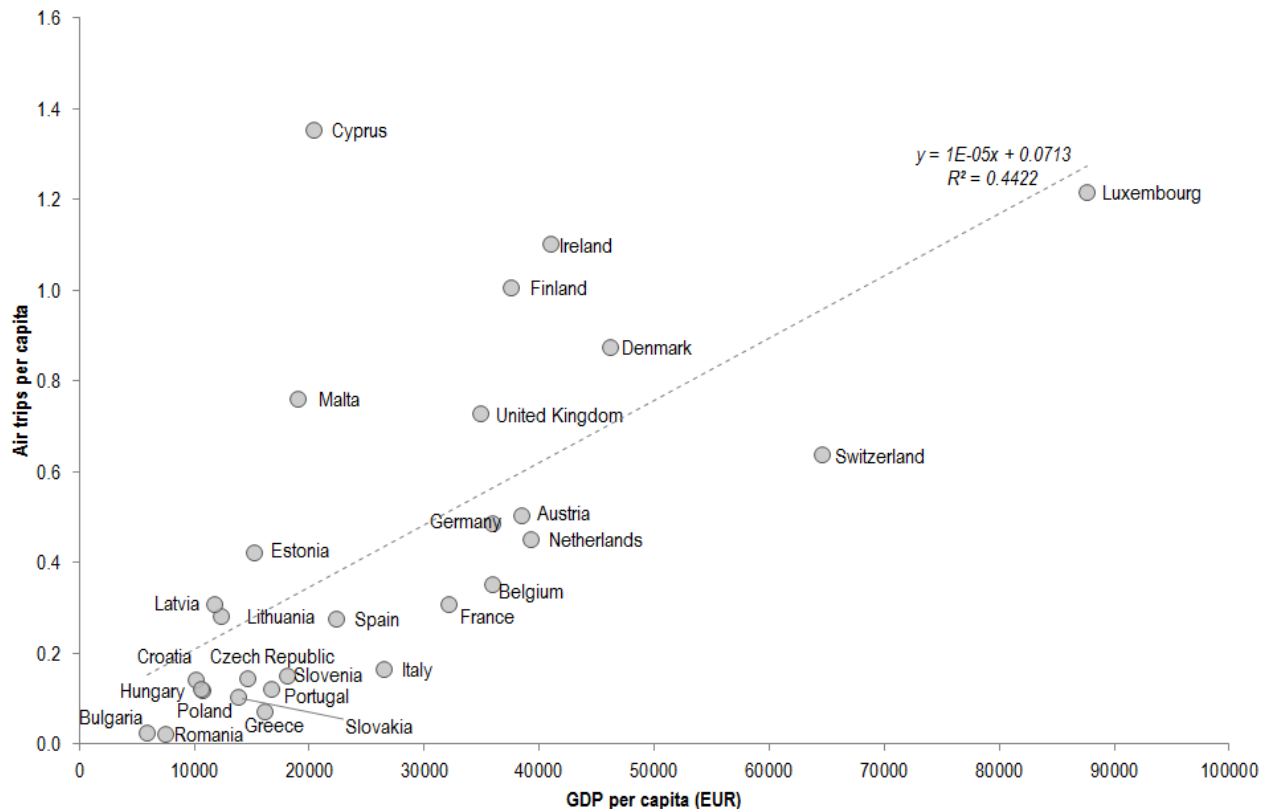


Figure 22: Correlation GDP per capita and air trips per capita (data: Eurostat, 2014b/2014c)

The income level of a country or a region is usually applied as an explanatory factor in the determination of air travel demand. Different studies find that a higher GDP per capita, which is often used as a proxy for income, is usually associated with higher levels of air travel (CAPA, 2014). An analysis by IATA (2008) indicates that increases in income have been explaining a large share of air traffic growth in the past. Further statistical evidence implies decreasing income elasticities in more developed markets. Only a small amount of countries is considered within the DATASET2050 sample compared to the global one in the CAPA analysis, though. Here, the number of air trips is explained by the level of GDP to a certain degree as the coefficient R^2 shows. Considering this relationship, a range of countries has growth potential in terms of air traffic such as Romania or Poland. However, there are other factors determining the level of air traffic within a country which have been elaborated on in the previous sections.

3.2.1 Investigation of journey types

After having gained a first insight into prevalence of air traffic across the European country sample within DATASET2050, this section investigates the type of routes flown in terms of city pairs as well as stage length covered. This will help to evaluate the current feasibility of the four hours door-to-door goal in a better way, i.e. how much time is spent in the gate-to-gate process today, which routes are currently most frequented and what are the routes with growth potential in the future. As a first step, Figure 23 outlines the stage length distribution of flights within Europe for the year 2014. In regard to respective block times depicted in the figure, an Airbus 320 with a speed of Mach 0.76 has been taken as reference. This is to give a first indication of the potential time a passenger spends in the gate-to-gate process.

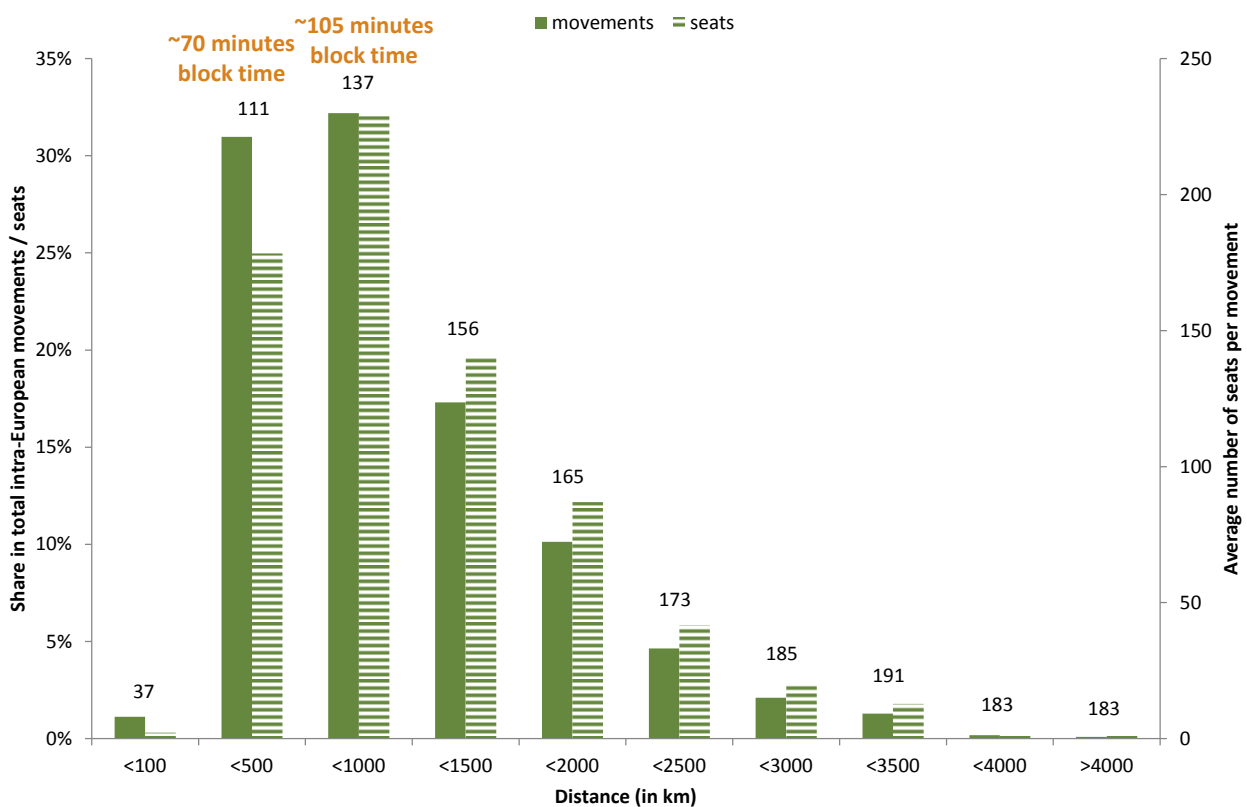


Figure 23: Distance distribution of European flights (weighted by movements/seats, data: OAG, 2014a)

The figure above shows that more than 60 per cent of all air trips taken within Europe in terms of aircraft movements are up to a distance of 1000 kilometres. Also, more than 50 per cent of airline seat capacity offered within Europe is up to this particular distance. Another 17 per cent of movements and 20 per cent of seats are within the range segment 1001 up to 1500 kilometres. The secondary y-axis shows the average number of seats per movement which is increasing up a distance of 3500 kilometres. Assuming a certain passenger load factor, one can infer the number of

passengers travelling within each distance segment as well as the frequency at which flights are taking place.

Having attained the stage length distribution, the associated block times and hence an overview of which distances are most frequented, the Figure 24 depicts the type of airport pairs with a high share of European seats. It shows air traffic flows in terms of supplied seats (OAG, 2014a) for different types of airports. In order to distinguish between flows, airports have been classified into hub airports ("hub"), secondary hub airports ("2nd") and those airports only serving origin and destination traffic ("intra"), being abbreviated in the text as O&D airports. Within the figure the share of offered seats for each airport pair is depicted, considering 50 per cent of total seats offered within Europe.

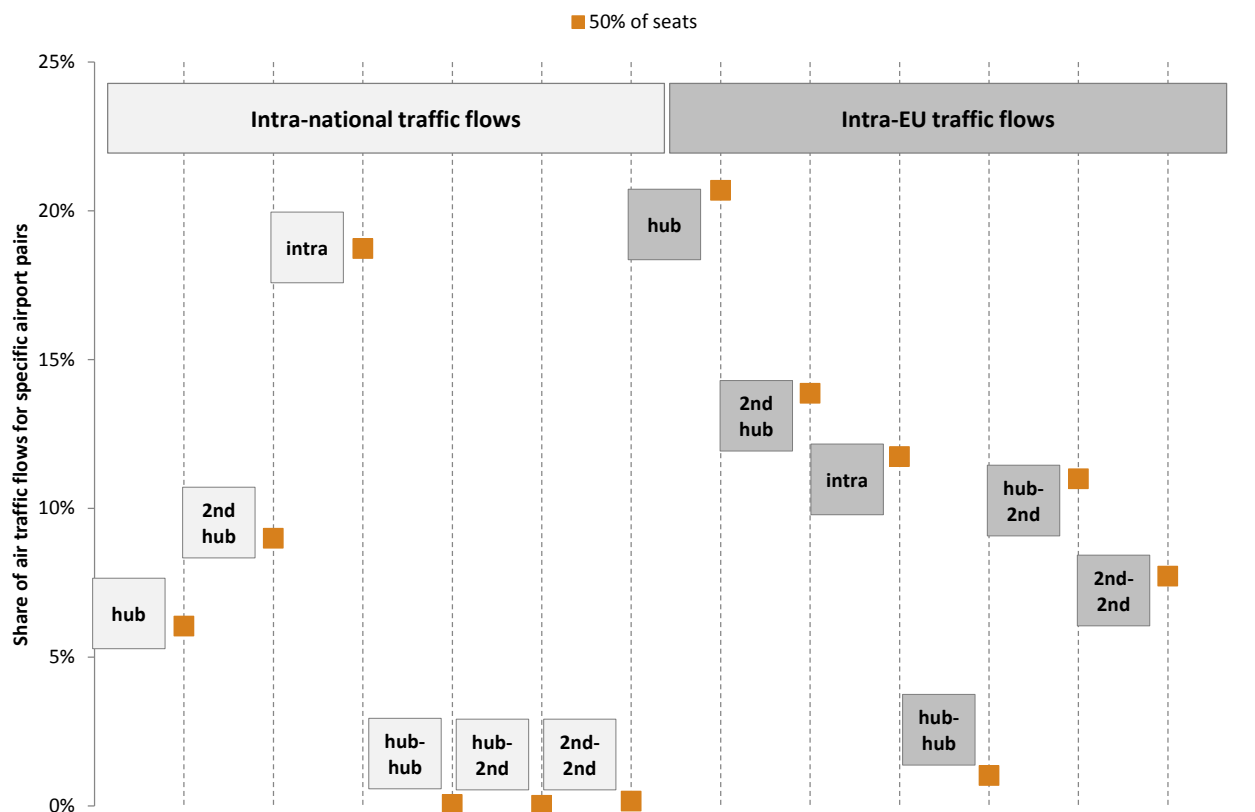


Figure 24: Air traffic flows between specific airport pairs within Europe (data: OAG, 2014 a)

