Environmental Impacts of Business Trips

A data analysis of business travel in Germany

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Summary

Business travel represents a major part of the travel which takes place all over the world. According to the WTO (World Trade Organisation) around 30 per cent of international trips are for business and it shows no sign of decreasing.

Business travel, however, has not received the same importance which has been addressed to leisure travel. Nevertheless, it should be highly considered because of the strong impact it has on the environment. Most of the emissions released by business travel are caused by the "long-distance" trips, which differently from the "short-distance" trips are less frequent, but stretch themselves over a longer period of time and cover a higher distance. As Li et al. (2022) reported, long-distance (LD) travel causes important energy and greenhouse emissions (GHG). Air travel particularly contributes to a significant share of emissions, which (apart from during the period of pandemic) increased almost everywhere in the world.

Given the environmental impacts of business trips on a large scale, it is important to analyse the causes of this phenomenon and its upcoming trend. One aim of the thesis is therefore to provide – thanks to a literature review – a wide range of information related to the business travel phenomenon with the help of scientific articles. A data analysis of the "MiD 2017– Mobilität in Deutschland" survey will fill the gap in the literature providing a deep examination of the phenomenon in Germany. The analysis will reveal the difference between short-distance and long-distance business trips with particular focus on demographic (age, income, employment) and situational variables (distance, means of transport). The results obtained by the analysis will mostly be coherent with the literature considered in the previous part. Indeed, it will emerge that business travellers mostly have a high salary, are in the mid working age and favour the use of car to cover the distance of their trips.

In order to estimate the environmental impacts of business travel in Germany, there will be a calculation of the emissions caused by long-distance trips for the different transport modes. It will emerge that car and plane released the greatest part of emissions, which in total amounted to 793 tons of CO_2. Nevertheless, these emissions will only represent a small percentage of the total emissions caused by the transport sector in Germany.

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1 Introduction

Business travel refers to journeys taken for work purposes which do not include daily commutes (trips from home to the workplace are excluded) and leisure trips.

As mentioned earlier, business travel is increasing almost all over the world and there are many reasons for this (Faulconbridge et al. 2009). Firstly, the economic growth between 1950 and 2000, globalisation and development in transport drove to an increasing demand for business travel. (Swarbrooke 2012). Aguilera (2008) explained that the globalisation of multifacility companies and an increase in partnerships and professional events are one of the main causes for this upcoming trend.

Business trips are indeed planned to exchange information, gain professional networks, and to conduct deals. It mainly consists of visiting business sites and meeting other people to undertake business activities. (Kulendran, N. e Wilson, Kenneth 2000). Frequent long-distance travellers are usually high educated, have a high income and an important position in their company (Snepenger e Milner 1990). Moreover, as introduced earlier, long-distance business travel is responsible for a high rate of emissions. Frequent travellers (especially the ones travelling by plane) release a huge amount of greenhouse gases into the atmosphere, causing severe environmental issues.

Another important aspect to consider regarding business travel is the comparison with touristic travel since business travel is almost driven by economic reasons. It is also more stable than vacation travel, as tourism demand is often seasonal and its destinations change repeatedly (Snepenger e Milner 1990). Secondly, the business traveller has no choice whether to go or not on a business trip, since it is a need for the company, while vacation travellers are more flexible in choosing time and location of the journey.

The aim of the bachelor's thesis is a deep analysis and understanding of business travel in Germany. Goal of the work is to receive a detailed overview of who goes on business trips and which characteristics (as income, age, employment) do the travellers have. The main source for the analysis is represented by MiD 2017 (Mobilität in Deutschland), a survey conducted between 2016 and 2017 which takes into consideration the number of trips made by more than 150,000 households from every region of Germany.

At first, a literature review will provide relevant information about different aspects of the business travel phenomenon from different scientific articles identifying the possible gaps in the literature. Further on, the second chapter will deal with the analysis of the MiD data set with particular focus on the distinction between the short and long-distance trips (two separate data sets from the MiD). The analysis will initially consider individual variables influencing business trips; after that a bi-variate analysis will relate different pairs of variables to examine the phenomenon more in detail. Furthermore, there will be a calculation of the emissions caused by the long-distance travellers for the different transportation modes (plane, car, rail, bus) and an estimation of the share of the emissions in relation to the total emissions in the transportation

field. Lastly, a conclusion of the thesis will be drawn together with the limitations of the work and some proposals of future research in the business travel field.

2 Literature review

The literature review will consider some scientific articles providing information from different case studies and analysing various aspects related to business travel.

As motivation for the thesis an article about the reduction of the emissions caused by business travel will be taken into consideration. Li et al. (2022) analysed the impacts of Long-Distance (LD) travel in terms of greenhouse emissions thanks to a survey made in Austin in 2019 which collected 2327 LD trips made by 929 respondents. 490 trips in this data set were business related. The article provided the concept that trips for tourism/leisure and business purposes are essential to understand long-distance travel: they reported that in 2015 business travel in the U.S.A accounted for around 30% of the total U.S. travel.

The goal of the article was to provide some solutions for reducing the high environmental impact and costs of LD business travel. There are actually various opportunities to replace business trips since they mainly consist of exchanging information and conducting deals. For example, video-conferencing technologies and remote participation can connect people at a long distance without actual travel, allowing an effective communication from any side of the world and without time delay (Julsrud et al. 2012). The application of new technologies including connected and self-driving cars and a dynamic ridesharing can also reduce the energy and emissions impacts of LD trips (LaMondia et al. 2016). Nevertheless, the survey conducted reported that even if there were possibilities for replacing business travel only around 30% of the participants were willing to substitute it for remote participation.

This statement motivated further data analysis for better understanding who long-distance travellers were and why they travelled, and this will represent the core of the thesis. The 593 respondents who had undertaken LD travel were selected and a negative binomial model was used to predict the number of business and non-business trips per year. The article mentioned that the most significant variable influencing the probability to making more business trips was the annual household income, with around 3.28 trips per year for those having an income above 200,000$ a year. Age and sex also played an important role since men between 35 and 44 years tended to do more business trips; in addition, a higher education (e.g., by holding a PhD degree) resulted in more probability of going on a trip. Having someone at home who needs to be taken of or who is over 16 years of age but cannot drive tended to make less business trips; lastly, people from more densely populated regions went more likely on a business trip.

In conclusion, the article showed that there was actually a huge potential for remote participation and a significant reduction of GHG emissions; however, only a small part of the participants was

willing to change their habitudes. Lastly, the key aspect of the article was to understand the business traveller conditions and the factors which influence the travel experience.

These aspects were analysed by another article which specifically examined demographic variables and situational variables taking into consideration the responses from 749 business travellers to Alaska. The purpose of the article was to identify factors which could influence the business travel experience. An important highlighted aspect was the role of variables such as the pre-trip planning variable, the on-location variable, and a post trip evaluation measure. The aim of these variables was to value the business trip experience by giving the time spent planning the trip, the overall length of stay and with a generic valuation of it.

Important for the research was to classify the demographical and situational variables characterizing business travellers' behaviour and how they were related to the three cited stages of the travel experience. Demographics provided a biographical representation of the business traveller and can be seen as independent variables easy to identify and measure (Snepenger e Milner 1990). In contrast, situational variables explain in which physical and temporal situations the business travellers find themselves (Snepenger e Milner 1990). The demographic variables such as age, gender, education, marital status, occupation, and annual household income indicated that most of the respondents were between 25 and 44, male (88%), graduated from college (66%) and employed with medium/high income rate. The four situational variables were the business activity (representing whether the traveller came for work purposes or business meetings or conversation), the trip purpose (did the traveller come strictly for business or also for pleasure?), previous visitor (indicating whether the representant already came to the destination or not), and the travel agent (so if the visitor used a travel agent or not).

The goal of the research was to find correlations (thanks to a multiple regression analysis) between the demographical-situational variables with the pre-trip, on-location and post-trip behaviours and attitudes. An issue of the analysis was related to the high correlation between independent variables. The article reported that on the one side only the factor age among the demographics influenced the planning time with older representants planning a shorter stay.

On the other side, situational variables such as business activity and trip purpose influenced the planning time, as travellers coming only for work and who combined business with pleasure needed more time to plan the trip. The length of stay was influenced by both demographic and situational variables with older, professional, college graduates and married people who came up only for business tending to have a shorter stay. In contrast, those travellers staying longer were often younger, non-professional, noncollege graduates, single and not relied on a travel agent. Moreover, the results revealed that the evaluation of the trip was not influenced by any of the overcited factors; a curious fact was that the travellers who combined business and pleasure showed a higher trip rating.

In conclusion, the article by Snepenger e Milner (1990) gave a wide overview of the most important factors influencing the business trip experience in Alaska. Nevertheless, the article mentioned that future research (the article was dated in 1990) should also focus on other types of

variables such as season of the year, time of the week, or people accompanying the business traveller. Moreover, the quantity of benefits from the business experience could be researched but this would require more data from the travellers and the employers.

Most studies on business travel do not explicitly consider geographical aspects of the trips. The distance between the business traveller's living place and the business location is an important factor because it influences the costs the company must pay for the trip and the willingness of the business traveller to undertake it. It is a relevant parameter to determine the number and location of sites which are accessible within a certain time (Aguilera, 2008). This article focused on the willingness of the French workers to travel for business purposes and analysed mainly two parameters: the individual's socio-occupational group and the workplace location. The data used came from the 2008 French National Transport and Travel Survey. Only long-distance business trips of many days above 80 km (both national and international) were considered and were treated with a Poisson regression.

It was confirmed again that income particularly influences mobility, as long-distance travellers' income is normally higher than the average (Mallett, 1999). Another important factor is the age, influenced by the level of professional responsibility, which normally rises over time for executives. Researchers suggested that the need for business travel, particularly long-distance travel, is generally higher at the end of a person's career, but it can also be significant in the middle (Davison e Ryley, 2013). For this statement there may be two reasons: firstly, young executives have fewer family responsibilities and therefore are more willing to travel, and secondly, elder executives try to avoid travel because of the stress situations it causes (Gustafson 2012) and therefore choose to assign some of their trips to younger colleagues (Aguilera 2008).

As shown in previous research, the model confirmed that income was highly significant since a raising salary resulted in more frequent business travel. Oppositely to the income, the relation between age and business travel was not confirmed: the model showed that that workers aged between 30 and 39 were more mobile than workers aged 50-59, confirming that in the end of the career people tried to reduce the load of travel (Jeong et al. 2013).

When considering the workplace location, it emerged that the trip frequency was lower in the Parisian urban area than in all other locations. This occurred because Paris still represents the most important urban centre in terms of employment, thus generating "short distance" trips inside the city. Except for Paris, business trip frequency in urban areas was higher than in rural areas with no difference between isolated and non-isolated urban areas. Another outcome was the correlation between the size of the urban area (except for Paris) and business travel demand, since trip frequency in small-middle cities was smaller than in cities with over 200,000 inhabitants.

As explained in the introduction, business travel demand is driven by economic reasons. A study aimed to identify the economic variables that influence business trips in Australia using a standard demand modelling. Kulendran, Nada e Wilson, Kenneth (2000) identified the existence of a "casual" relationship between trade and international travel by examining business trips in Australia. Robert Cleverdon. The Economist Intelligence Unit, 40 Duke Street, London W1M 5DG,

United Kingdom (1985) considered several economic variables: for instance, the growth of the economy of the origin country influences positively the level of business travel. Countries with more open markets and greater real income will provide greater opportunities for international travel. Another factor is the demonstrated success of former business travellers since many of them were likely to travel to Australia to seek market opportunities to sell products to the Australians. The relative price between two countries also plays a key role in the study, although costs of business travel are normally paid by the firm. Nevertheless, if the destination country starts to become more expensive, firms would try to find alternatives to business travel such as the already mentioned information and communication technologies. Holiday travellers could also influence positively business travel, as they could see business opportunities and encourage or be encouraged to undertake a business trip. In conclusion, the study stated that little attention was devoted to investigating business travel and that further research is required to confirm the relationship between international trade and business travel.