Moving from left to right in Figure 24, the left hand part depicts the flows taking place on a domestic level and the right hand side shows those movements between countries within the European Union. Both intra-national (domestic) and intra-EU flows are divided into six different categories:

1. **"hub"**: air traffic flows between a hub airport and an airport offering only origin and destination traffic

- a. an intra-national example might be flights from Bremen Airport to Frankfurt airport (Germany, hub) or from Marseilles to Paris Charles de Gaulle (France, hub)
 - b. an intra-EU example might be flights from Hamburg Airport (Germany) to London Heathrow (UK, hub) or from Gran Canaria (Spain) to Amsterdam Schiphol Airport (the Netherlands, hub)
- 2. **"2nd hub"**: air traffic flows between a secondary hub airport and an airport offering only origin and destination traffic
 - a. an intra-national example might be flights from Bergen Airport to Oslo Airport (Norway) or from Alicante Airport to Barcelona Airport (Spain)
 - b. an intra-EU example might be flights from Hanover Airport (Germany) to Stockholm Arlanda Airport (Sweden, secondary hub) or from Geneva Airport (Switzerland) to Brussels Airport (Belgium, secondary hub)
- 3. **"intra"**: air traffic flows between two airports only offering origin and destination traffic
 - a. an intra-national example might be flights from Toulouse Airport to Paris Orly Airport (France) or from Madeira Airport to Porto Airport (Portugal)
 - b. an intra-EU example might be flights from Stuttgart Airport (Germany) to Glasgow Airport (UK) or from Cyprus Airport (Cyprus) to Milan Bergamo Airport (Italy)
- 4. **"hub-hub"**: air traffic flows between two hub airports
 - a. an intra-national example might be flights between Munich Airport and Frankfurt Airport (Germany)
 - b. an intra-EU example might be flights between Amsterdam Schiphol Airport (the Netherlands) and Madrid Airport (Spain)
- 5. **"hub-2nd"**: air traffic flows between a hub airport and a secondary hub airport
 - a. an intra-national example might be flights between Madrid Airport (hub) and Barcelona Airport (Spain)
 - b. an intra-EU example might be flights between Prague Airport (Czech Republic, secondary) and London Heathrow Airport (UK, hub) or between Dublin Airport (Ireland, secondary) and Paris Charles de Gaulle Airport (France)
- 6. **"2nd-2nd"**: air traffic flows between two secondary airports
 - a. an intra-national example might be flights between Milan Malpensa Airport and Rome Fiumicino Airport (Italy)
 - b. an intra-EU example might be flights between Prague Airport (Czech Republic) and Dublin Airport (Ireland) or Stockholm Arlanda Airport (Sweden) and Athens Airport (Greece)

Considering the distribution of seats for the sample, one can identify those flows containing the most seats within Europe. On the national level, traffic between airports offering only origin and destination flights ("intra") is most common (about 18 per cent), followed by flights between O&D airports and secondary hub airports with about nine per cent ("2nd hub"). On the intra-EU level, flights between O&D airports and hub airports are most common with slightly more than 20 per cent, followed by flights between O&D airports and secondary hub airports. A ranking of routes according to offered seats yields the following results:

1. Intra-EU flows between hub and O&D airports (21 per cent)
2. Intra-national flows between O&D airports (19 per cent)
3. Intra-EU flows between secondary hub and O&D airports (14 per cent)
4. Intra-EU flows between O&D airports (12 per cent)
5. Intra-EU flows between secondary hub and hub airports (11 per cent)
6. Intra-national flows between secondary hub and O&D airports (9 per cent)
7. Intra-EU flows between secondary hub airports (8 per cent)
8. Intra-national flows between hub and O&D airports (6 per cent)

These results assist in the definition of passenger demand profiles by establishing route profiles, i.e. determining what type of trips different passenger groups are taking. Considering the highest share of flows between hub and O&D airports, passengers can either be interested in the direct connection between these two airports or in the transfer opportunities offered at the hub airport. Therefore, passengers using these routes can either be originating in the EU or from outside the EU. These different profiles will be considered in the passenger type section since they determine passenger requirements as well. In addition to the routes flown, it is important to analyse which countries passengers are mainly travelling to.

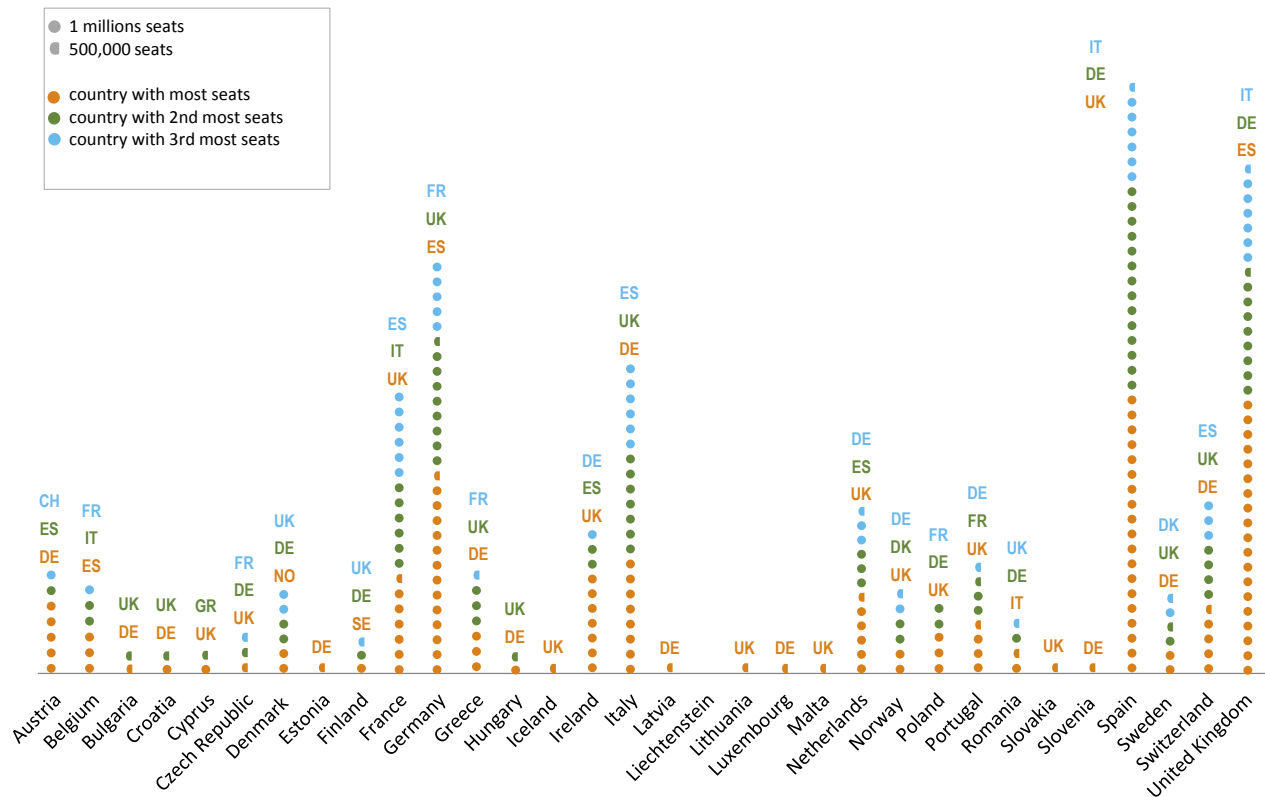


Figure 25: Top three air traffic flows for EU28 and EFTA countries (data: OAG, 2014a)

Figure 25 shows the top three air traffic flows for all EU28 and EFTA countries in terms of departing seats, i.e. only one-way seat capacity between countries is depicted. If seat capacities do not exceed 500,000 only the main air traffic flow is depicted as in the case of Estonia or Luxembourg, for example. It is apparent, that the countries receiving the majority of traffic are Spain, Germany, the United Kingdom, France, and Italy. This strongly correlates with the respective population figures outlined in section 2.1. Furthermore, some flows can be ascribed to geographical proximity of countries and resulting interrelations, such as Denmark and Norway, Cyprus and Greece, or Finland and Sweden.

3.2.2 Passenger luggage

According to SITA (2016), one out of five passengers is travelling without checked baggage, i.e. with carry-on luggage only or without any luggage. On average, passengers with checked baggage had 1.2 pieces of luggage. In their study “Survey on standard weights of passengers and baggage” Berdowski et al. (2009) investigated passenger and baggage weights at eight large airports all over Europe (London Gatwick, Amsterdam Schiphol, Madrid Barajas, Copenhagen Kastrup, Frankfurt, Warsaw Frederic Chopin, Athens International, and Sofia Airports). They studied the relationship

between luggage weight and different passenger characteristics such as age or purpose of travel, trip characteristics such as airline used or number of persons travelling and flight characteristics such as stage length or destination region. The mean weight of carry-on luggage for all passengers is given in Table 3. Each passenger has carry-on luggage weighing 6.1 kilogrammes in the mean. The respective numbers for checked-in vary between 15 and 18 kilogrammes. However, the variables considered in the survey only explain six per cent of the differences in baggage weight. Unknown factors and errors were responsible for most of the variance in luggage weight. Therefore, the study gives an overview of potential factors influencing luggage weight but further variables have to be included as well.

Table 3: Weight differences in passenger luggage (data: Berdowski et al., 2009)

Season	Gender	Carry-on	Checked-in
Summer	Male	6.0	16.9
	Female	5.2	17.0
	Child (2-12)	2.0	14.0
	Total (weighted average)	5.3	16.9
Winter	Male	7.2	16.5
	Female	6.7	16.8
	Child (2-12)	2.2	17.1
	Total (weighted average)	6.9	16.6
Total	Male	6.7	16.7
	Female	5.9	16.9
	Child	2.0	15.1
	Total (weighted average)	6.1	16.7

An important issue regarding passenger luggage are mishandled bags since these might cause severe delays in passenger processes and hence inhibit the four hour door-to-door goal to be achieved. The Baggage Report by SITA (2016) shows that the number of mishandled bags decreased from 24.3 million in 2014 to 23.1 million in 2015, which amounts to an average of 6.5 mishandled bags per thousand passengers globally. The figure for Europe amounts to 7.8 bags in 2015. The costs for mishandling baggage added up to more than two billion US dollars globally in 2015.

3.2.3 Value of travel time, price and income elasticities

Understanding a passenger's willingness to pay as well as the reaction to a price increase of a particular travel alternative is very valuable in the determination of different passenger profiles. This section hence outlines important factors and shows differences in regard to region covered or passenger type considered.

Table 4: Definition of value of time and elasticities of demand (data: McCarthy, 2001)

Concept	Definition
Value of time (willingness to pay)	The amount of money a passenger is willing to pay in order to save a unit (i.e. minute) in travel time, keeping overall utility constant.
Price elasticity of demand	The (percentage) change in the amount demanded (i.e. of a travel alternative) considering a one per cent change in the price of this alternative.
Income elasticity of demand	The (percentage) change in the amount demanded (i.e. of a travel alternative) considering a one per cent change in the income of a person (traveller).

Different studies elaborate on passengers' willingness to pay and respective values of time in regard to air travel as well as other transport modes (see Table 6). These values strongly depend on the various factors outlined in the previous sections and depicted in Figure 26.