Business travel has the characteristic that the trip mode choice is often not a matter of the business traveller, but of the employer and his company. An article by R J Balcombe, I O York and D C Webster (2003) aims to better understand the reasons for mode choice for medium and long-distance journeys. The scope of the study was restricted to long-distance journeys in seven residential areas in Great Britain. The respondents had to answer to a first traveller survey where they revealed their journey pattern and to a second survey where they were designed to determine whether they would have chosen a better alternative transport.

The study collected 1651 long-distance single-destination trips (around 92 per cent by car and the rest as a combination of car and public transport and only public transport) and did not evidence a difference between the sexes in using public transport. On the other side, higher age and income revealed a higher propensity to use public transport. Comparing the different journey purposes showed that business and commuting trips were more likely to be made by public transport. The greater tendency to use public transport for business purposes was justified by the fact that costs are usually covered by the employer and not by the traveller himself. However, the article also reported that business travellers were more attracted by public transport only whether it was quicker than the alternatives. Around the half of the respondents doing long-distance journeys had a public transport option and more of the half of them preferred rail over the bus. Nevertheless, this preference was uncertain because it was affected by the availability of public transport in the area.

Another research from the National Travel Survey dataset (NTS) for Great Britain wanted to analyse the influence of different socio-economic and accessibility factors on trip rates, and whether these trips were stable over time Kaveh Jahanshahi, Ian Williams, Xu Hao (2009). The results confirmed once again the relative importance of demographic factors (i.e., age, gender, car ownership, household structure) influencing the individual decision for undertaking a trip. Moreover, it was found out that the current NTEM (National Trip End Model) model could be improved by including the socioeconomic class and individual income variables. An interesting

result was that individual income and socio-economic class were not highly intercorrelated and that the individual income played a more important role in the model.

One of the biggest issues of business travel studies deals with the collection of the data needed for a specific case study. Lu e Zhang (2015) developed machine learning methods for long-distance passenger travel with the help of passively collected LD trip dataset. The most recent sources of long-distance passenger travel information in the U.S. were the 1995 American Travel Survey (ATS) and the 2001 National Household Travel Surveys (NHTS). The first one collected detailed long-distance trip information (trips longer than 100 miles) from more than 80,000 households while the NHTS sampled approximately 60,000 households with around 45,000 trips longer than 50 miles.

Lu e Zhang (2015) reported that the relatively low frequency of long-distance travel for most households led to difficulties in efficient sampling methods. Lu e Zhang (2015) claimed that emerging technologies, including GPS, smartphones and social media could improve the accuracy of travel survey data. However, important trip information, such as trip purpose, travel mode, and travellers' characteristics could not be directly observed with passive data collection. The aim of the paper was therefore to impute trip purposes and missing information in passively collected long-distance data for LD trips.

All variables from the 1995 ATS were indeed divided into four categories: trip information that could be passively collected, trip information that could not be passively collected, traveller's characteristics and supplementary data. The three steps in the development of trip purpose imputation modes were the data processing, the machine learning, and the model validation. Different models were considered: for example, the four-purposes full model employed all available information and divided all trips into four purposes (leisure, social visit, business, personal business). The model accuracy rate rose when the considered variables decreased (business trip accuracy increased from 79% to 97,7% from the four variables to the two variables model – business and non-business–). Business trips showed higher classification accuracy than non-business trips in the two-purpose full model, but lower accuracy in three-purpose models.

In conclusion, the proposed machine learning methods showed a high accuracy (72-95 %) with various input data availability and with different purpose categories. The results from the paper suggested that in future passive data collection, additional information such as land use/economic data and traveller characteristics (for example by using located-based apps from the mobile phone) should also be collected to improve the trip purpose accuracy.

As a conclusion for the literature review, a perspective paper will be considered. It emerges again that it is difficult to define business trips (Swarbrooke 2012) and therefore the field remains an under-researched area. After some historical background to the phenomenon, the paper gave some prediction about how business travel will look like in the future. The world population will continue to rise, increasing the mobile workforce and the demand for business travel for generating wealth. By 2060, business travel will take place in mainly 20-30 urban networks, and international business travel will overtake domestic travel. There will be an increase of the cost of

business travel due to exploiting of resources, such as oil and water. Therefore, it will be essential to reduce the carbon footprint in the transportation sector and this will only be possible thanks to the technology innovation and more energy-efficient means of transport. High-efficiency rail, supersonic air travel, driverless vehicles as well as virtual meetings could help to move towards that direction.

In conclusion, the literature review considered some articles which reported different case studies and various aspects of the business travel phenomenon. Indeed, every case analysed in the review covered different research fields, took place in different times and locations, interviewed different people and so on. The following analysis will fill the literature gap by considering the business travel phenomenon in Germany in 2017.

The already cited "MiD" collected data to represent a high number of people in the German country. The result of the analysis will likely be very reliable and precise, since almost every category of the German population was represented in the survey. Differently from the other case studies, MiD did not only collect data about long-distance travellers, but also about short-distance business travellers going on a daily trip. This aspect allows to make a comparison between the more frequent SD trips and the more 'environmentally impacting' LD trips.

Moreover, not only demographic variables such as age, employment, income, but also situational variables (as means of transport, distance, day of the trip) were collected within the survey, resulting in a more detailed analysis.

Another important aspect to consider (differently from the other case studies) is that the MiD survey not only sampled business trips, but also "normal" trips taking place within the German country. This will allow the comparison between business and non-business trips: for example, the bi-variate analysis will present the age and income classes for business and non-business travellers.

The next chapter will firstly give an introduction of the MiD survey and after that the mentioned variables will be presented and evaluated.

3 Data analysis

3.1 Introduction MiD

As anticipated, one aim of the thesis is to gain a deep understanding of travel behaviour of business trips travellers in Germany. To achieve this goal, the source MiD 2017 (Mobilität in Deutschland) has been considered. The „Bundesministerium für Verkehr und digitale Infrastruktur" (BMVI) commissioned the „Institut für das angewandte Sozialwissenschaft GmbH" to conduct a third survey -after the ones in 2002 and 2008- together with 60 regional partners and the Institut für Verkehrsforschung am Deutschen Zentrum für Luft und Raumfahrt e.V. The survey was conducted for 12 months between May 2016 and September 2017 sampling 156.420 households (33.389 national and 123.031 at a regional level).

The goal of the data collection was to receive detailed information about the travel behaviour of the respondents including personal variables such as age, monthly salary, household members and so on. The survey mainly consisted of two phases: in the first one the respondents were asked about the composition of their households and about the ownership of cars or any other means of transport. The second one was an individual survey in which people were asked about their personals and their routes undertaken on a specific day. Differently from the previous MiD (in 2002 and 2008), the two phases (so the household and the path collection) were recorded by telephone, by a written formulary and with an online survey so that every respondent could choose among different options. The respondents were indeed reached through the post and the telephone network.

The data collection obtained six different data sets at different levels: the households, the people, the means of transport, the "short-distance" trips (Wege), the "long-distance" trips (Reisen) and their stages. Every data set contains determined attributes from the others: for example, the short-distance (SD) trip data set contains information about every person and household and vice versa. The short-distance trip data set (Wege) represents the trips made by a single person on a specific day with detailed information about the address of start and end of the trip, day and length of the trip, its purpose, which means of transport has been used and so on. On the other side, the long-distance trips data set sampled trips made over a longer period with more than one overnight stay. Variables such as distance covered, and number of overnight stays play a more important role for this data set. More specifically, the last three LD trips within the last three months and the last SD trip from the respondents were sampled.

An important aspect to consider is that the values of trips are weighted (so there is always an addition of a weighting factor, in German "Gewichtungsfaktor"), since for different reasons most of them are either overrated or underrated. So, for most of the graphs there will be the representation of the sample size and the weighted value, which is the more significant parameter to consider for the analysis.

The data collection specifically obtained a sample of 6235 long-distance and 19894 short-distance business trips: as mentioned earlier these will be a comparison of the two data sets according to different variables (demographic and situational variables).

The following chapter will deal with the data description of the two data sets, firstly giving the introduction of the most important variables which characterize short- and long-haul trips.

3.2 Data description

This chapter will provide a representation of the single variables which influence short-distance and long-distance trips. Firstly, there will be an introduction of some factors which characterize the two data sets.

Long-distance trips

Some interesting data about the destination and the overnight stays from the long-distance trip data set will be illustrated in the following graphs.

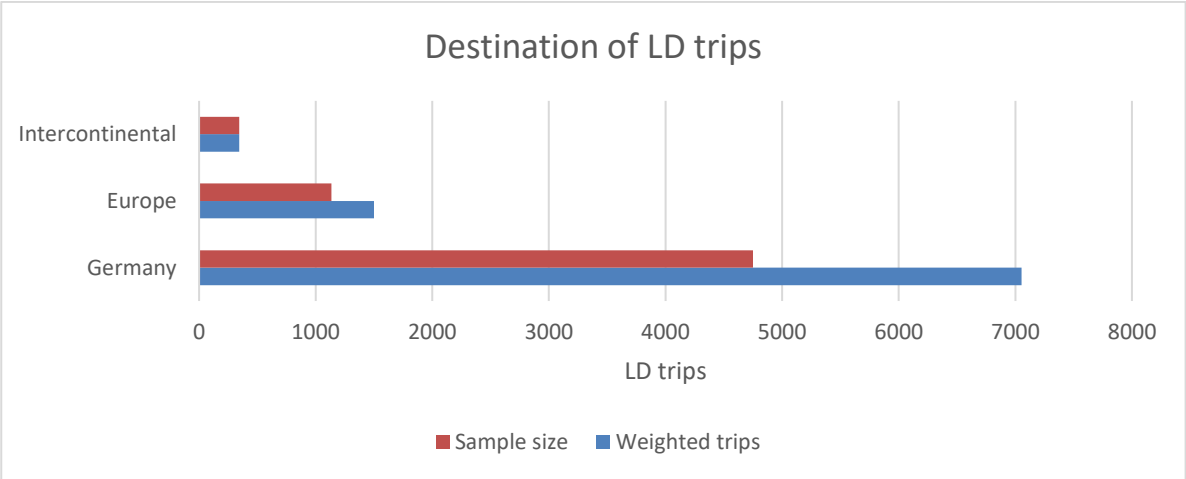

Figure 1: Destination of LD trips

As the graph indicates, a major part of long-distance trips took place in Germany. A smaller share of trips was undertaken in Europe and outside of the continent.

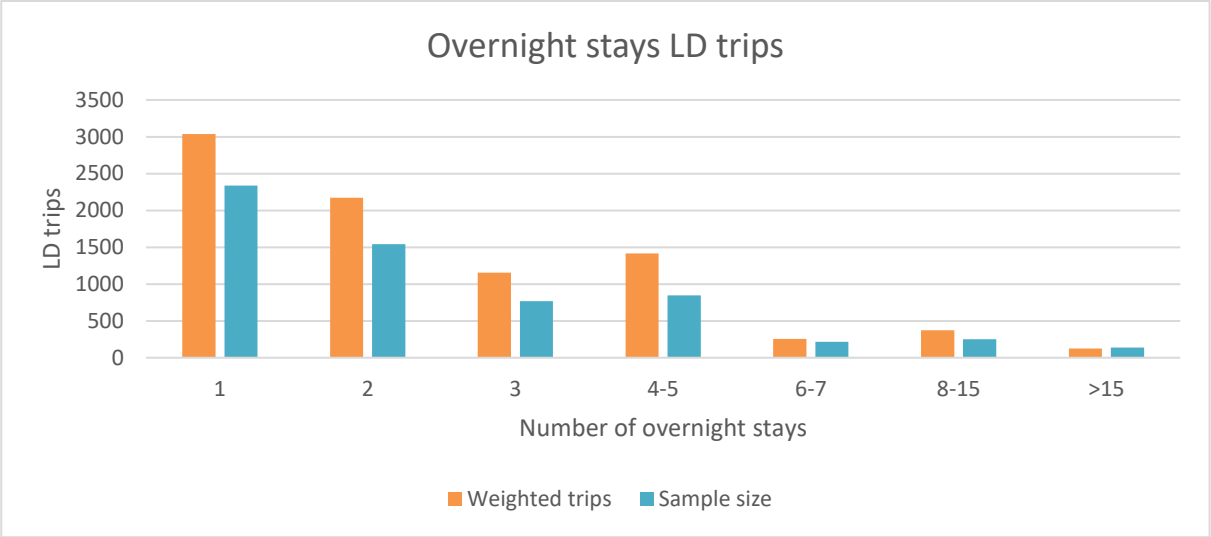

Figure 2: Overnight stays of LD trips

As already mentioned in the introduction, long-distance trips normally last more than on one day. Most of the long-distance trips lasted indeed for two days or three days (so with respectively one and two overnight stay in-between); more rarely trips stretched themselves for more than a week.