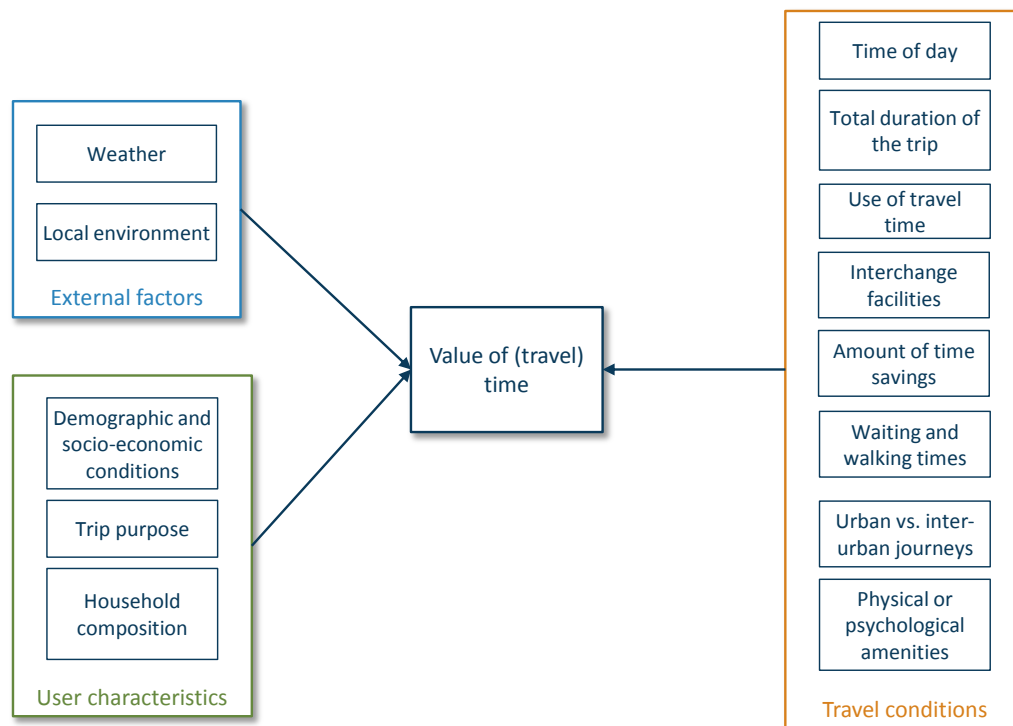


Figure 26: Parameters influencing the value of travel time (own depiction)

In regard to air travel, a range of studies investigated the airport access choice parameters including time and price of different alternatives. Tsamboulas et al. (2008) consider the case of Athens airport and passengers' willingness to pay in order to reduce airport access time. The authors differentiate by travel purpose, access mode, and passenger origin. The results imply that business travellers have a higher willingness to pay, that willingness to pay of private mode users exceeds that of public transport ones, and interurban travellers have a higher one than urban passengers. Although only tested for the case of Athens, this study gives important insight into the distinction by different parameters. Pels et al. (2003) also assess airport access choice, here with an application to potentially competing airports in the San Francisco Bay Area. The results show that leisure passengers are more sensitive to air fares than business passengers and that the latter are more sensitive to flight frequencies. The decision making factors hence differ by passenger type.

Table 5: Outline of different value of time studies

Transport mode	1	2	3	4	5	6	7
General	83%	25-50% (P) 150% (B)	UK: \$4.40 USA: \$8-40	€47-€60 €14-21 (P) €42 (B)	n/a	n/a	n/a
Air	145.75%	n/a	n/a	€25 (P) €47 (B) €34 (A)	\$18.35 (P) \$34.31 (B)	\$10 (P) \$40 (B)	\$23.81 (P) \$86.67 (B)
Rail	77.47%	€21 (B) €6.40 (C) €3.20 (P)	n/a	HSR €25 (P) €47(B) €34 (A)	n/a	n/a	n/a
Bus	56.81%	n/a	n/a	n/a	n/a	n/a	n/a
Car	82.44%	€21 (B) €6.00 (C) €4.00 (P)	UK: \$18 (B) Germany: \$13.5 (B), \$2.6 (P)	n/a	n/a	n/a	n/a

References: (1) Zamparini and Reggiani (2007), (2) Victoria Transport Policy Institute (2013), (3) Departement for International Development (2002), (4) Eurocontrol (2015), (5) Walker (2006), (6) Proussaloglou (1999), (7) Garrow (2007)

Table 5 outlines a range of studies concerned with the estimation of value of time for different users and transport modes. There is no common value of time across the studies which implies that these values differ strongly by region considered, availability of transport, income level of travellers and others (as depicted in Figure 26). In the table, "P" stands for private passengers, "B" for business, "C" for commuting and "A" includes all types of users. For the purpose of feeding the DATASET2050 model with relevant data on different passenger requirements, certain value of time

studies might be selected. Since the model includes different transport modes, i.e. including different airport access modes, the values differ in regard to stage of the journey.

Table 6: Overview price elasticities of (air travel) demand (data: IATA, 2008)

Region	Route level (-1.4)		National level (-0.8)		Supra-national level (-0.6)	
	short-haul	long-haul	short-haul	long-haul	short-haul	long-haul
Intra-Europe	-2.0	-2.0	-1.2	-1.1	-0.9	-0.8
Trans-Atlantic	-1.9	-1.7	-1.1	-1.0	-0.8	-0.7
Europe-Asia	-1.4	-1.3	-0.8	-0.7	-0.6	-0.5

Table 6 shows passengers' reaction to price changes in the different air transport markets. Price sensitivity is highest on the route level and lowest on the supra-national level, i.e. between different European countries. Figures on the trans-Atlantic and Europe-Asia traffic are included as well since passengers on these routes often use European hub airports to change between intra-European (feeder) flights and long-distance connections.

The analysis conducted in this section serves as basis to determine a range of generalized passenger journeys and match these with the different passenger profiles derived based on demographic, socio-economic, geographic, and behavioural information regarding the predefined country sample.

4 PASSENGER PROFILES WITHIN DATASET2050

Within this section passenger demand profiles are derived based on the data acquired in the previous sections as well as on existing passenger studies outlined in the Appendix. Furthermore, based on passenger mobility data, generalized or archetype journeys are derived in order to be tested in regard to the four hour door-to-door goal. All these archetype journeys include an air travel stage since this is the main focus of the project. Hence, the journey types are depicted from airport to airport but represent different urban and rural regions. Using supply data from work package 4, it can then be determined which access modes are available to passengers and how long respective access times might be. The section starts out with the depiction of six different passenger profiles and continues with the elaboration of distinct journey types associated with these passenger groups.

4.1 Description of passenger profiles

The passenger profiles taken from a variety of studies (see Appendix) can again be clustered in order to identify similarities and differences. At first, passenger profiles are distinguished by travel purpose, i.e. whether they travel for personal or for business reasons. Following that, passenger groups are assigned to predefined age cohorts taken from the analysis of European countries (see Figure 27) as well as respective average travel activity within the particular age group. For example, "cosmopolitan commuters" and "leisure and family tourists" travel for private reasons and are assigned to the age group 25 to 44 years. People within this age group account for 36 per cent of all travellers and conduct an average of 1.13 trips per capita per year.

However, not all studies include a reference to age for the described passenger group. Hence, other criteria are included in order to cluster existing passenger profiles and match these with the data available on a European level. These parameters include income level, technological affinity, or the type of accommodation selected. A large amount of the already existing passenger profiles is of qualitative nature and hence clustering of these profiles cannot be conducted according to statistical clustering methods. These profiles are hence grouped based on the descriptions that are available in regard to travel purpose, destination choice, or experience sought. An overview of considered criteria and the respective classification can be found in the Appendix.

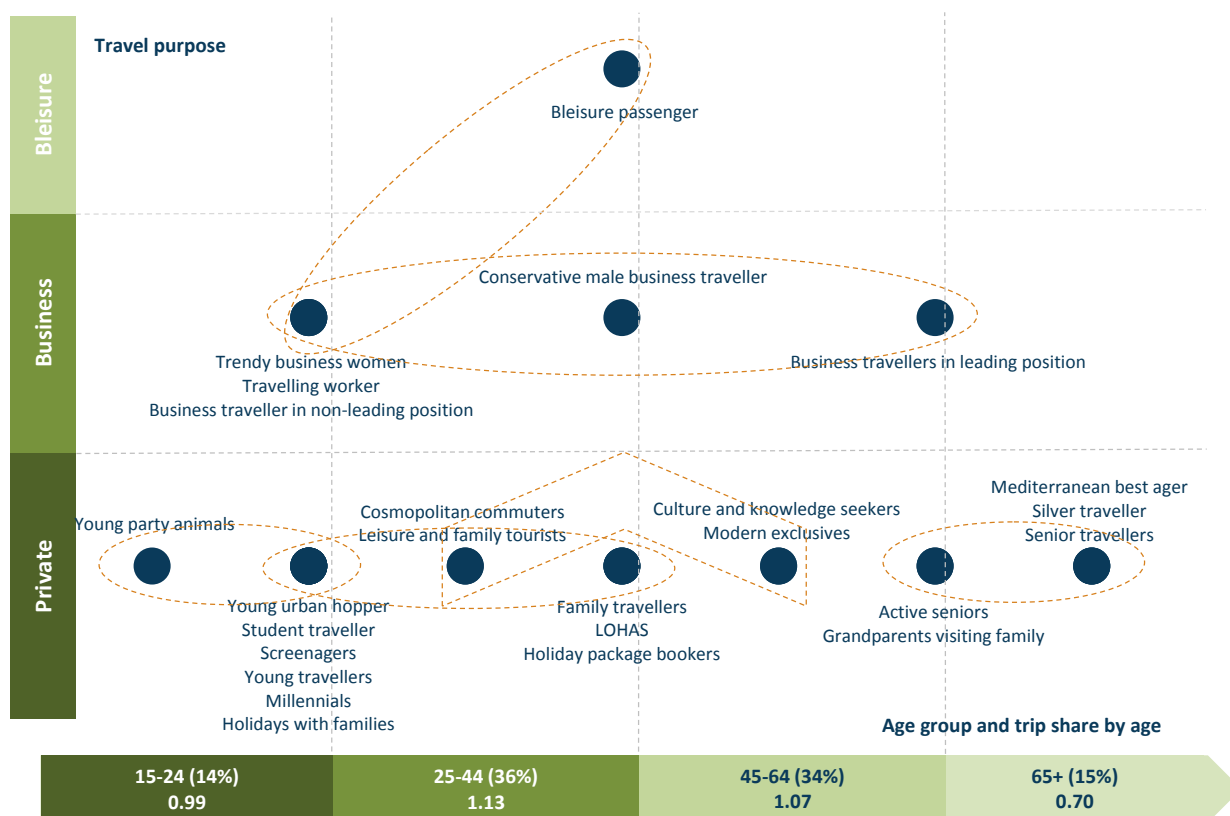


Figure 27: Passenger cluster – age and travel purpose (own depiction)

In addition to the initial grouping according to age and travel purpose, passenger profiles are classified according to their income level, their degree of travel activity, their length of stay as well as additional qualitative characteristics if available (see Table 7). By doing so, an aggregated set of DATASET2050 passenger groups from the different studies is created, which are then backed by the quantitative data derived in the previous sections.

The selection of six different passenger profiles is based on the identified similarities between the analysed passenger groups and the data available from the sample of European countries. First, since the amount of passengers travelling for private reasons exceeds that of passengers travelling for business reasons (on average across all countries 10 per cent business trips), there are four groups describing leisure passengers and two groups describing business travellers. Second, data on travel activity within the EU28 and EFTA countries is available for different age groups. Hence, the passenger profiles are allocated to these age groups if possible. Figure 27 gives an overview of the classification of existing profiles into European age cohorts.

Table 7: Passenger profiles within DATASET2050

	Exclusive Experience Traveller	Family and Holiday Traveller	Best Agers	Youngsters	Executives	Price-conscious Business Traveller
Share in total transport trips	On average 90 per cent of European travellers (all modes)				On average 10 per cent of European travellers (all modes)	
Included passenger profiles	5d, 7c, 4d, 4a, 4f, 4b, 6c	5b, 7d, 7b, 6b, 7e, 8d	6a, 8g, 5c, 5e, 7f	8c, 5a, 8e, 1a, 4c, 7a, 3a	7h, 6d, 8b, 8a	8f, 7g, 4e, 2a
Main travel purpose	Private	Private	Private	Private	Business	Business
Predominant age group	25-64	25-44	65+	15-30	40-65	25-44
Income level	Medium / high	Medium	Medium	Low	High	Medium
Amount for transport expenditure	Medium	Medium / low	Medium	Low	High	Medium
Use of technical devices and respective retrieval of information	Medium to high frequency	Low to medium frequency	Low frequency	High frequency	High frequency	Medium frequency
Length of stay	> 3 nights	> 7 nights	> 3 nights	> 3 nights	1-2 nights	1-2 nights
Travel activity (trips per capita)	1.1	0.9	0.7	1.1	1.5	0.8
Travel party size	1 - 2 people	≥ 3 people	1 - 2 people	1 - 3 people	1 - 2 people	1 - 2 people
Luggage requirements	Check-in luggage	Check-in luggage (several bags)	Check-in luggage	Hand luggage only (short trips) Check-in luggage	Hand luggage only	Hand luggage only
Value of time	Medium	Low	Low	Low	High	High
Access mode choice	Public transport	Public transport Private car (park and travel)	Private car (park and travel) Kiss & fly	Public transport	Taxi Private car (park at airport)	Public transport

All six passenger groups differ by their income. "Executives" and partly "Exclusive Experience Traveller" have a high income; "Youngsters" have a low income and the remaining passenger groups have a medium income. Income alone has a great impact on travel budget and consequently on travel behaviour, such as luggage or access mode choice.

The use of technical devices throughout the entire journey differs by age groups (as outlined in section 0). Hence, the six passenger groups are characterized by a different level of frequency in regard to mobile phone and internet usage. This translates to their booking and travelling behaviour as well. "Youngsters" and "Executives" are the two passenger groups using ICT with a high frequency. "Youngsters", for example, are digitally savvy and more likely to complete travel related tasks online compared to the group of "Best Aged". Such processes along the travel chain could be checking-in online or generating a boarding card on a mobile device. For the DATASET2050 model, these are important differentiations since they determine the time spent in the multiple processes from door-to-door.

The value of time also influences travel behaviour as passengers who value time a lot tend to save time along their journey and vice versa. Among all six passenger groups, "Executives" and "Price-conscious Business Traveller" value time the most contrasting "Youngsters" which are young, often students or apprentices, and money poor but time rich. To compensate their low income, they tend to use public transport to save money as they do not mind the additional time spend in public transport. "Family and Holiday Traveller" and "Best Aged" also have a rather low value of time.

The six passenger groups also differ by their length of stay. The trip length in terms of nights staying is another parameter influencing the amount of luggage a particular passenger is taking along the journey. The duration differs both by travel purpose and by type of journey conducted. Business travellers tend to spend fewer nights per trip than leisure passengers. And "Youngsters" visiting friends in urban centres spend less nights than "Family and Holiday Traveller" on their summer vacation. In turn, this may influence the access mode selected, the time spent in luggage check-in processes, or during luggage collection at the destination airport. Business passengers tend to reduce the amount of luggage taken along in order to minimize time and effort accrued to respective handling processes. The times assigned to the different process steps are outlined in further detail within the supply profile of this project (WP4); these are then varied according to considered passenger profile.

In regard to persons with reduced mobility, the same approach is taken here as in the DORA project (2016) by assuming that mobility impaired travellers can be part of each defined passenger group. Hence, characteristics in regard to income level, use of technical devices, or travel activity are the same. Differences arise when considering the time spent in the various processes and the requirements regarding potential physical assistance during the different steps of the journey.

4.2 Definition of generalized journeys

As a novelty regarding the analysis of passenger demand, a range of generalized journeys is identified based on the mobility behaviour of European passengers (see section 4). With this, specific route profiles are matched with the different DATASET2050 passenger profiles described

above. This approach provides the input for the theoretical model derived in D2.2 of the project by assigning trip characteristics to the six user profiles. In order to meet the scope of the project concerning the modelling of archetype journeys not all countries, regions, and single routes can be considered. Hence, the following section identifies archetype journeys by considering high frequency routes, typical destinations of specified passenger journeys as well as relevant data obtained within the passenger characteristics section.

The derivation of these generalized journeys is conducted within different steps:

1. Distribution of air traffic and selection of **relevant European countries**
 - a. Selection of most frequented countries
 - b. Identification of remote countries in terms of air traffic access and air travel activity
2. **Business** traveller journeys
 - a. Countries with highest absolute amount of business travellers
 - b. Distinction by domestic and outbound traffic
 - c. Consideration of share of air traffic of respective countries and most frequented destinations out of these countries
 - d. Selection of generalized business passenger journeys
3. **Private** passenger journeys
 - a. European capitals and main traffic flows to these (representative for urban hopping, culture seeking)
 - b. Identification of "holiday locations" for long-term holidaymakers
 - c. Depiction of main flows between these destinations and countries within sample
 - d. Selection of generalized private passenger journeys

1. Distribution of air traffic and selection of relevant countries

The countries with the highest amount of offered scheduled airline seats within Europe are the United Kingdom, Spain, Germany, Italy, and France. Hence, a range of generalized journeys will concentrate on these countries as origin or destination countries. Considering the offered airline seats per capita within Europe the top five countries are Norway (7.32), Iceland (6.65), Malta (5.54), Cyprus (3.31), and Ireland (3.12) which can be ascribed to the geographical location, i.e. being an island or a large country with sparse population like Norway. Since the latter also has a high amount of offered airline seats, it can be taken into account when defining generalized journeys. In terms of remoter regions and less air travel supply countries such as Romania, Bulgaria, Estonia, or Lithuania are taken into consideration.

In addition to differentiating between business and leisure passengers, a distinction can be made between passengers travelling point to point, i.e. origin and destination traffic (O&D), and transfer passenger, i.e. those passenger changing flights at a hub airport in order to get their final destination. However, the definition of generalized journeys will not differentiate between O&D and transfer passengers. This fact can be accounted for when making assumptions about the time spent in different processes throughout the journey due to i.e. an increased amount of luggage or different border control restrictions.

2. Business traveller journeys

Regarding business passenger journeys, it is distinguished between domestic air traffic journeys and intra-EU (or EU-bound) journeys. Further assumptions include the origin of this type of traffic mainly in urban agglomerations and a stage length of a flight of slightly more than 500 kilometres for domestic journeys (see Figure 28). Since the aim is to identify exemplary routes that serve as input for the DATASET2050 model, the focus will be on those countries with a high share of domestic business trips. As can be seen in Figure 28, Italy has the highest amount of domestic air trips, closely followed by Spain. However, the amount of domestic business traffic within both countries is significantly lower than in other countries. Therefore, the total amount of business trips within a country is also taken into consideration.

Germany, the United Kingdom, and France make up almost 70 per cent of total domestic business travel (all modes) within the considered European countries (see Figure 29). In addition, each country has a high share of domestic trips as can be seen in Figure 17 (all transport modes) and Figure 21 (supplied domestic airline seats). Hence these countries and respective connections between national urban agglomerations are taken as exemplary routes for business travellers. The average stage length of a flight, which is weighted by offered seats, differs by country with Germany at a weighted average of 430 kilometres, the United Kingdom of 418 kilometres, and France of 583 kilometres (Figure 28).

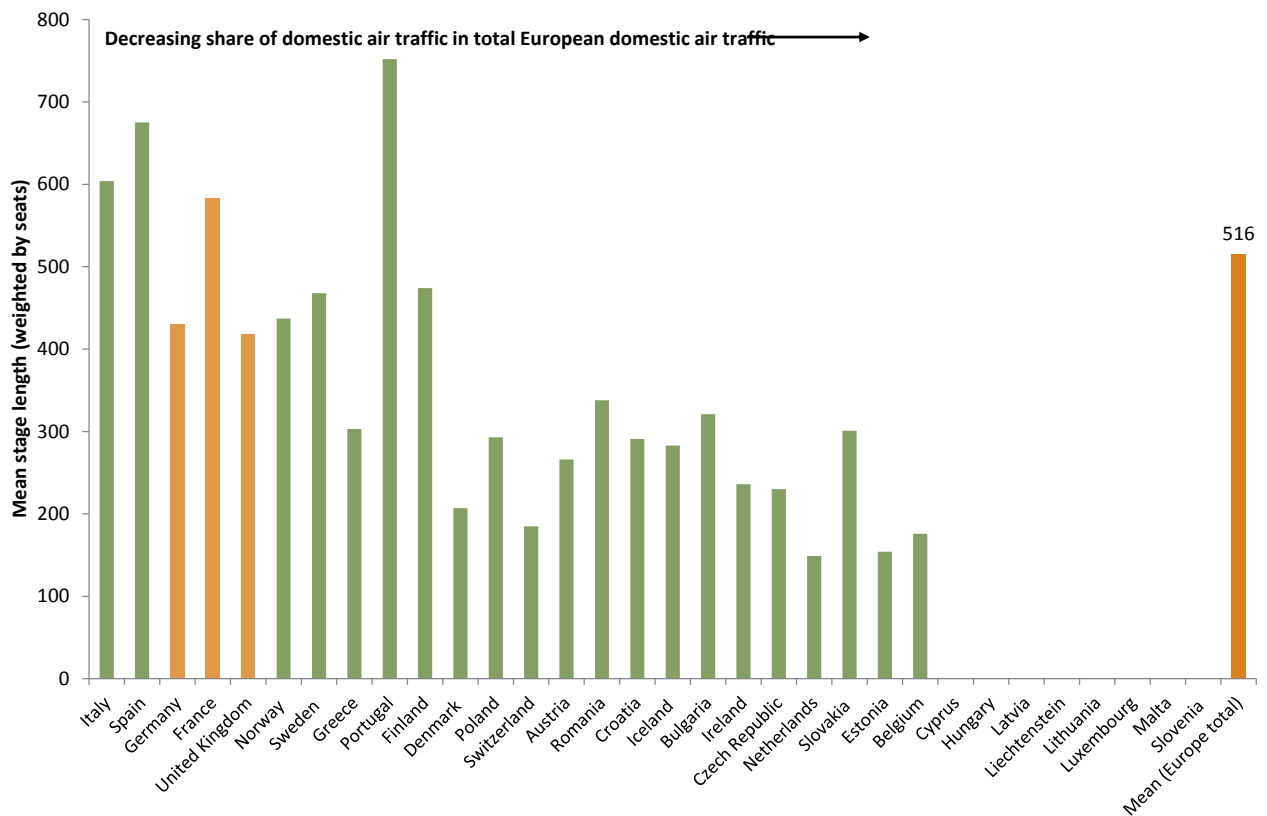


Figure 28: Stage length distribution European domestic business traffic (data: OAG, 2014a)

For the assessment of EU-bound traffic, the main destinations out of each country have been analysed. Figure 29 shows the amount of business trips (all transport modes) taken for the considered European data set (missing countries due to lack of data: Norway, Sweden, Iceland, and Liechtenstein). The countries in the figure are ranked in descending order of the share of air transport in total transport. Malta, Ireland, and Cyprus all have a share of more than 40 per cent. In addition to the air travel activity the absolute amount of business trips plays a decisive role in determining exemplary business routes. Leading in this regard are Germany, the United Kingdom, France, Spain, Italy, and Finland, together accounting for more than 80 per cent of all business trips in the sample. For each of these countries the main destination countries are also outlined in the figure. Germany, for example, has the highest amount of total business trips (almost 40 million) with outbound business trips accounting for 24 per cent. The main receiving countries of German air traffic are Spain, the United Kingdom and France.