Short-distance trips

In this section some data regarding short-distance trips will be presented.

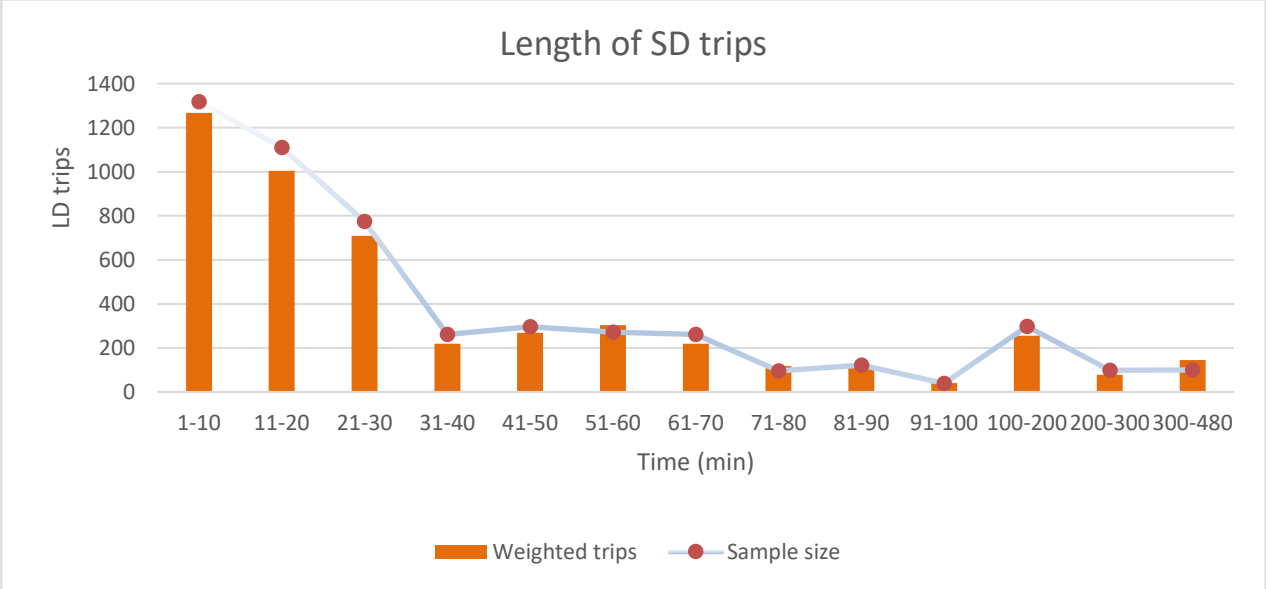

Figure 3: Length of SD trips

The length of the trips is represented in the previous graph with intervals of 10 minutes. As you can observe an important number of SD trips were relatively short (between 1 and 30 minutes). As the sample size of trips from 100 minutes decreased, the length classes from 100 minutes have

been “merged” into three categories, indicating that most of the SD trips lasted less than one and half hour.

An important aspect to consider about the length is related to the inaccuracy of the collected data since many respondents often did not give exact values but rounded ones for the length of their trips (e.g., 5, 10, 15 minutes etc). Therefore, it was important to represent the most suitable length categories for this data description.

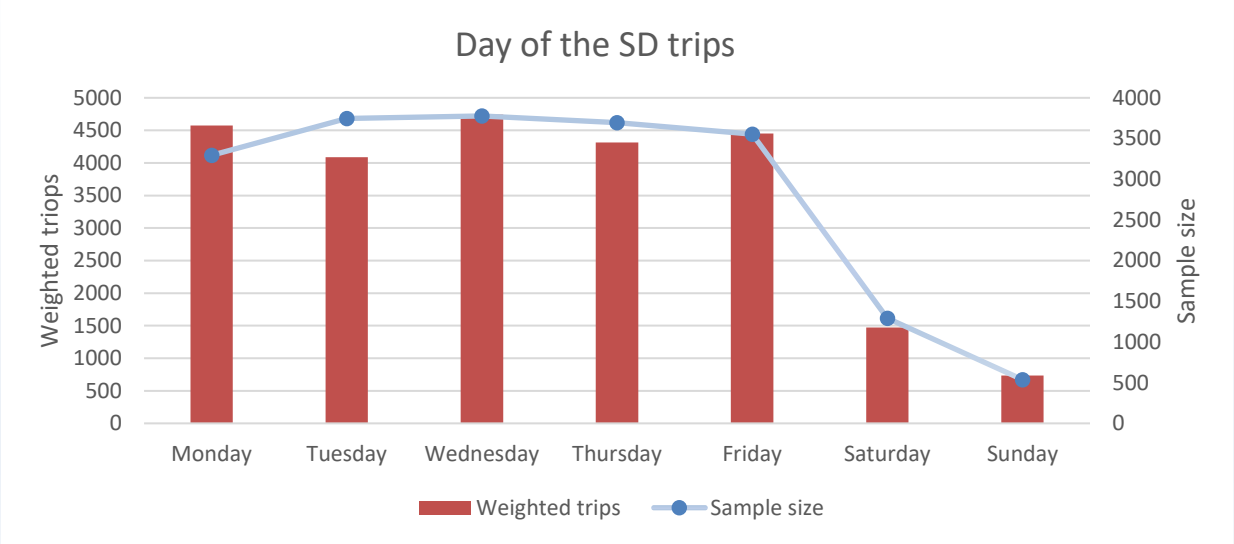

Figure 4: Day of the SD trips

Another interesting data regarding SD trips was related to the day of the trip. As expected, most of the trips took place during the “working days” of the week. Trips in the weekend were rarer (especially on Sunday).

After this little introduction to the two data sets, the most important demographic and situational variables will be presented comparing the two data sets.

Distance covered

One important factor which differentiate long-distance from short-distance trips is surely the distance. However, as stated in previous literature, there is no clear "boundary" which strictly define SD and LD trips. Nevertheless, the data set indicated 100 km to be the upper limit of SD trips.

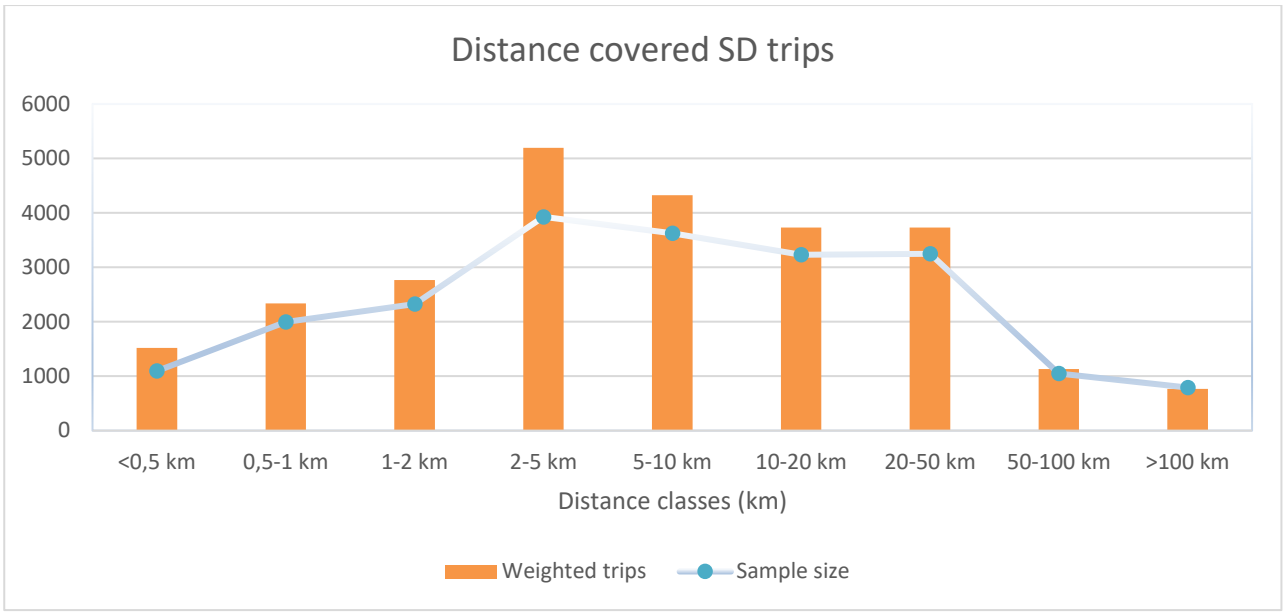

Figure 5: Distance covered SD trips

Indeed, as you can notice from the previous graph, SD trips mainly covered a distance between 0,5 km and 100 km with most of them ranging between 2 and 50 km.

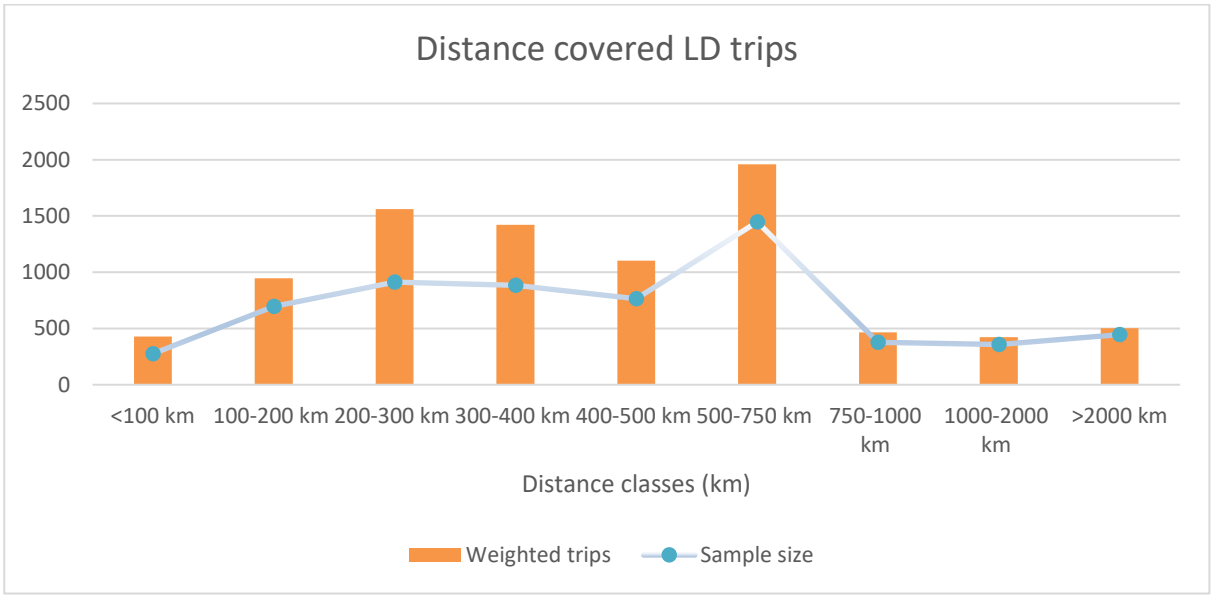

Figure 6: Distance covered LD trips

As for the SD trips, the distance covered by LD trips was heterogeneous, with most of the trips ranging between 100 and 750 km. The most representative distance class was the one between 500 and 750 km; up from this distance the number of trips sensibly decreased.

Means of transport

Business trips travellers used different means of transport, as illustrated in the following graphs.