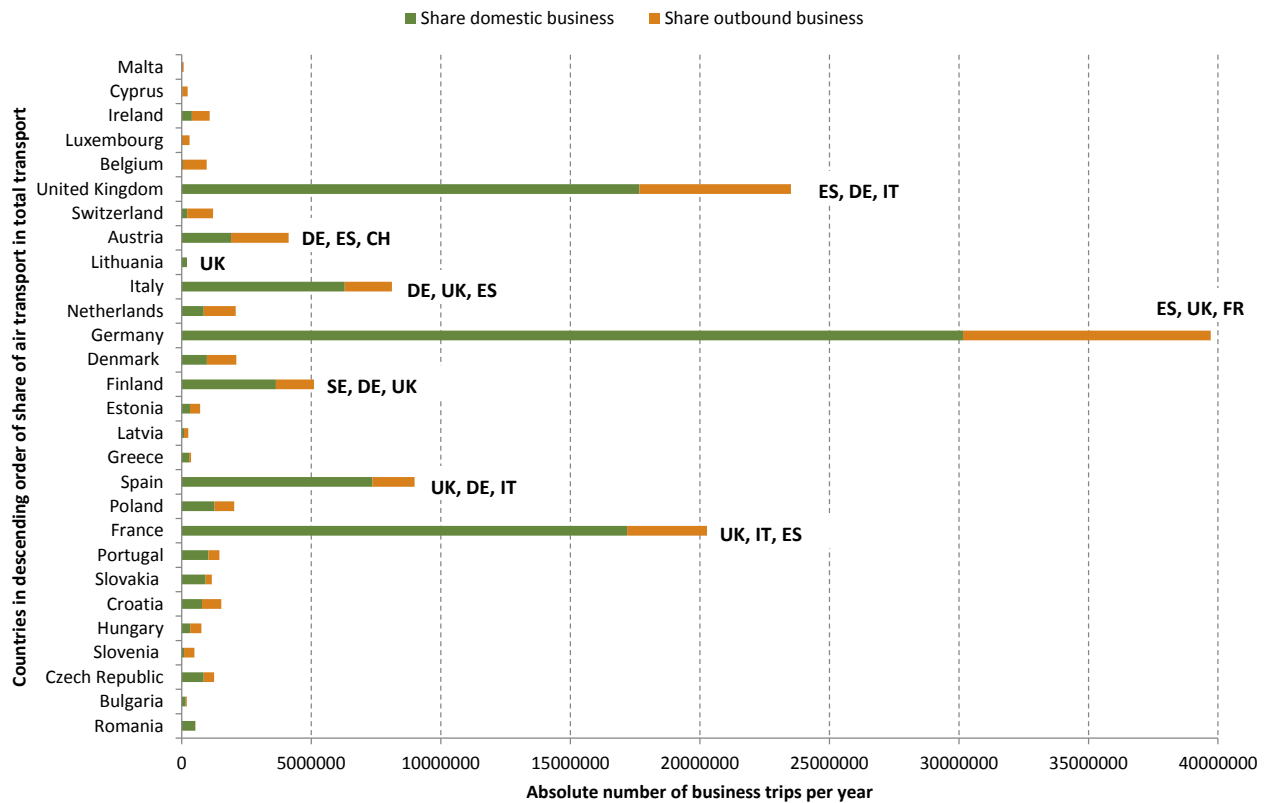


Figure 29: EU-bound business trips and air travel activity by country (data: Eurostat, 2014)

Based on the EU-bound connections originating in countries with a high amount of business traffic, including Germany, the United Kingdom, France, Spain, Italy, Finland, Austria, and Lithuania as rather remote location (Figure 29), the average stage length of flights is calculated. Since the top three destination countries are outlined for each country, these are used as basis to compute average distances. Hence, the mean distance covered by air for European traffic amounts to about 1320 kilometres (Figure 30).

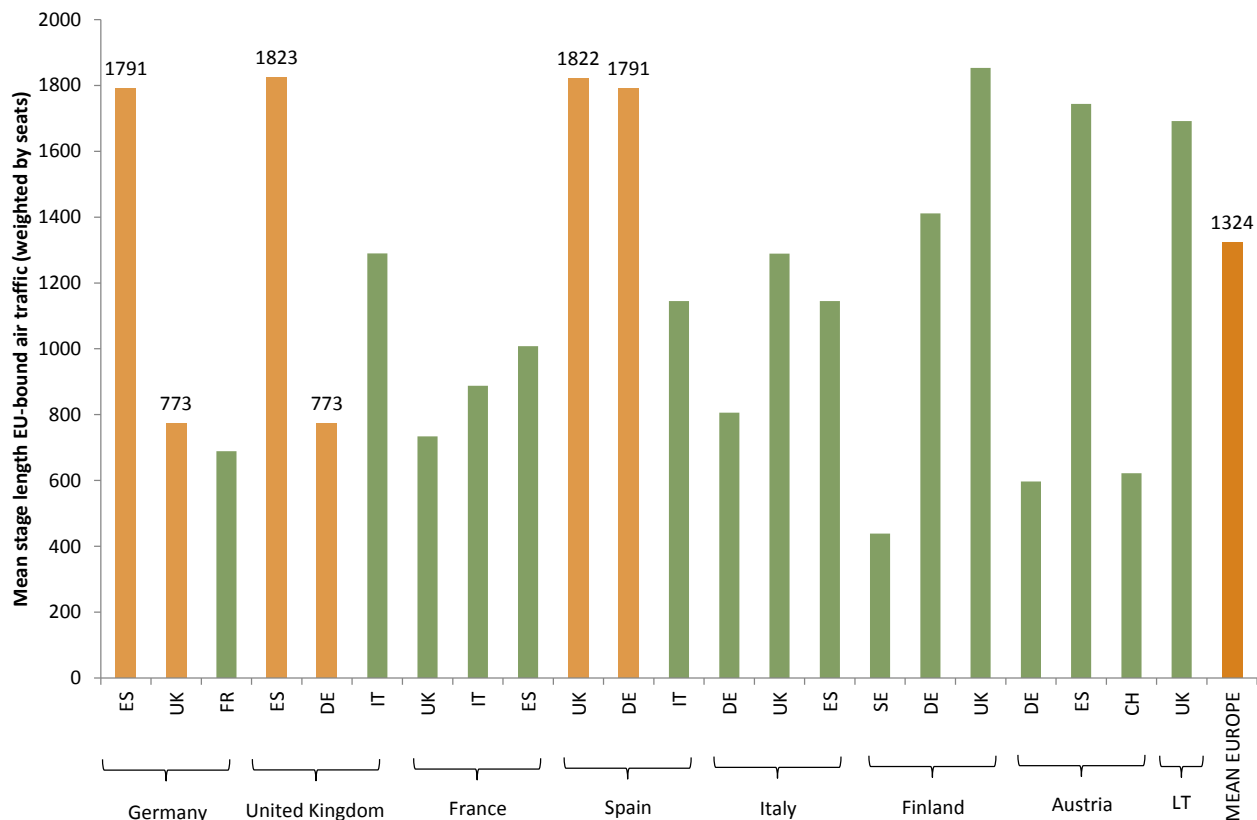


Figure 30: Stage length distribution intra-European business traffic (data: OAG, 2014a)

The most frequented routes in terms of scheduled airline seats offered are between Germany and Spain, Germany and the United Kingdom, and between the United Kingdom and Spain (as highlighted in orange in Figure 30), Lithuania is included as representative of a rather remote air traffic destination. For a first assessment of overall travel times for business travellers' specific routes between urban agglomerations of these countries may be considered. The analysis can then be extended by the countries offering a high share of business passengers as well as those countries currently representing a rather remote location. The type of journeys selected also represents the air traffic flows between different types of airports, both on a domestic and an intra-EU level (as depicted in Figure 24).

For business passenger the following generalized journey types are hence defined:

Table 8: Archetype journeys for business travellers

Journey type	Mean distance	Distance distribution (mean km major routes)	Exemplary routes (highest amount of scheduled airline seats)	Urban agglomerations
Domestic	516 km	430 km (DE), 583 km (FR), 418 km (UK)	DE: MUC-TXL, FRA-TXL, HAM-MUC, DUS-MUC, CGN-TXL FR: ORY-TLS, NCE-ORY, BOD-ORY, ORY-MRS, CDG-TLS UK: EDI-LHR, LHR-MAN, ABZ-LHR, GLA-LHR, LGW-EDI	Munich (DE), Berlin (DE), Frankfurt (DE), Hamburg (DE), Dusseldorf (DE), Cologne-Bonn (DE) Paris (FR), Toulouse (FR), Nice (FR), Marseille (FR), Bordeaux (FR) Edinburgh (UK), London (UK), Manchester (UK), Aberdeen (UK), Glasgow (UK)
EU-bound	1324 km	773 km (DE-UK), 1791 km (ES-DE), 1822 km (UK-ES), 1692 km (LT-UK)	DE: FRA-LHR, FRA-VIE, MUC-LHR, FRA-CDG, FRA-BCN, MUC-CDG, FRA-MAD, TXL-ZRH UK: LHR-DUB, LHR-FRA, LHR-AMS, LHR-MAD, LHR-MUC, LHR-CDG, LGW-BCN, LGW-DUB ES: MAD-LHR, BCN-LGW, BCN-AMS, BCN-CDG, MAD-LIS, BCN-FRA, MAD-ORY, MAD-FCO LT: VNO-RIX, VNO-FRA, VNO-LTN, VNO-TLL, VNO-CPH, VNO-WAW, VNO-STN	Frankfurt (DE), London (UK), Vienna (AT), Munich (DE), Paris (FR), Barcelona (ES), Madrid (ES), Berlin (DE), Zurich (CH), Dublin (IE), Amsterdam (NL), Lisbon (PT), Rome (IT), Vilnius (LT), Riga (LV), Tallinn (EE), Copenhagen (DK), Warsaw (PL)

3. Private traveller journeys

As a first step, all European capitals are considered and the mean distance of respective connections at these. This serves as representative for shorter city trips conducted by different private passenger groups such as "Best Ager" or "Youngsters". In a next step, those destinations are identified which are popular regarding longer term holidaymakers such as "Family and Holiday Traveller". In order to identify feasible destinations, data from Figure 18 is used. Here, the amount of average nights spent by NUTS2 regions is outlined and those regions are selected where travellers spend a high amount of nights. For private passengers, three journey archetypes result: (1) city trips, (2) coastal holiday trips, and (3) island trips. The differentiation between these destinations is made since the access modes to the airport cannot only differ by individual airport but also by type of airport and by prevailing passenger group. Furthermore, as outlined, different

passenger types are more likely to conduct specific journeys. The assigned trip characteristics for each group (Table 7) can hence be assumed for the respective journey type.

Table 9: Archetype journeys for private travellers

Journey type	Mean distance	Distance distribution (mean km major routes)	Exemplary routes (highest amount of scheduled airline seats)	Cities and regions
City trips	987 km	1003 km (London), 1011 km (Dublin), 1031 km (Prague), 898 km (Rome), 971 km (Amsterdam), 950 km (Paris)	LHR: DUB, EDI, FRA, AMS, MAD, MUC DUB: LHR, LGW, STN, MAN, BHX, CDG PRG: CDG, FRA, AMS, LHR, FCO, BRU FCO: CTA, LIN, PMO, CDG, MAD, BCN AMS: LHR, BCN, CDG, FCO, CPH, MAD CDG: LHR, FRA, FCO, AMS, BCN, MUC	London (UK), Dublin (IE), Prague (CZ), Rome (IT), Amsterdam (NL), Paris (FR) Edinburgh (UK), Frankfurt (DE), Madrid (ES), Munich (DE), Manchester (UK), Birmingham (UK), Brussels (BE), Catania (IT), Milan (IT), Palermo (IT), Barcelona (ES), Copenhagen (DK)
Coastal holiday trips	1082 km	957 km (Tuscany), 1744 km (the Algarve)	PSA: STN, LGW, PMO, ORY, CAG, FCO FAO: LGW, MAN, DUB, BRS, EMA, LIS	Pisa (IT), London (UK), Palermo (IT), Paris (FR), Cagliari (IT), Rome (IT), Manchester (UK), Dublin (IE), Bristol (UK), East Midlands (UK), Lisbon (PT)
Island trips	1287 km	1821 km (Crete), 3053 km (Tenerife), 1143 km (Mallorca)	HER: ATH, LGW, DUS, SKG, MAN, MUC TFS: LGW, MAN, EMA, BHX, DUS, GLA PMI: BCN, MAD, DUS, CGN, HAM, FRA	Athens (GR), London (UK), Dusseldorf (DE), Thessaloniki (GR), Manchester (UK), Munich (DE), East Midlands (UK), Birmingham (UK), Dusseldorf (DE), Glasgow (UK), Barcelona (ES), Madrid (ES), Dusseldorf (DE), Cologne-Bonn (DE), Hamburg (DE), Frankfurt (DE)

5 SUMMARY AND NEXT STEPS

Within this deliverable D3.1, a variety of characteristics describing the demand for mobility in general and for air transport in particular within the predefined EU28 and EFTA countries have been discussed. The focus was placed on demographical, geographical, socio-economic and behavioural aspects influencing the passengers' travel behaviours as well as general mobility aspects of European passengers.