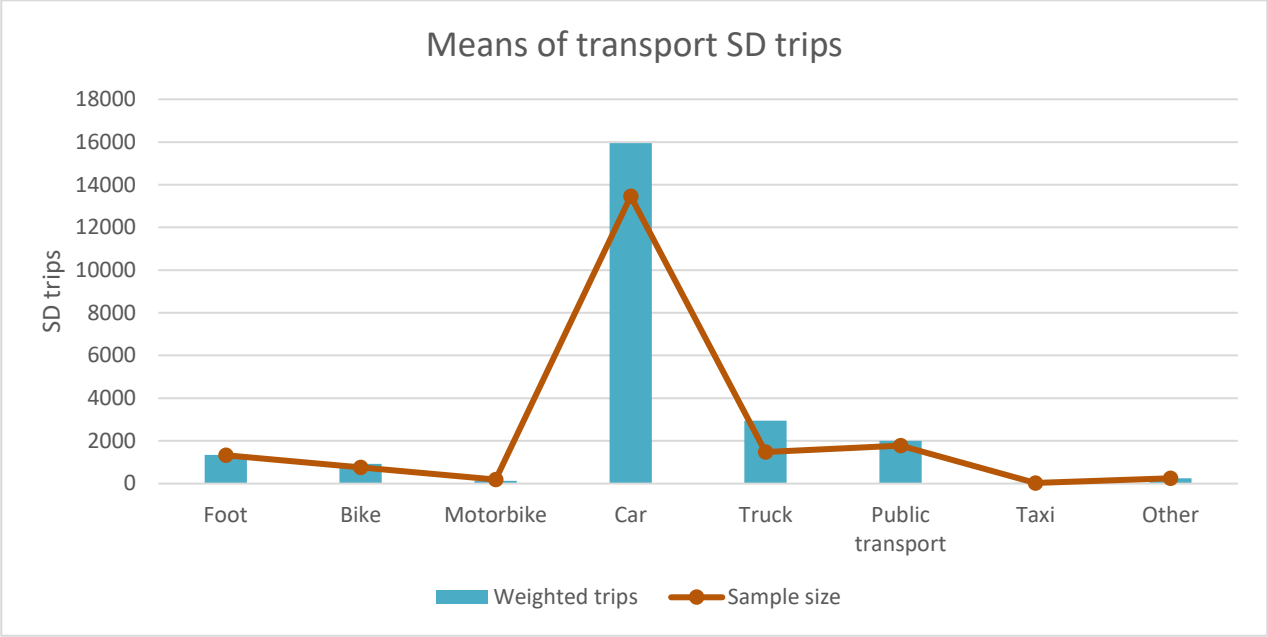

Figure 7: Means of transport SD trips

The dominant means of transport for the short-distance trips was the car (followed by truck and public transport). Passengers and drivers ("Pkw Mitfahrer" and "Fahrer") have been merged into the same category "Car". Interesting is that a considerable part of short distance travellers used the bike or went on foot to reach their business location.

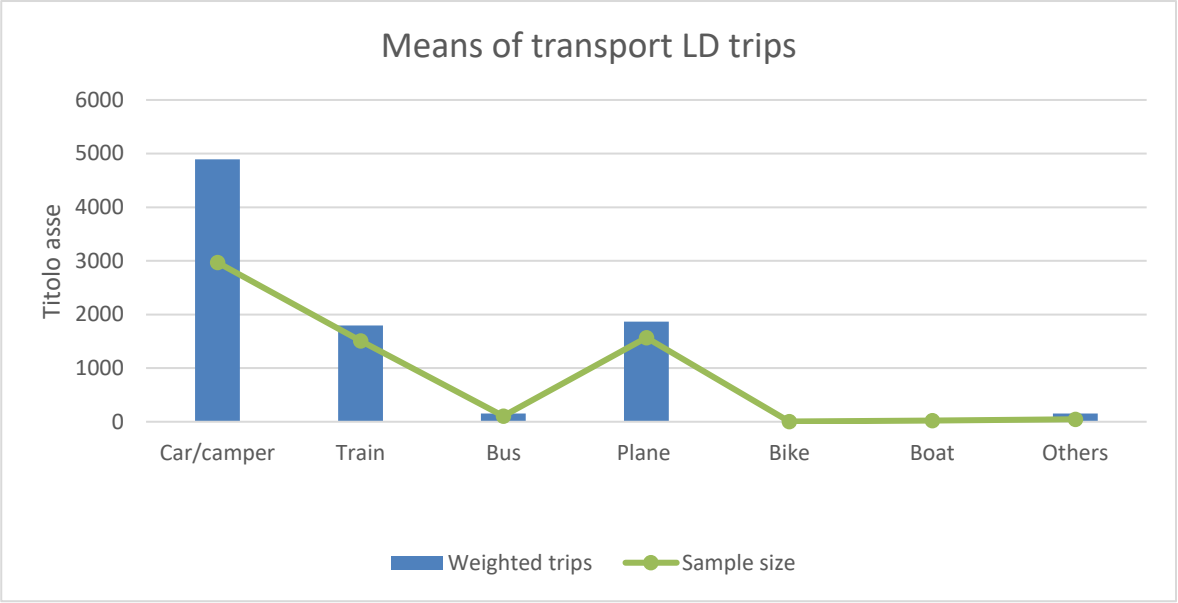

Figure 8: Means of transport LD trips

The dominant means of transport for LD trips remained the car (or camper), but differently from the short-distance travellers, a great part of long-distance travellers used the train and the plane (especially for trips outside of the country). The other means of transport (bus, bike, boat…) were not representative within the survey.

Monthly salary

As stated in the literature, the monthly salary is an important variable which characterize business travellers. Here the representations for both SD and LD trips.

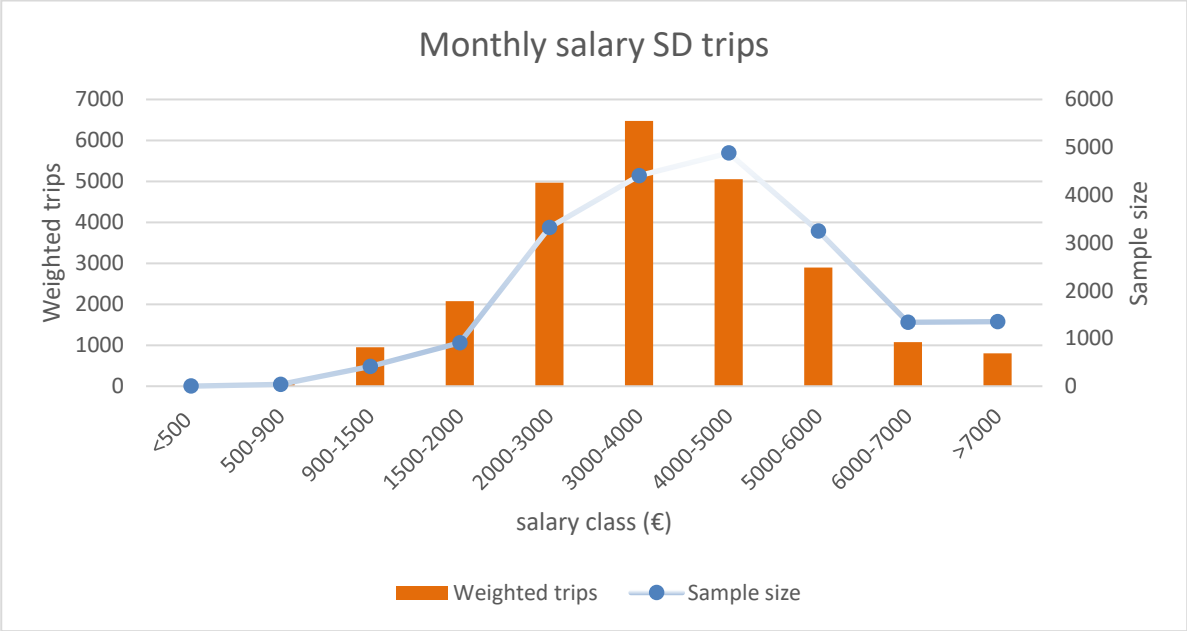

Figure 9: Monthly salary SD trips

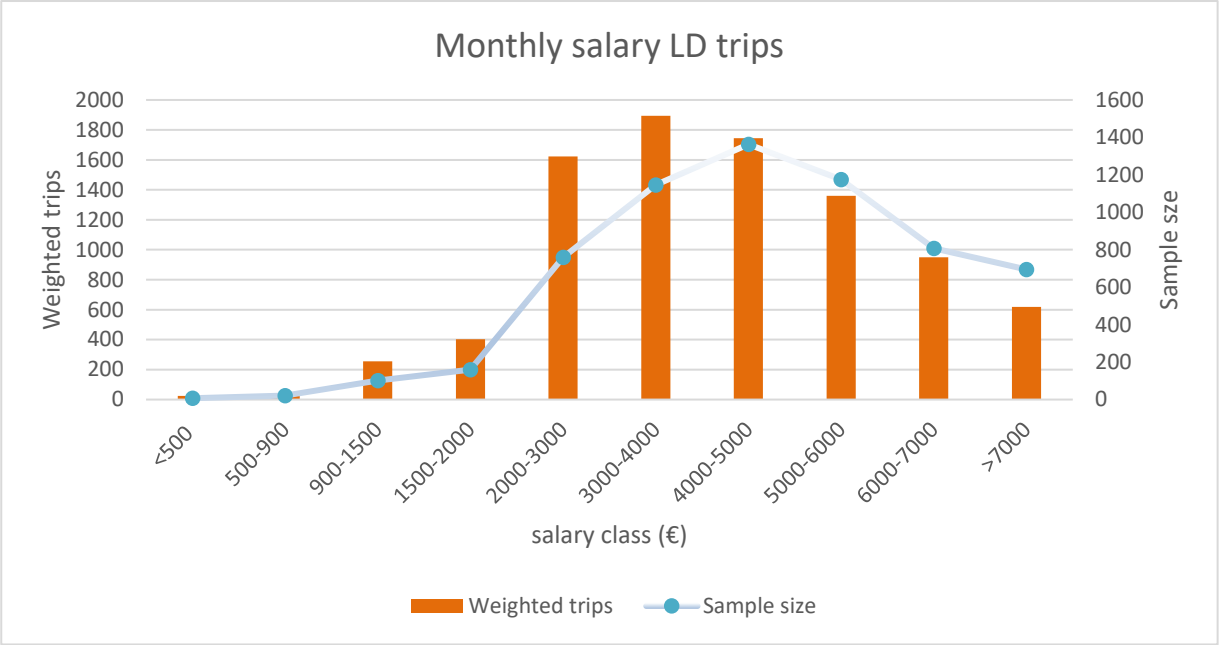

Figure 10: Monthly salary LD trips

As you can observe from the previous two graphs, the average monthly salary for business travellers in Germany amounted to 3000-4000 euros. The ones gaining less than 2000 euros represented a smaller part of the sample for both SD and LD trips. Moreover, the two graphs gave the idea that the LD travellers earned more than the SD ones, with many respondents gaining over 5000 euros per month. What you can indeed notice is that differently from the LD travellers, SD travellers with an income higher than 5000 euros sensibly decreased.

Another aspect to consider from the comparison between the weighted values and the sample size is that the respondents with high income are overrepresented in the survey; vice versa, respondents with an average income look to be underrepresented.

Employment

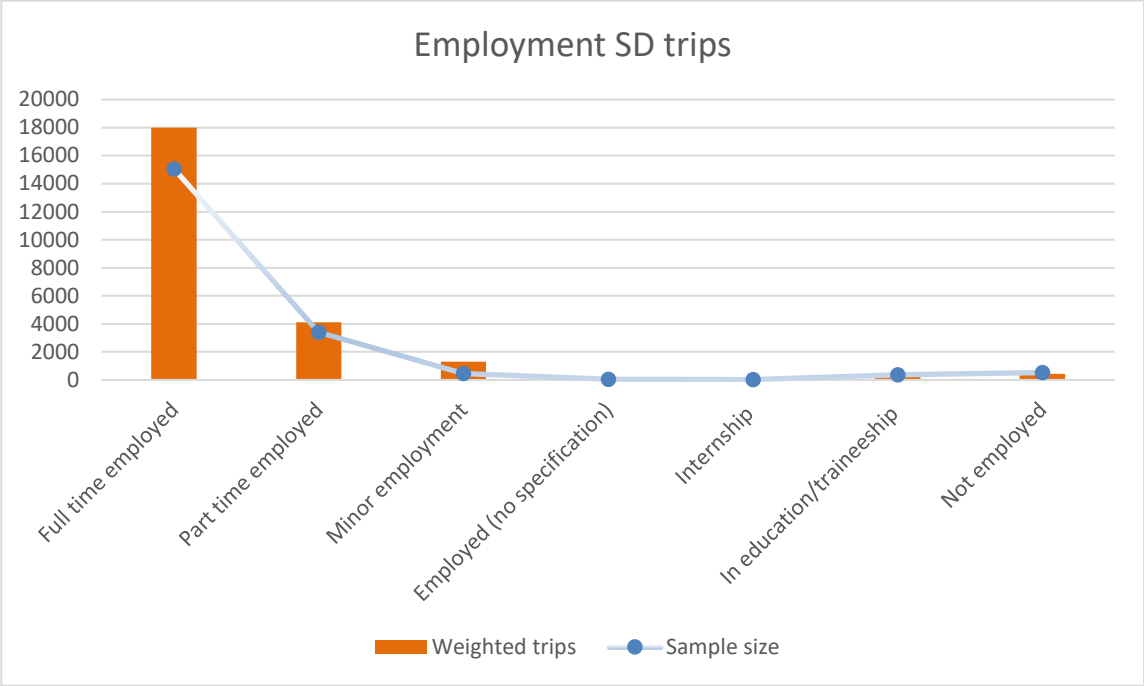

Figure 11: Employment SD trips

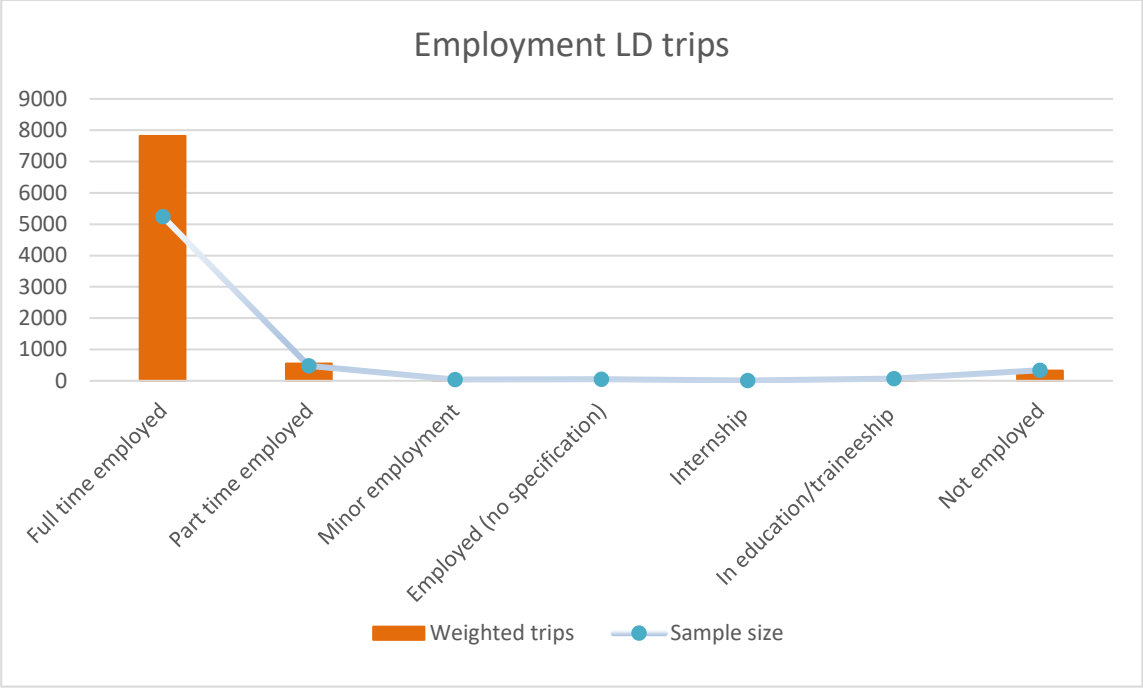

Figure 12: Employment LD trips

As you can notice from the previous two graphs, most of the people involved in the survey were full time employed. The share of part-time employees and employees with minor employment appears to be bigger for the short-distance travellers rather than for the LD ones. The other categories are almost not represented. Since most of the business travellers were full-time employed the variable will not be further evaluated in the bi-variate analysis.

Age

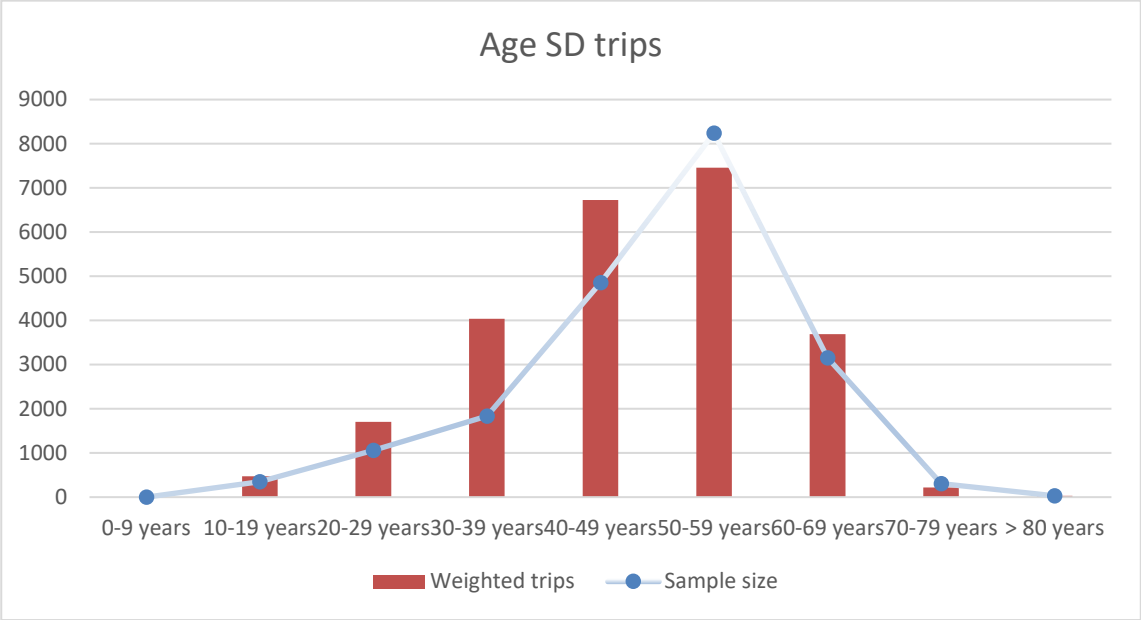

Figure 13: Age SD trips

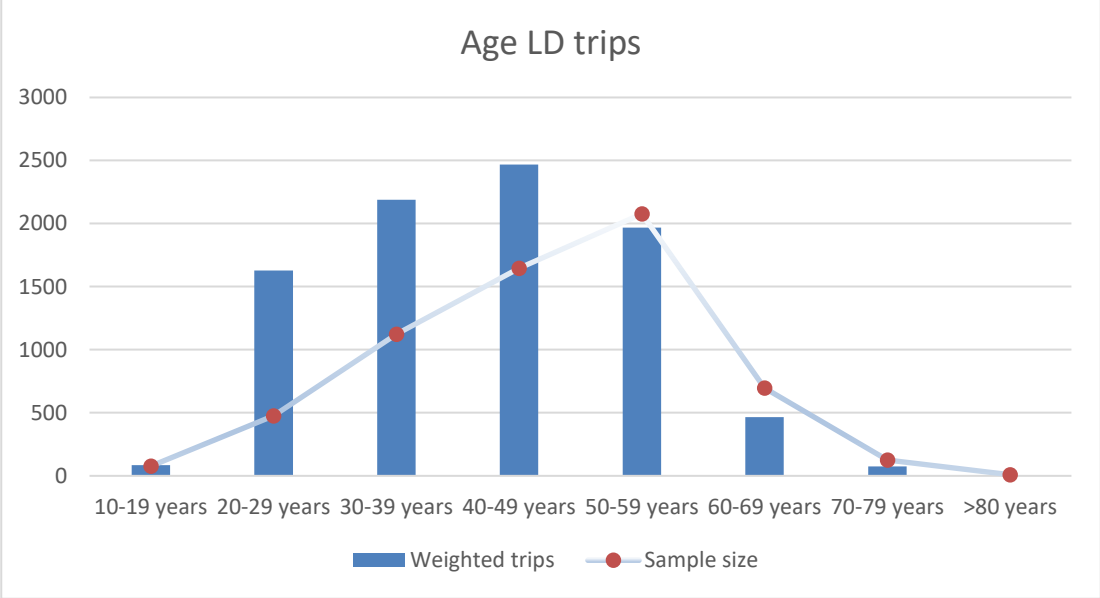

Figure 14: Age LD trips

Considering the age of business trip travellers, it emerges that for both trip categories most of the interviewed people were “in the working age”, so between 20 and 69 years. The peak is represented by people aged 50-59 and 40-49 for respectively SD and LD business travellers.

The following chapter will also represent the age classes in relation to the share of business trip to non-business trips.

3.3 Bi-Variate data analysis

The following chapter will provide a more detailed examination through a bi-variate analysis, which relates the already described variables in pairs. The choice of the variables to "combine" is mostly derived from the literature and is result of a "trial and error" approach.

Means of transport per destination LD trips

This section will deal with the correlation of the destination of long-distance travellers (Germany, Europe, and international trips) with the means of transport used.

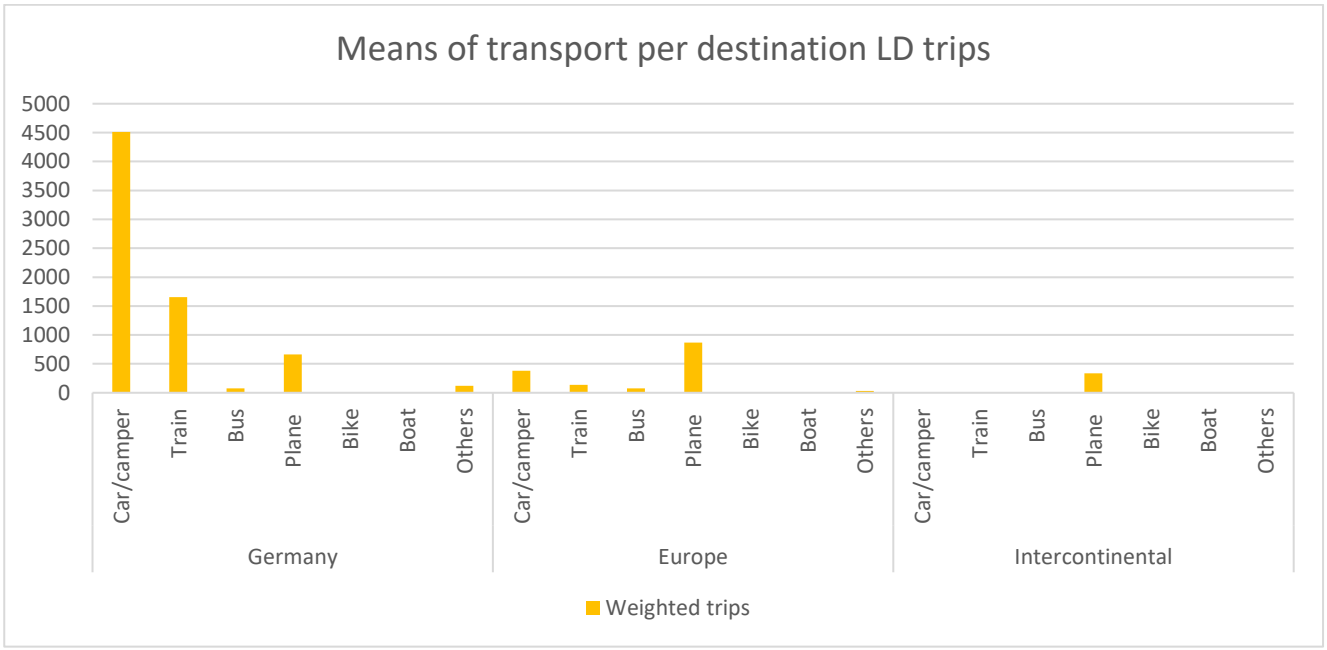

Figure 15: Means of transport per destination LD trips

As expected, national trips were mostly undertaken using the car, followed by train and plane. Oppositely to national business trips, trips to other parts of the continent and of the world were mostly made by the plane. However, it is worth saying that the sample size of intercontinental trips was smaller than the sample size of national trips.