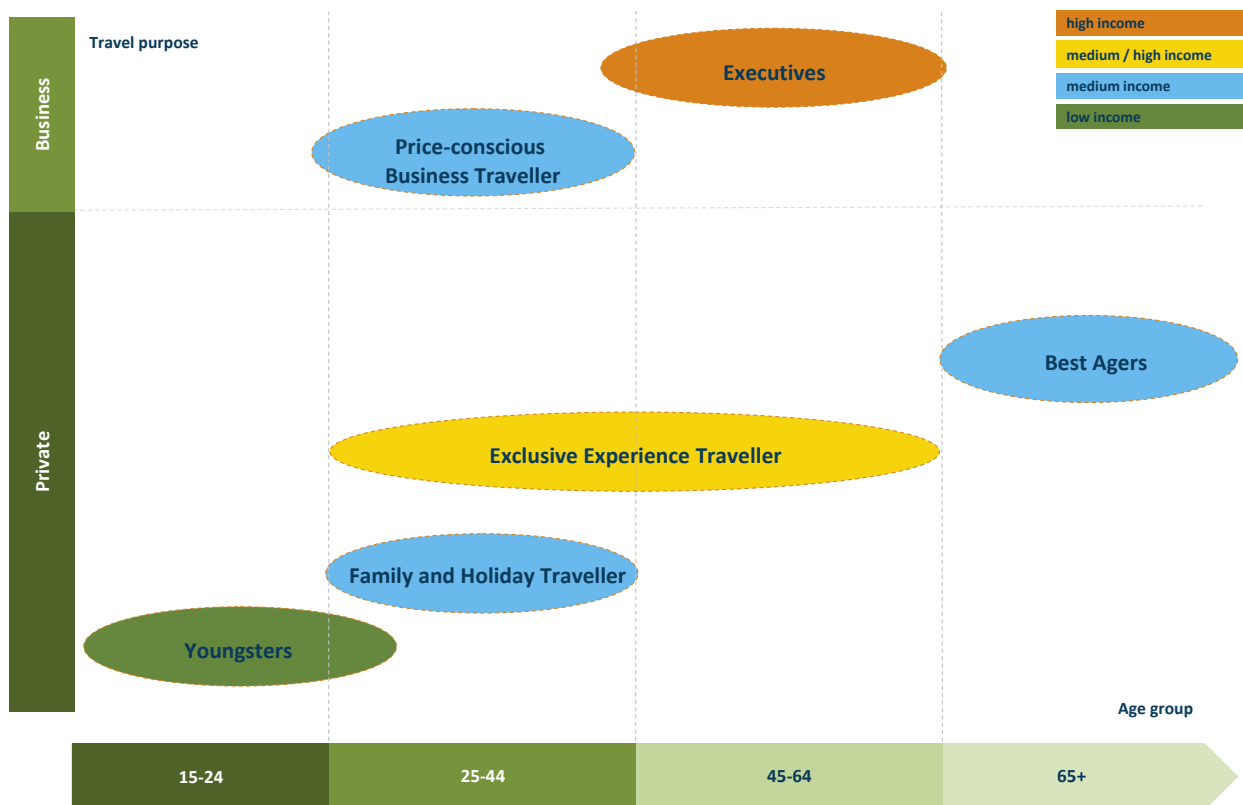


Figure 31: DATASET2050 passenger profiles

Based on the analysis of this data and specific mobility behaviour of the different member states, six different passenger profiles (Figure 31) and five different archetype journeys have been developed. The passenger profiles are distinguished by age cohort, travel purpose and income level. According to this classification, further attributes such as technological affinity or luggage requirements are assigned to each group.

For each passenger type, the likeliness of conducting a specific archetype journey is outlined. As can be seen in Table 10, not every passenger profile is assigned each journey type.

Table 10: Matching passenger profiles with journey archetypes

Journey type	Exclusive Experience Traveller	Family and Holiday Traveller	Best Agers	Youngsters	Executives	Price-conscious Business Traveller
Domestic business trip						
EU-bound business trip						
City trips						
Coastal holiday trips						
Islands trips						

Likelihood of passenger group to conduct this journey:

very likely	likely	not likely
-------------	--------	------------

The two business passenger profiles are hence associated with both domestic and EU-bound business trips. "Family and Holiday Traveller", for example, are associated with coastal and island holiday trips. Since their overall stay at the destination usually exceeds seven days their journey planning and time valuation is different to that of an "Exclusive Traveller". These different characteristics assigned to the six passenger profiles hence determine the different process steps throughout the journey and finally the feasibility of the four hour door-to-door goal.

The data analysis showed a high level of dispersion across the considered country sample in regard to income level, share of domestic and outbound travel, or household size. The share of air travel within the different member states also fluctuates, with some countries clearly dominating this market in terms of offered scheduled airline seats. Rather remote regions in terms of air traffic supply have hence not explicitly been considered so far but can easily be integrated into the assessment using the DATASET2050 model. The focus so far has been placed on high density routes both in terms of air traffic and population density in order to capture a high share of potential passenger for the current demand profile. Based on these profiles and journey times, metrics will be developed which deliver specific input for the model. Hence, there is close alignment with the respective work packages WP2 and WP5.

However, the dynamics of the passenger market, especially in regard to aviation, will change in the future and passenger profiles as well as archetype journeys will adjust accordingly. The next steps

therefore include the analysis and assessment of future developments and respective implications for passenger demand profiles. The work conducted in this area will be summarized in the subsequent deliverable D3.2 within this particular work package. In addition to that, the matching of passenger demand profiles and archetype journeys with the supply profile yields insight into current bottlenecks of the system and resulting potential for improvement.

6 APPENDIX

Table 11 outlines existing studies on different passenger groups besides traditional leisure and business classification. In total, eight different studies have been considered and analysed. Since all reports have a different focus, i.e. reasoning why passenger profiles have been developed, the existing profiles have been structured according to predefined categories and respective parameters (see Table 12). The categories are based on the structure within this deliverable, i.e. demographic, geographic, socio-economic, behavioural, and mobility. However, information on these is not provided within each report. Hence, socio-economic aspects are addressed by age, family status, income, and education. Mobility aspects are represented by travel purpose, frequency of travel, season and duration of trip, booking and information gathering, type of accommodation and level of travel expenditure, and the expected comfort level. Factors relating more to passenger behaviour are technological affinity as well as the experience sought at the destination. In order to obtain a comprehensive and comparable overview of the different groups, simplified classes for each factor have been introduced; these are outlined in Table 13.

The studies considered in this report are as follows, the number assigned to each study will be used in the different tables:

1. SITA (2015), Air Transport industry Insights: The Future is Personal, SITA - A 360 Degree Report
2. Skift (2015), Megatrends defining travel in 2015, Yearbook / Issue: 01, Skift Travel IQ
3. OAG (2014b), OAG Trends Report: What is shaping air travel in 2015?, OAG Aviation Worldwide Limited
4. Future Foundation (2015), Future Traveller Tribes 2030 - Understanding Tomorrow's Traveller
5. GfK Mobilitätsmonitor (2011), Airport Private Traveller Study - Reiseverhalten, Einstellungen und Werte der Privatreisenden am Airport, GfK Mobilitätsmonitor - GfK Roper Consumer Styles
6. Henley Centre HeadlightVision (2007), Future Traveller Tribes 2020 - Report for the Air Travel industry
7. DORA Project (2016), User Groups and Mobility Profiles (D2.2)
8. Plötner, K. O. and Schmidt, M. (2014), FASCINATIONS2050 project. Final report.

Table 11: Short description of existing studies on different passenger profiles

#	Passenger group/ cluster	Description
1	(a) Screenagers	Teenagers that grew up with connectivity and pervasive use of technological devices/applications and hence expect ubiquitous, fast and reliable connectivity.
2	(a) Bleisure passenger	Passengers combining business trips with leisure activities (sightseeing, dining, art/culture), bringing along family members, adding extra days to business trip.
3	(a) Millennials	Passengers that grew up with using technology in all areas of life, mobile devices are used to control travel and "on-the-go" booking etc.; blur between leisure and work, sharing economy, "pay for what you use" mentality.
4	(a) Simplicity searcher	Outsourcing of decision-making to third parties and systems, simplified choices bundled into packages; travel: safe and comfortable and have a "home-away-from-home" feeling; new travellers from emerging markets including first-time tourists fall into this category.
	(b) Cultural plurists	Seeking to experience true local lifestyle, avoiding common tourist destinations, "niche experience"; not using traditional travel agencies but rather networks to connect and exchange with other travellers alike; travelling to remote, non-tourist destinations; sharing as part of the travel experience; travel purpose in line with personal interests.
	(c) Social capital seekers	Expected personalisation according to individual preferences and interests; sharing of holiday experience online (often in real time); decision-making strongly based on social opinion and trends; social media presence of both travellers and suppliers (e.g. travel brands) is expected; travellers seek rewards for their social interaction and sharing, e.g. rewards by travel brands; ubiquitous, free connectivity with sufficient bandwidth is expected; travellers want to increase personal (online) recognition.
	(d) Reward hunters	Seeking (travel) rewards for high achievements in business/personal life; demand for temporary escape, focus on indulgence, minimising personal effort, unique experience; technology used as a means to obtain unique travel experience but otherwise rather avoided; quantified self: online health tracking and biometric data sharing.
	(e) Obligation meeters	Travellers with strict travel specifications; teleconferencing as supplement for business travel; hassle-free, minimal-choice booking, integrated platforms, covering entire journey; simplification of travel-related processes and real-time information along the journey; integrated airport and airline systems required to enable flexible journey management (alignment in case of disruptions); efficient conversion of waiting time into productive time; ensuring network security and continuous connectivity; loyalty programs and tracking of passenger preferences.
	(f) Ethical travellers	Increasing ethical awareness (environmental, social, political conditions and effects of travel), adjustment of travel behaviour accordingly; increased pressure on corporate social responsibility; increased transparency regarding (carbon) footprint of entire journey, widespread carbon offsetting and automated carbon footprint tracking along the journey; online sharing and exchange of recommendations for ethically-friendly travel options.
5	(a) Young urban hopper	Travel during off-season months, budget travelling (hostels, friends and family, "couch surfing"); spontaneous booking behaviour, focused on online offers; young travellers (students, young professionals) but also "young at heart"; fun and action as main motivation; city trips.
	(b) Leisure and family tourist	Family focused, usually travelling for two weeks; package tours with tour operators; destinations in the Mediterranean; aged between 30 and 44, middle income class; relaxation as main focus.