The next section will deal with the correlation between means of transport and distance considering the comparison between short-distance and long-distance trips.

Means of transport in relation with distance covered

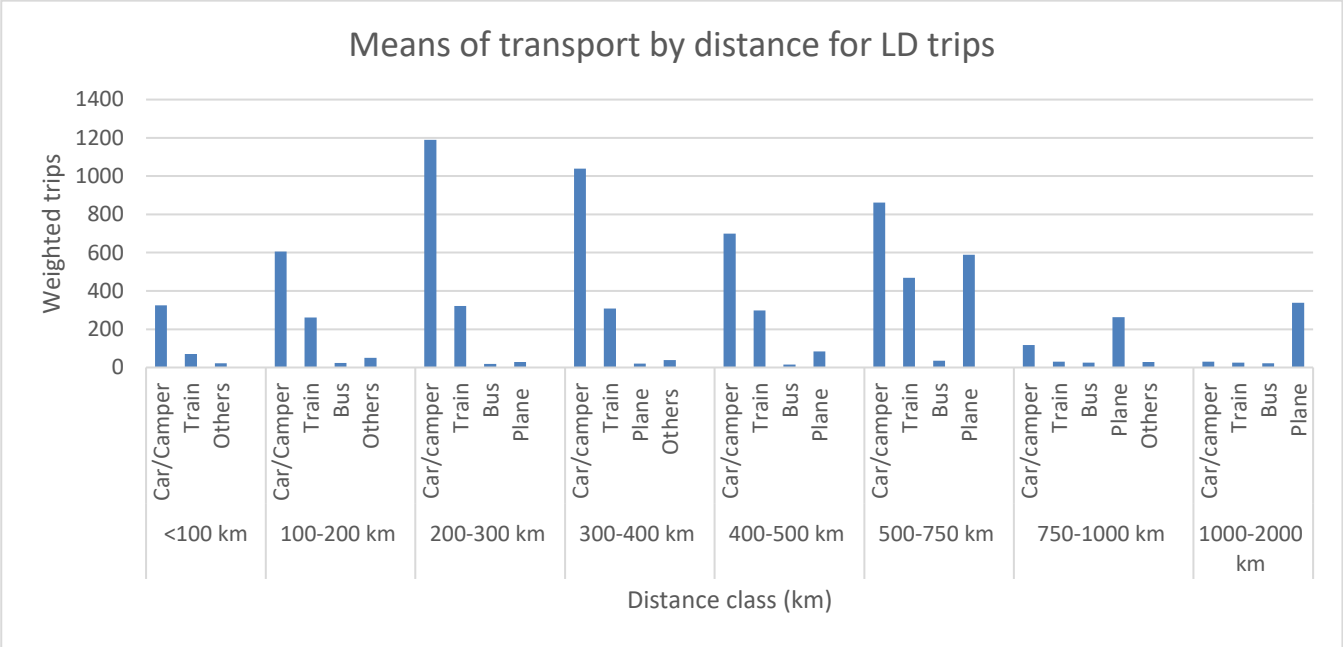

Figure 16: Means of transport by distance for LD trips

The previous graph puts into evidence what the analysed literature reported and that business travellers preferred to use the car to cover the distance of the trip. Indeed, the car was the preferred mode choice for all trips up to 750 km, with the train representing the “second choice”. Up from 500 km, the plane considerably rose in importance becoming the most used means of transport from trips above 750 km.

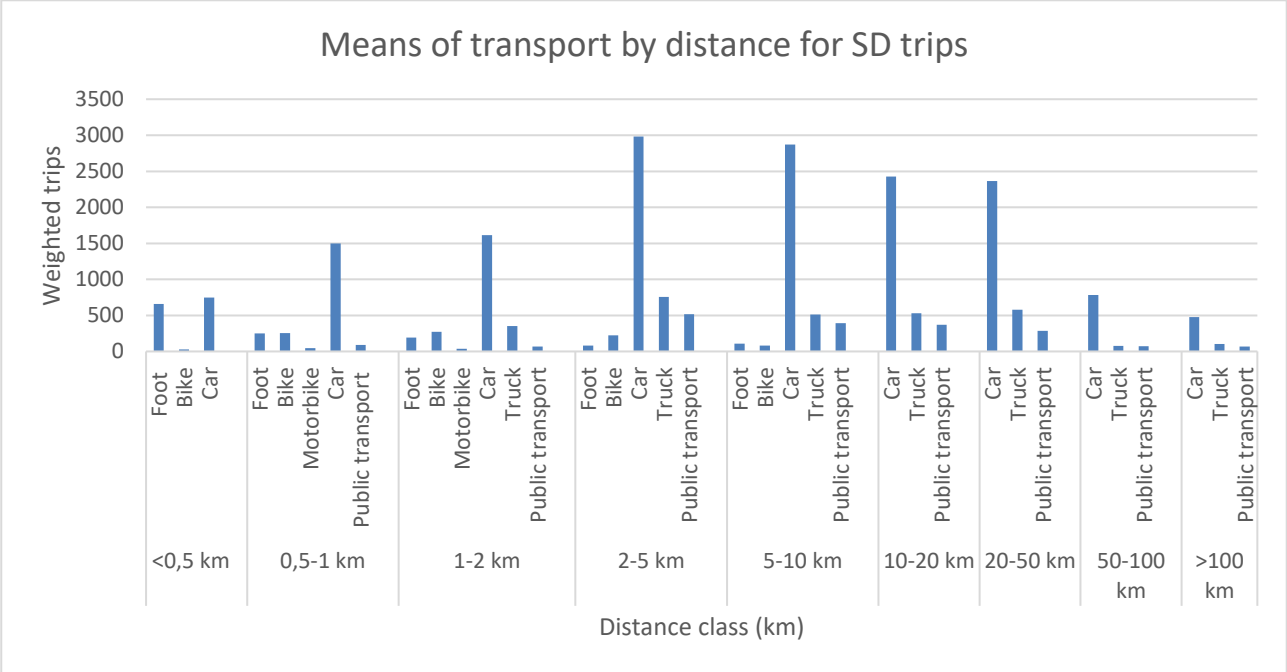

Figure 17: Means of transport by distance for SD trips

Similarly, short-distance travellers preferred the use of the car for any of the distance categories. For short distances below 2 km the respondents considered walking as an option or used the bike/motorbike. From 2 km distance the use of bike/motorbike decreased in favour or public transport (the data from “regional” and “long-distance” public transport have been merged into the same category “public transport”). Interesting is the use of truck, used by many respondents for their business trips.

In the following sections there will be a deeper analysis of the income and age classes considering the whole data set, so the share of business trips compared to non-business trips.

Income classes

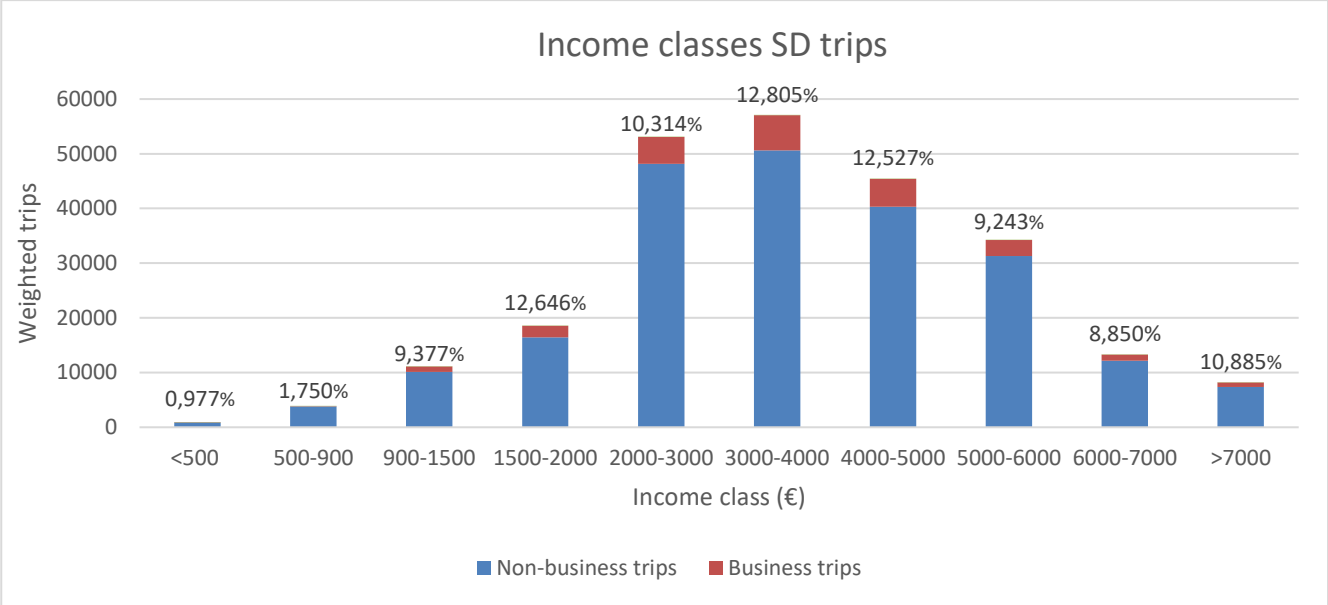

Figure 18: Income classes SD trips

The graph shows the amount of non-business and business short-distance trips for the different income classes. The value above gives information about the share of SD business trips in relationship to the whole set of SD trips (“Wege”).

As expectable, the percentage of business trips for the first two income classes is very low and this can have two explanations. First, the sample size of the first two classes is not representative; secondly, it means that people with low income usually do not undertake business trips. Indeed, the percentage of respondents going on business trips rises with a bigger income class and establishes at around 12% for 3000 to 5000 euros salary. Respondents with a salary higher than 5000 euros gradually decrease as the percentage of business travellers. The analysis about the long-distance travellers will help to obtain more information about this variable.

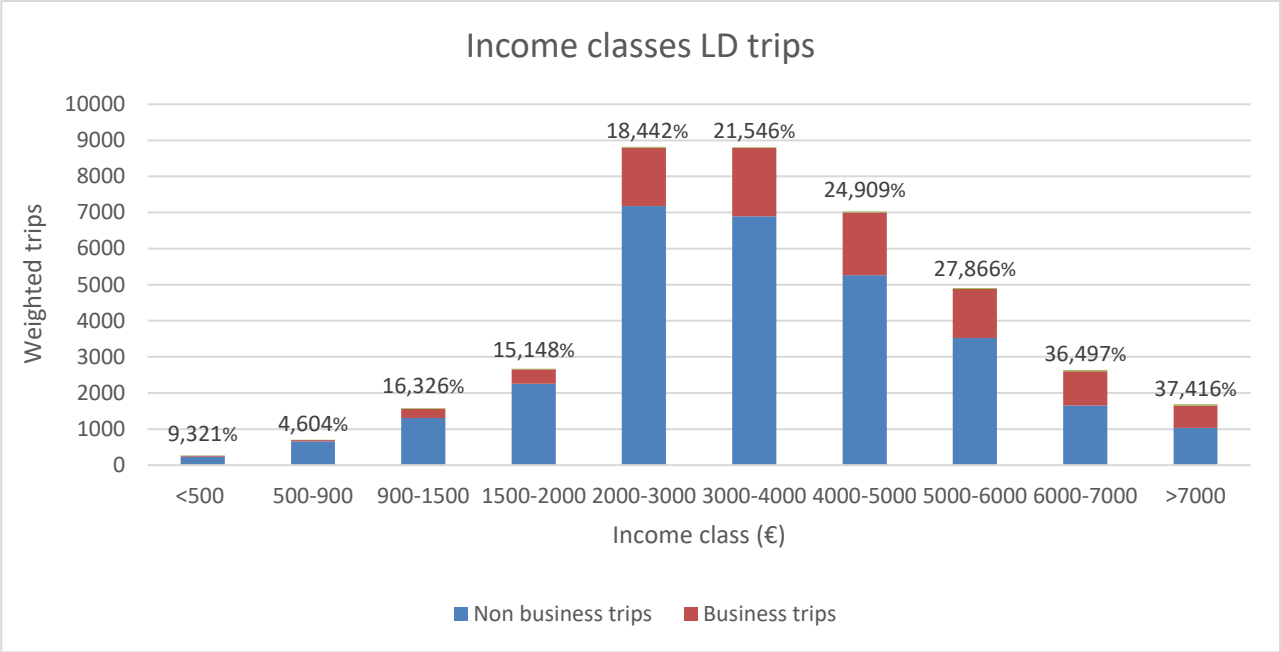

Figure 19: Income classes LD trips

The graph above reports the share of long-distance business travellers in relation to the long-distance trips ("Reisen") for the same income classes. As for the short-distance travellers, the first two income classes are not well represented within the survey. What is interesting to observe from the representation is that the share of business travellers gradually rises with the income to reach around 37% of the total trips for an income class of over 7000 euros. And even if the number of respondents from the last income classes decreases. This reinforces the previous statement, that people on a long-distance business trip are likely to have a high monthly salary.

Age classes

The same approach can be taken for the age classes to compare the results with the findings of the literature. There seemed to be no clear connection between the age and the inclination to business travel; indeed, what emerged from the literature is that on the one side, companies are usually in need for experienced people to conduct business trips, but on the other younger people are more inclined to travel than elder ones. Hence there will be an analysis of the share of the business travellers in relation to general travellers for the different age classes.

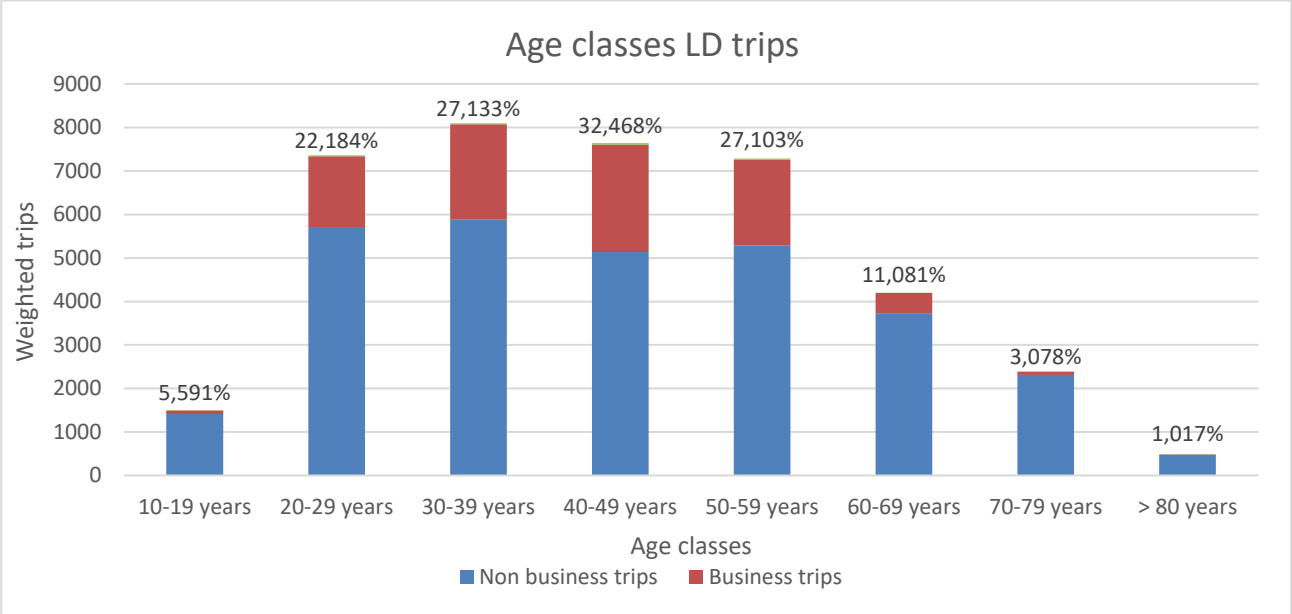

Figure 20: Age classes for LD trips

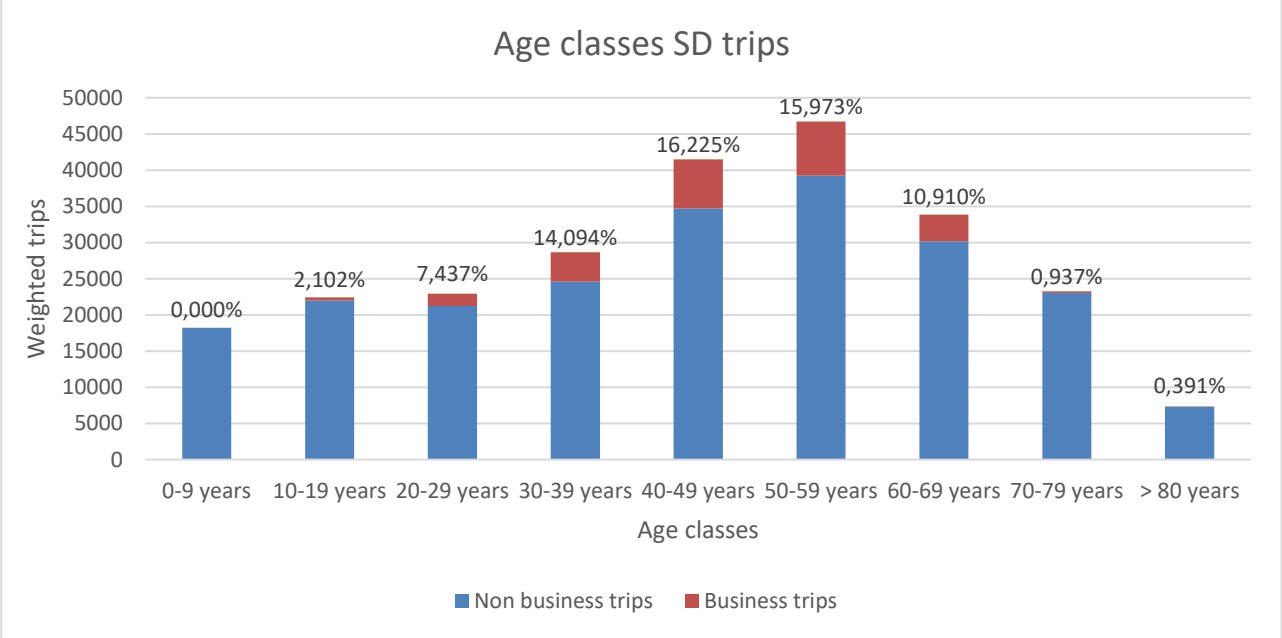

Figure 21: Age classes for SD trips

As you can observe from the previous two graphs, the share for business trips in relation to "general" trips reaches its peak between 40 and 49 years for both the short-distance and long-distance trips, so in the "middle" working age. For long-distance travellers the share varies between 25% and 32% for people in working age (so between 20 and 60 years), while for short-distance travellers it varies between around 7% and 16%.

It also emerges that people up from 50 years of age tended to travel less, since the share of people participating in business trips decreases. In conclusion, the results correspond to what has been found in the literature: more experienced working people (so between 40 and 49 years of age) are more likely to go on a business trip than younger ones. Moreover, people from 60 years of age are less inclined to business travels because of possible retiring and due to the "stress" situations which travel causes.

In the following section the relationship between age and distance covered for both SD and LD trips will be illustrated.

Age in relation with distance covered

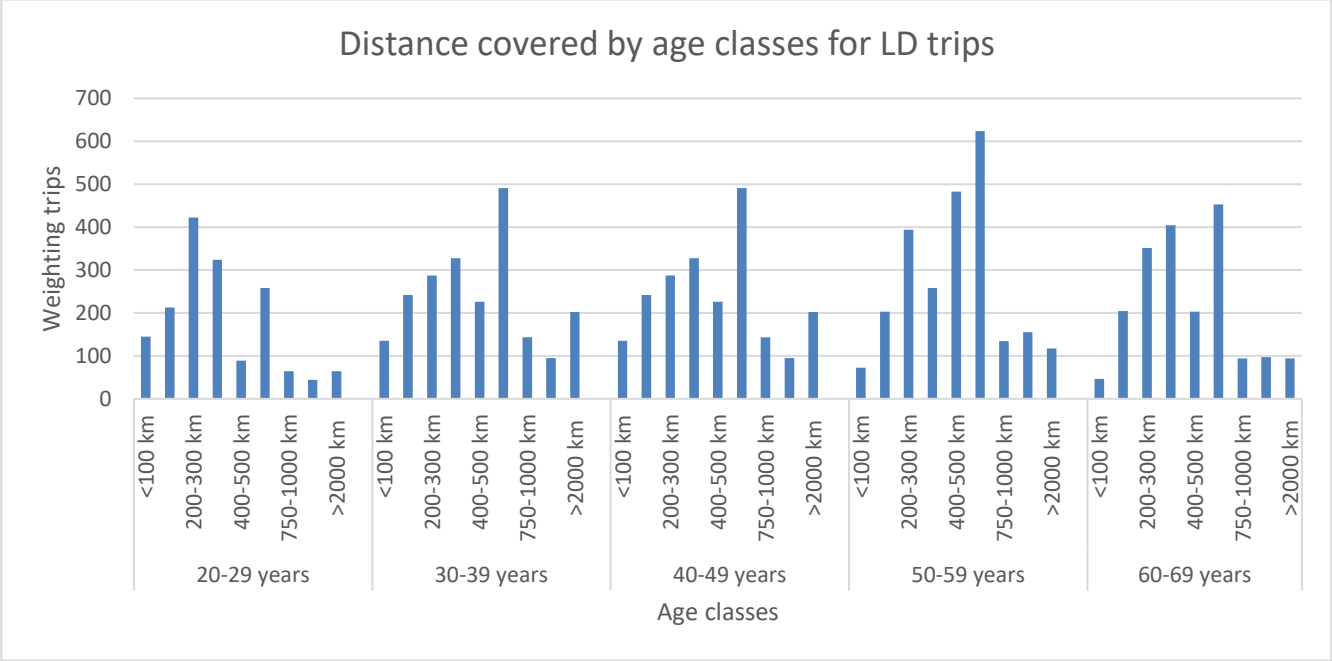

Figure 22: Distance covered by age classes LD trips

From the LD trips graph it appears that the trend for the classes between 30 and 60 years is similar, with the peak reached within the trips with a distance between 500 and 750 km.

Long trips over 1000 km were the most frequent between 30 and 50 years of age (reinforcing the previous statement from the literature) and then gradually decreasing from 50 years. The other age classes have been omitted since not enough representative for the graph.