#	Passenger group/ cluster	Description
	(c) Mediterranean best-ager	Package tours, spending higher than average; main travel period during off-season; selection of 4-/5-star hotels; traditional ways of information acquisition; dominated by persons >60 years; belonging to middle income class; seeking relaxation (wellness, creativity).
	(d) Culture and knowledge seeker	Long-distance travel, mainly during winter months; travel usually involves air transport; contacting different information sources, booking with tour operator; city and cultural destinations; tertiary education, top end of middle class/high income group; exploring new cultures and sites.
	(e) Silver traveller	Culture and sightseeing; large travel budget and longer trips (>14 days), travel during off-season; use of small and specialised tour operators, close contact and exchange with operators; dominated by travellers >60 years.
6	(a) Active seniors	Aged 50-75 years, healthy and (mostly) active retired, taking holidays and short breaks to relax and enjoy life and the freedom of retirement; from affluent regions with ageing populations including most developed countries; seasoned and vocal consumers of products and services, who will have travelled extensively in their younger days; seeking holidays with a specific focus, e.g. travelling to see friends and relatives abroad, wellbeing/medical tourism, learning/cultural holidays and ethical voyages; many of them single through relationship breakdown and bereavement; By 2020, many senior travellers may be from the emerging BRIC markets; time and money to travel and doing so frequently; having a number of specific travel needs associated with ageing
	(b) Global clans	People travelling internationally (due to globalisation and migration causing scattered families), either alone or in family groups to visit family and friends for holidays which enable them to be together and re-connect; associated with regions with large immigrant populations; travel is likely to coincide with key dates such as national holidays and festivals; Travel will be increasingly booked online; price sensitive; focus for travel is family reunion rather than 'a holiday experience'; focused on groups
	(c) Cosmopolitan commuters	Living and working in different regions, taking advantage of falling travel costs and flexible work styles to give them greater quality of life; will commute short-haul distances to work on a weekly or fortnightly basis; freelance consultants or employees with flexible work contracts predominantly in their 20s, 30s and 40s; knowledge workers; others with a desire to progress in their career will take advantage of the rising numbers of short-term international placements; dependent on lower travel costs; will travel at peak times during the week; travel is likely to be frequent and block booked in advance for cost saving; key needs: time efficiency, flexibility; will need to be able to work on the go
	(d) Global executives	Senior executives making short and long-haul journeys abroad on business, travelling in premium or business class and by air-taxi or private jet; either travel alone, with an entourage, or with a partner, perhaps combining a business and leisure trip; typically originate from developed markets around the globe, but by 2020, growing numbers from the BRIC countries; will not be price sensitive and they will not manage their own travel booking; trips will be a combination of long-haul and short-haul; key needs: time efficiency, flexibility; used to premium, luxury experiences; need to have access to wide range of technology
7	(a) Young travellers	18-30 years of age; singles/couples; low income; priority: cost-efficiency
	(b) LOHAS	Lifestyle of health and sustainability; 30-55 years of age; singles/couples; upper middle and higher income; priority: sustainability
	(c) Modern exclusives	>45 years of age; singles/couples; majority upper middle and middle income class; appreciate everything trendy and prefer a certain kind of exclusiveness

#	Passenger group/ cluster	Description
	(d) Family travellers	30-50 years of age; one or more children; majority upper middle and middle income class; priorities: cost-efficiency, predictability
	(e) Holiday package bookers	30-70 years of age; singles/couples; majority with income below average (lower middle and low income); priority: cost-efficiency
	(f) Senior travellers	>65 years of age; one, two or three travellers; middle class and upper middle class; priorities: Main priorities: culturally interested, social responsibility, monetary and environmentally conscious
	(g) Business travellers in not-leading position	20-65 years of age (active working phase); priorities: time efficiency, cost-efficiency, open-mindedness
	(h) Business travellers in leading position	>50 years of age; priorities: status, luxury, individualisation, time efficiency, flexibility
8	(a) Trendy business women	Single traveller; young adult; regular trips using aircraft, familiar with processes; transport A-B; highly time-sensitive; less price-sensitive; quality seeking; environmentally concerned; early adopters; departure location in the city; arrival location in the city
	(b) Conservative male business traveller	Single traveller; middle age adult; frequent traveller, familiar with processes; transport A-B; highly time-sensitive; non price-sensitive; high quality seeking; less environmentally concerned; mostly early adopters; departure location: inner city or close to the airport; arrival location in the city
	(c) Party animals	Mixed teenager group travel; leisure travel, part of the event; travel frequency: sometimes, quite familiar with processes; highly price-sensitive; less time-sensitive; less quality seeking; less environmentally concerned; early adopters; departure location: outer city (not close to the airport or city w/o airport); arrival location: city centre
	(d) Holidays with family	Family with child(ren); leisure travel, part of the event; travel frequency: sometimes, quite familiar with processes; need some assistance; highly price-sensitive; less time-sensitive; quite quality seeking; less environmentally concerned; very late adopters; departure location: city w/o airport; arrival location: city w/o airport
	(e) Student traveller	Mainly single traveller; transport A-B; travel frequency: sometimes, quite familiar with processes; no assistance required; highly price-sensitive; less time-sensitive; less quality seeking; quite environmentally concerned; early adopters, departure location: outer city area; arrival location: outer city area
	(f) Travelling worker	Mainly single traveller; transport A-B; travel frequency: sometimes, quite familiar with processes; no assistance required; highly price-sensitive; less time-sensitive; less quality seeking; less environmentally concerned; non-adopters; departure location: city w/o airport; arrival location: outer city area
	(g) Grandparents visiting family	Leisure travel, part of the event; seldom trips, not familiar with processes; reduced but w/o assistance; time-sensitive; less price-sensitive; quality seeking; less environmentally concerned; non-adopters; departure location: countryside; arrival location: countryside

Table 12: Assignment of predefined characteristics to existing passenger clusters

	Passenger type	Age	Family status	Income	Education	Travel purpose	Frequency of travel	Season of trip	Duration of trip (days)	Booking/Information gathering	Accommodation	Travel expenditure	Expected comfort level	Technological affinity	Experience sought
1	a	18-30												3	
2	a	25-64				3	3		3-5	1		2	2	2	
3	a	20-35				1				1				3	
4	a			3		1	2			2	1		2,3		1
	b				3	1				2	2,3	1	1		2
	c					1									4
	d		1	3		1				2	1	3	3		
	e					2	3	1,2,3,4			1		2		2
	f					1							1		
5	a	18-30		1		1		1,4	< 7	1	2,3		1	3	3
	b	30-44		2		1		2	14	1			2	2	1
	c	> 60		2		1		3	8-14	2			3	1	1
	d	> 45		3		1		4	> 7	2			3	2	2
	e	> 60		3		1		3,4	> 14	2			3	1	2
6	a	50-75		2		1	3						2		
	b					1	2					1	1		
	c	25-45		3		1	4					1			
	d			3		2	3						3		
7	a	18-30	1,2	1						1					
	b	30-55	1,2	2											
	c	> 45	1,2	2											
	d	30-50	4	2						1					
	e	30-70	1,2	1											
	f	> 65	3	2						2				1	
	g	20-65				2							2		
	h	> 50		3		2							3		
8	a	18-30		3	3	2	3	1,2,3,4,		2	1		3	3	
	a	30-55		3	3	2	4	1,2,3,4		2	1		3	2	
	b	15-25		1	2	1	2			1	2,3,4	1	1	3	
	c	0-45	4	2		1	1						2	2	
	d	18-30		1	2	1	2			1	2,3,4	1	1	3	
	e	18-35		2	3	2	2	1,2,3,4		2	1,2	1	1	1	
	f	60+	2	2	2	1	1	1,2,3,4			4	2	3	1	

Table 13: Classification of different factors outlined in Table 10

Factor	1	2	3	4	5	6
Age	see table					
Family status	single	couple	>2 persons	with children		
Income	low	medium	high			
Education	primary	secondary	tertiary			
Travel purpose	private	business	bleisure			
Frequency of travel	seldom	occasionally	frequently	very frequently		
Season of trip	spring	summer	autumn	winter		
Duration of trip (days)	see table					
Booking/ information gathering	online	outsourced (travel agency)				
Accommodation	hotel	hostel	couchsurfing	family/ friends	apartment	other
Travel expenditure	low	medium	high			
Expected comfort level	low	medium	premium			
Technological affinity	low	medium	high			
Experience sought	relax/ wellness	culture and knowledge	fun and action	acknowledgement		

7 REFERENCES

- Alsnih, R. and Hensher, D.A., 2003, The mobility and accessibility expectations of seniors in an aging population, *Transportation Research Part A: Policy and Practice*, 37(10), 903-916.
- Berdowski, Z., van der Broek-Serlé, F.N., Jetten, J.T., Kawabata, Y., Schoemaker, J.T. and Versteegh R., 2009, Survey on standard weights of passengers and baggage, accessed on 28.06.2016, <http://www.easa.europa.eu/system/files/dfu/Weight%20Survey%20R20090095%20Final.pdf>
- Böhler, S., Grischkat, S., Haustein, S. and Hunecke, M., 2006. Encouraging environmentally sustainable holiday travel. *Transportation Research Part A: Policy and Practice*, 40(8), 652-670.
- Boksberger, P.E., Bieger, T. and Laesser, C., 2007, Multidimensional analysis of perceived risk in commercial air travel, *Journal of Air Transport Management*, 13(2), 90-96.
- Boston Consulting Group, 2006, Understanding the demand for air travel: How to compete more effectively, accessed on 28.06.2016, <https://www.bcg.com/documents/file14820.pdf>.
- Boston Consulting Group, 2013, Data privacy by numbers, accessed on 28.06.2016, https://www.bcgperspectives.com/content/slideshow/information_technology_strategy_digital_economy_data_privacy_by_the_numbers#ad-image-2.
- Brouwer, R., Brander, L. and Van Beukering, P., 2008, "A convenient truth": air travel passengers' willingness to pay to offset their CO₂ emissions, *Climatic Change*, 90(3), 299-313.
- BusinessWire, 2016, HolidayIQ Insights: What Women Want, BusinessWireIndia, accessed on 30.06.2016, <http://businesswireindia.com/news/news-details/holidayiq-insights-what-women-want/47701>.
- CAPA, 2014, Air travel rises with a country's wealth. Law of nature, or can government policy make a difference?, accessed on 28.06.2016, <http://centreforaviation.com/analysis/air-travel-rises-with-a-countrys-wealth-law-of-nature-or-can-government-policy-make-a-difference-170674>.
- Castillo-Manzano, J.I. and López-Valpuesta, L., 2013, Check-in services and passenger behaviour: Self service technologies in airport systems, *Computers in Human Behavior*, 29(6), 2431-2437.
- Chang, Y.C., 2013. Factors affecting airport access mode choice for elderly air passengers. *Transportation research part E: logistics and transportation review*, 57, 105-112.
- Cohen, S.A. and Higham, J.E., 2011, Eyes wide shut? UK consumer perceptions on aviation climate impacts and travel decisions to New Zealand, *Current Issues in Tourism*, 14(4), 323-335.
- Departement for International Development, 2002, The Value of Time in Least Developed Countries, Knowledge and Research (KaR) 2000/01 DFID Research No. R7785, Final Report, July 2002.

- DORA Project, 2016, Door to door information for air passengers: User groups and mobility profiles (D2.2), accessed on 28.06.2016, <https://bscw.dora-project.eu/pub/bscw.cgi/d13884/D2-2-DORA-v1-1.pdf>.
- Eijgelaar, E., 2009, Voluntary carbon offsets a solution for reducing tourism emissions? Assessment of communication aspects and mitigation potential, *Transport and Tourism: Challenges, Issues and Conflicts*, 46-64.
- EUROCONTROL (2015), Standard Inputs for EUROCONTROL Cost Benefit Analysis (Edition Number: 7.0, November 2015), accessed on 28.06.2016, <https://www.eurocontrol.int/sites/default/files/publication/files/standard-input-for-eurocontrol-cost-benefit-analyses-2015.pdf>.
- Eurostat, 2014a, Database, Population [t_demo_pop], accessed on 05.07.2016, <http://ec.europa.eu/eurostat/de/data/database>.
- Eurostat, 2014b, Database, Tourism [tour], accessed on 05.07.2016, <http://ec.europa.eu/eurostat/de/data/database>.
- Eurostat, 2014c, Database, Annual national accounts [nama_10], accessed on 05.07.2016, <http://ec.europa.eu/eurostat/de/data/database>.
- Eurostat, 2014d, Database, Income and living conditions [ilc], accessed on 05.07.2016, <http://ec.europa.eu/eurostat/de/data/database>.
- Eurostat, 2014e, Database, Education and training [iedtr], accessed on 05.07.2016, <http://ec.europa.eu/eurostat/de/data/database>.
- Eurostat, 2014f, Database, Level of internet access [tin00134], accessed on 05.07.2016, <http://ec.europa.eu/eurostat/de/data/database>.
- Plötner, K. O. and Schmidt, M., 2014, FASCINATIONS2050 project. Final report.
- Future Foundation, 2015, Future traveller tribes 2030: Understanding tomorrow's traveler, accessed on 28.06.2016, <http://www.amadeus.com/documents/future-traveller-tribes-2030/travel-report-future-traveller-tribes-2030.pdf>.
- Garrow, L.A., Jones, S.P. and Parker, R.A., 2007, How much airline customers are willing to pay: An analysis of price-sensitivity in online distribution channels, *Journal of Revenue and Pricing Management*, 5(4), 271-290.
- GfK Mobilitätsmonitor (2011), Airport Private Traveller Study: Reiseverhalten, Einstellungen und Werte der Privatreisenden am Airport, accessed on 28.06.2016, http://www.munich-airport.de/media/download/bereiche/mediacenter/extras/deutsch/Airport_Private_Travelle_r_Study.pdf.
- Gilbert, D. and Wong, R.K., 2003, Passenger expectations and airline services: a Hong Kong based study, *Tourism Management*, 24(5), 519-532.

- Global Business Travel Association, 2011, The business traveler of today: New study profiles corporate travelers and their needs while in transit, accessed on 23.06.2016, <http://www.gbta.org/foundation/pressreleases/Pages/rls072611.aspx>.
- Gössling, S., Haglund, L., Kallgren, H., Revahl, M. and Hultman, J., 2009, Swedish air travellers and voluntary carbon offsets: towards the co-creation of environmental value?, *Current Issues in Tourism*, 12(1), 1-19.
- Hares, A., Dickinson, J. and Wilkes, K., 2009, Climate change and the air travel decisions of UK tourists. *Journal of Transport Geography*, 18(3), 466-473.
- Hess, S., & Polak, J. W. (2005). Mixed logit modelling of airport choice in multi-airport regions. *Journal of Air Transport Management*, 11(2), 59-68.
- Henley Centre HeadlightVision, 2007, Future traveller tribes 2020: Report for the air travel industry, accessed on 28.06.2016, <http://www.amadeus.com/documents/future-traveller-tribes-2030/travel-report-future-traveller-tribes-2020.pdf>.
- I.T. Transport, 2002, The value of time in least developed countries, accessed on 28.06.2016, <http://r4d.dfid.gov.uk/pdf/outputs/R7785.pdf>.
- IATA, 2008, Air Travel Demand, IATA Economics Briefing No. 9, IATA, April 2008.
- IATA, 2015a, IATA Global Passenger Survey: 2015 Survey Highlights, accessed on 23.06.2016, <http://www.iata.org/publications/Pages/global-passenger-survey.aspx>.
- IATA, 2015b, Passengers like self-service options and SMS flight updates, IATA's Global Passenger Survey says, Press release, accessed on 23.06.2016, <http://airlines.iata.org/agenda/passengers-like-self-service-options-and-sms-flight-updates-iata%E2%80%99s-global-passenger-Survey>.
- International Student Travel Confederation together with the Association of Tourism and Leisure Education, 2003, Today's Youth Traveller: Tomorrow's Global Nomads, accessed on 30.06.2016, http://www.atlas-euro.org/pages/pdf/FINAL_Industry_Report.pdf.
- Kalter, M.-J., Harms, L. and Jorritsma, P., 2011, Changing travel patterns of women in the Netherlands, *Transportation Research Board Conference Proceedings*, 2(46), 179- 190.
- Mackie, P.J., Wardman, M., Fowkes, A.S., Whelan, G., Nellthorp, J. and Bates, J., 2003, Values of Travel Time Savings UK, accessed on 23.06.2016, http://eprints.whiterose.ac.uk/2079/2/Value_of_travel_time_savings_in_the_UK_protected.pdf
- Mair, J., 2011, Exploring air travellers' voluntary carbon-offsetting behavior, *Journal of Sustainable Tourism*, 19(2), 215-230.
- Mandle, P., Mansel, D. and Coogan, M., 2000. Use of public transportation by airport passengers. *Transportation Research Record: Journal of the Transportation Research Board*, (1703), 83-89.

- McCarthy (2001), *Transportation Economics*, Wiley-Blackwell, Hoboken.
- McGuckin, N. and Murakami, E., 1995, Examining trip-chaining behavior: A comparison of travel by men and women, accessed on 28.06.2016, <http://nhts.ornl.gov/1995/Doc/Chain2.pdf>.
- Möller, C., Weiermair, C. and Wintersberger E., 2007, The changing travel behaviour of Austria's ageing population and its impact on tourism, *Tourism Review*, 62(3/4), 15-20.
- OAG, 2014a, Official Airline Guide Schedules Data, 2014.
- OAG, 2014b, OAG Trends Report: What is shaping air travel in 2015?, accessed 28.06.2016, <http://www.oag.com/oag-trends-report-2015>.
- Pels, E., Nijkamp, P. and Rietveld P., 2003, Access to and competition between airports: A case study for the San Francisco Bay area, *Transportation Research Part A: Policy and Practice*, 37(1), 71-83.
- Proussaloglou, K. and Koppelman, F.S., 1999, The choice of air carrier, flight, and fare class, *Journal of Air Transport Management*, 5(4), 193-201.
- Ringle, C.M., Sarstedt, M. and Zimmermann, L., 2011, Customer satisfaction with commercial airlines: The role of perceived safety and purpose of travel, *Journal of Marketing Theory and Practice*, 19(4), 459-472.
- Sakai, M., Brown, J. and Mak, J., 2000, Population aging and Japanese international travel in the 21st century, *Journal of Travel Research*, 38(3), February 2000, pp. 212-220.
- SITA, 2015a, Air transport industry insights: The baggage report, accessed on 28.06.2016, <http://ru.sita.aero/wp-content/uploads/2015/03/Baggage%20Report%202015.pdf>.
- SITA, 2015b, Air transport industry Insights: The future is personal, accessed on 28.06.2016, <http://www.missionline.it/wp-content/uploads/2015/08/360-report-the-future-is-personal-2015.pdf>.
- SITA 2016, Air transport industry insights: The passenger IT trends survey, accessed on 28.06.2016, <https://www.sita.aero/globalassets/docs/surveys--reports/passenger-it-trends-survey-2016.pdf>.
- Skift, 2015, Megatrends defining travel in 2015, accessed on 28.06.2016, <https://trends.skift.com/yearbook/the-megatrends-defining-travel-in-2015-2>.
- Smyth, M. and Pearce, B., 2008, Air Travel Demand, IATA Economics Briefing No. 9, accessed on 28.06.2016, https://www.iata.org/whatwedo/Documents/economics/air_travel_demand.pdf.
- Tsamboulas, D.A. and Nikoleris, A., 2008, Passengers' willingness to pay for airport ground access time savings, *Transportation Research Part A: Policy and Practice*, 42(10), 1274-1282.
- United Nations, 2015, Population Division – Population of Urban Agglomerations with 300,000 Inhabitants or More in 2014, by Country, 1950-2030, File 12.

- Victoria Transport Policy Institute, 2009, Transportation cost and benefit analysis: Techniques, estimates and implications, accessed on 28.06.2016, <http://www.vtpi.org/tca>.
- World Tourism Organization, 2016, Affiliate Members Global Reports, Volume thirteen – The Power of Youth Travel, UNWTO, Madrid.
- Walker, J.L. and Parker, R.A., 2006, Estimating utility of time-of-day demand for airline schedules using mixed logit model, in: Transportation Research Board 85th Annual Meeting Compendium of Papers.
- World Bank, 2014, Doing business: Economy rankings, accessed on 05.07.2016, <http://www.doingbusiness.org/rankings>
- World Bank, 2016, World DataBank: World development indicators, accessed on 05.07.2016, <http://databank.worldbank.org/data/reports.aspx?source=2&Topic=16>
- World Economic Forum, 2014, Smart travel: Unlocking economic growth and development through travel facilitation, accessed on 27.06.2016, <https://www.weforum.org/reports/smart-travel-unlocking-economic-growth-and-development-through-travel-facilitation>.
- World Economic Forum, 2016, Digital media and society: Implications in a hyperconnected era, accessed on 24.06.2016, http://www3.weforum.org/docs/WEFUSA_DigitalMediaAndSociety_Report2016.pdf.
- Zamparini, L. and A. Reggiani, 2007, Meta-analysis and the value of travel time savings: A transatlantic perspective in passenger transport, *Networks and Spatial Economics*, 7, 377-396.

8 LIST OF FIGURES

Figure 1: Factors influencing passenger demand for mobility (own depiction)	5
Figure 2: Population in EU28 and EFTA countries by age group (data: Eurostat, 2014a)	6
Figure 3: Accumulated distribution of different age groups (data: Eurostat, 2014a)	7
Figure 4: Travel activity of different age groups (data: Eurostat, 2014b)	8
Figure 5: Share of female and male travellers (data: Eurostat, 2014b)	10
Figure 6: Correlation urbanization and GDP per capita (data: Eurostat, 2014c; World Bank, 2016)	12
Figure 7: Population density by NUTS 2 region (data: Eurostat, 2014a)	13
Figure 8: Urban agglomerations across European countries (data: World Bank, 2015)	14
Figure 9: GDP per capita and ease of doing business index (data: Eurostat, 2014c; World Bank, 2014)	15
Figure 10: Household size across different European countries (data: Eurostat, 2014d)	17
Figure 11: Income distribution across different household types (data: Eurostat, 2014d)	18
Figure 12: Educational attainment level by country (data: Eurostat, 2014e)	19
Figure 13: Frequency of internet access (data: Eurostat, 2014f)	21
Figure 14: Passengers' usage of self-technology during travel (data: SITA, 2016)	23
Figure 15: Privacy issues across different age groups in the US (data: BCG, 2013)	26
Figure 16: Trips per capita (all modes) and nights spent per capita (data: Eurostat, 2014b)	28
Figure 17: Distribution of domestic and outbound trips (data: Eurostat, 2014b)	29
Figure 18: Nights spent in tourist accommodations (NUTS2, data: Eurostat, 2013)	30
Figure 19: Average expenditure per trip by country (data: Eurostat, 2014b)	31
Figure 20: Prevalence of air travel in different European countries (data: Eurostat, 2014b)	32
Figure 21: Supplied national and intra-EU airline seats by country (data: OAG, 2014a)	33
Figure 22: Correlation GDP per capita and air trips per capita (data: Eurostat, 2014b/2014c)	34
Figure 23: Distance distribution of European flights (weighted by movements/seats, data: OAG, 2014a)	35
Figure 24: Air traffic flows between specific airport pairs within Europe (data: OAG, 2014a)	36
Figure 25: Top three air traffic flows for EU28 and EFTA countries (data: OAG, 2014a)	39
Figure 26: Parameters influencing the value of travel time (own depiction)	41
Figure 27: Passenger cluster – age and travel purpose (own depiction)	45
Figure 28: Stage length distribution European domestic business traffic (data: OAG, 2014a)	50
Figure 29: EU-bound business trips and air travel activity by country (data: Eurostat, 2014)	51
Figure 30: Stage length distribution intra-European business traffic (data: OAG, 2014a)	52
Figure 31: DATASET2050 passenger profiles	55

9 LIST OF TABLES

Table 1: Countries included in the DATASET2050 analysis	4
Table 2: Digital media consumption levels (World Economic Forum, 2016)	22
Table 3: Weight differences in passenger luggage (data: Berdowski et al., 2009)	40
Table 4: Definition of value of time and elasticities of demand (data: McCarthy, 2001)	41
Table 5: Outline of different value of time studies	42
Table 6: Overview price elasticities of (air travel) demand (data: IATA, 2008)	43
Table 7: Passenger profiles within DATASET2050	46
Table 8: Archetype journeys for business travellers	53
Table 9: Archetype journeys for private travellers	54
Table 10: Matching passenger profiles with journey archetypes	56
Table 11: Short description of existing studies on different passenger profiles	59
Table 12: Assignment of predefined characteristics to existing passenger clusters	62
Table 13: Classification of different factors outlined in Table 10	63