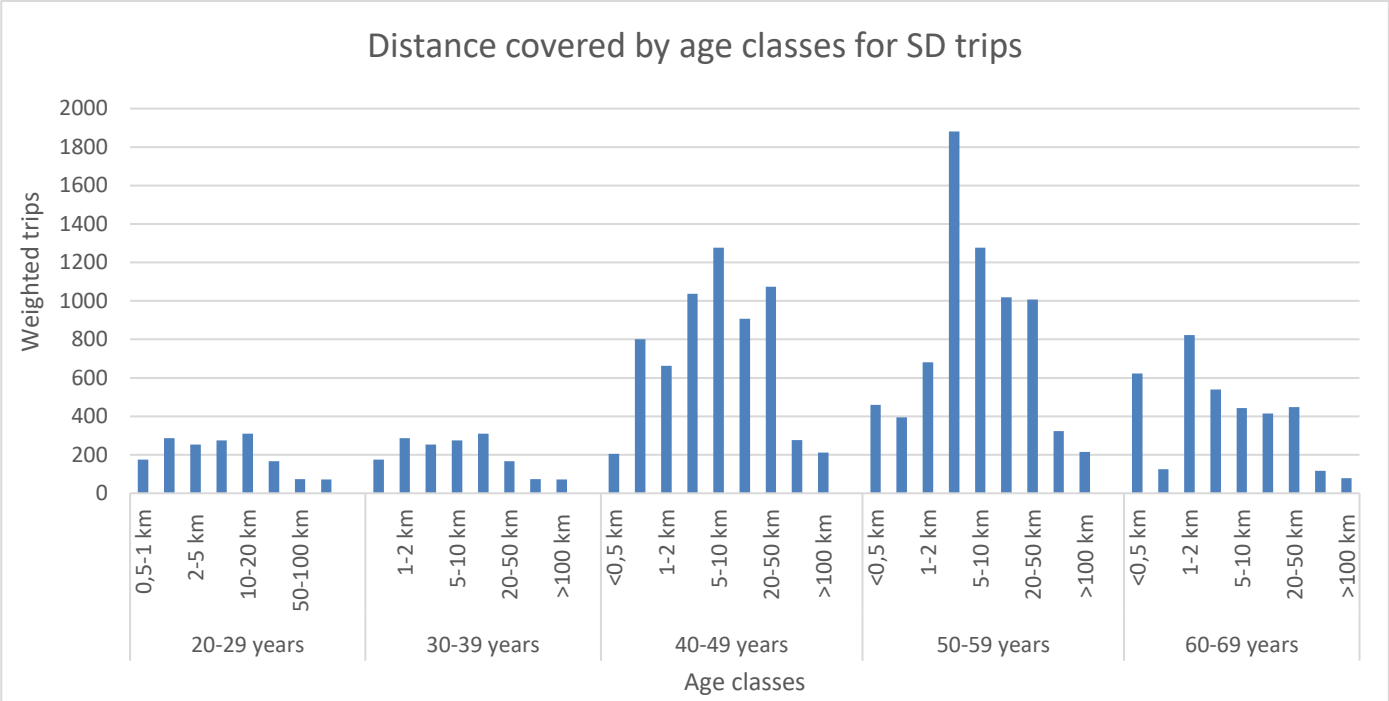

Figure 23: Distance covered by age classes SD trips

The trend for the SD trips suggests again the propensity of the respondents in the middle working age to undertake business trips. Indeed, business travellers between 60 and 69 years went more rarely on longer trips (over 50 km) than their "younger colleagues".

For instance, the relationship between age and income will be presented in the following graphs.

Age in relation with income classes

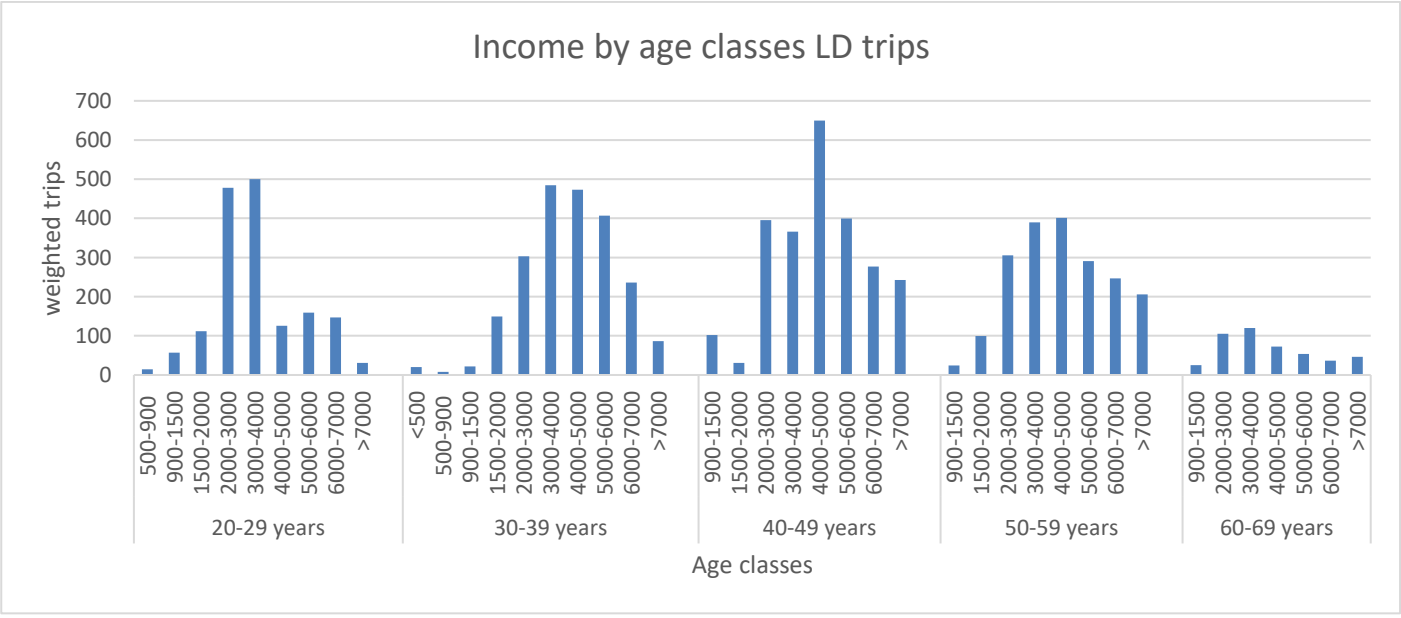

Figure 24: Income by age classes LD trips

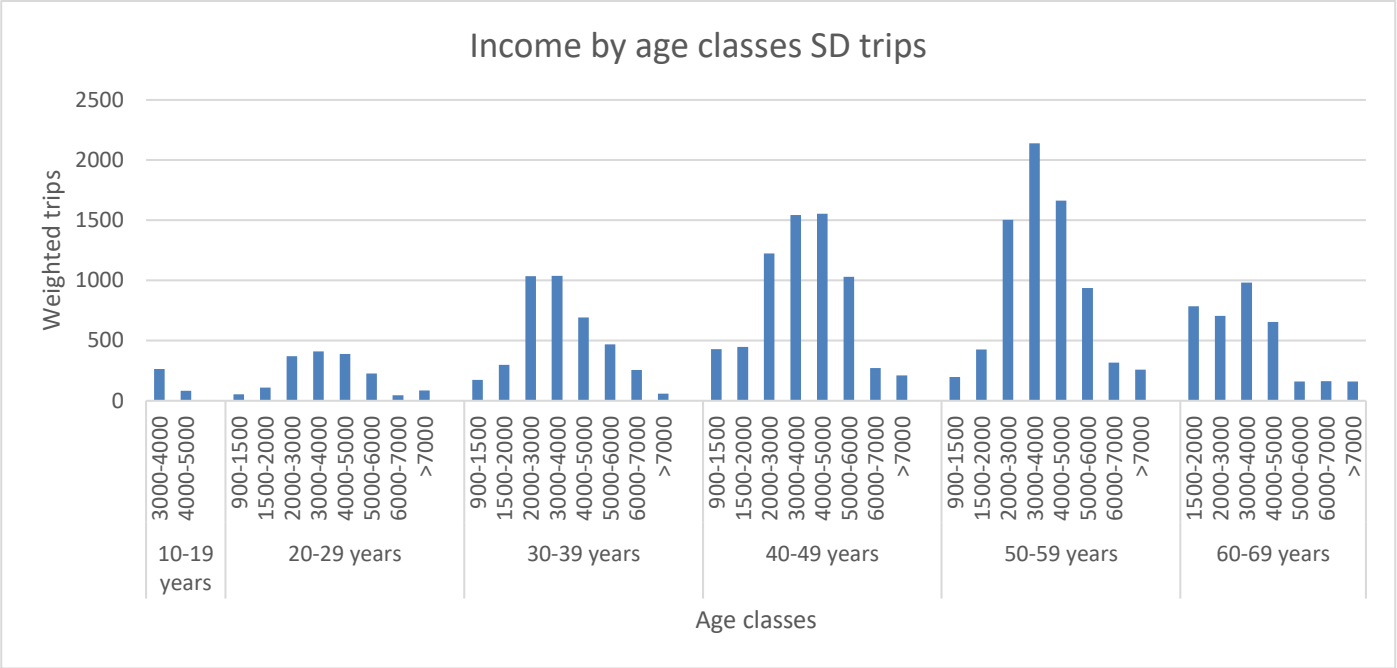

Figure 25: Income by age classes SD trips

As you can observe from the previous two graphs, the trend for LD and SD trips looks similar. Business travellers with work experience (so from up 40 years) tend to earn more than the younger ones. The number of respondents with over 6000 euros monthly salary decreases for all age categories.

Another interesting aspect to consider is whether there is a relationship between the salary and the distance covered by a business traveller, and this will be analysed in the following section.

Distance in relation with income classes

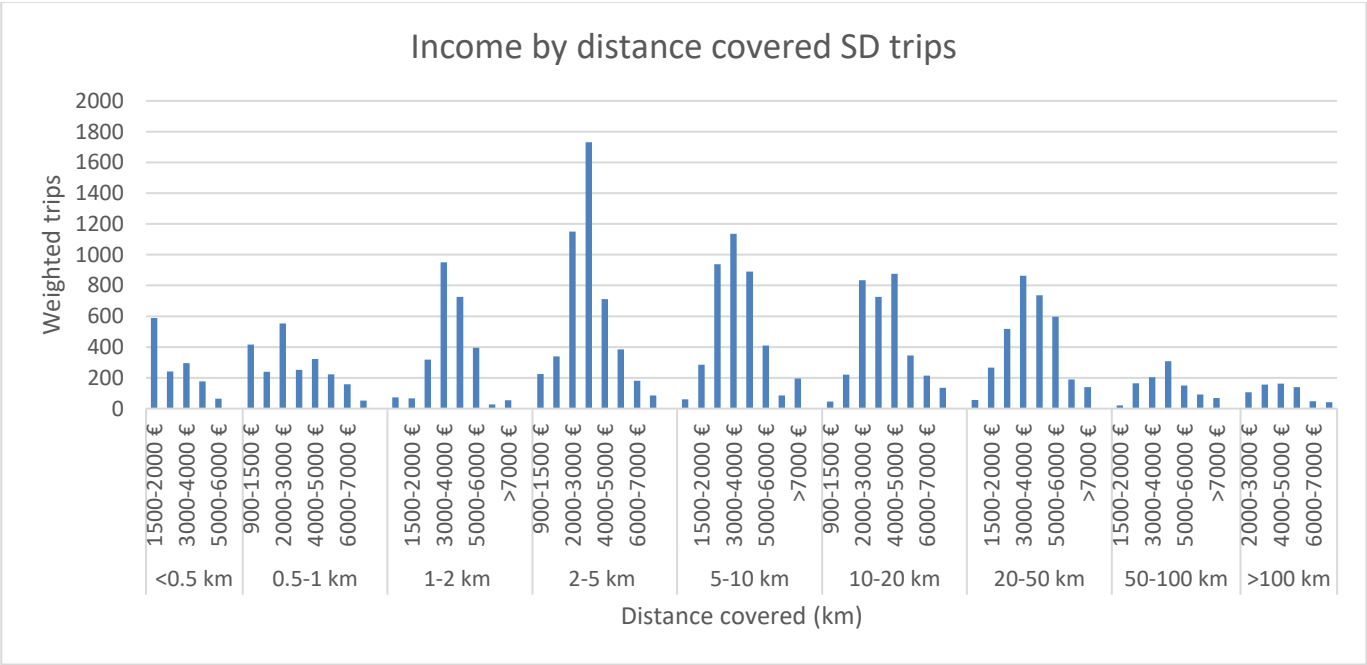

Figure 26: Income by distance covered SD trips

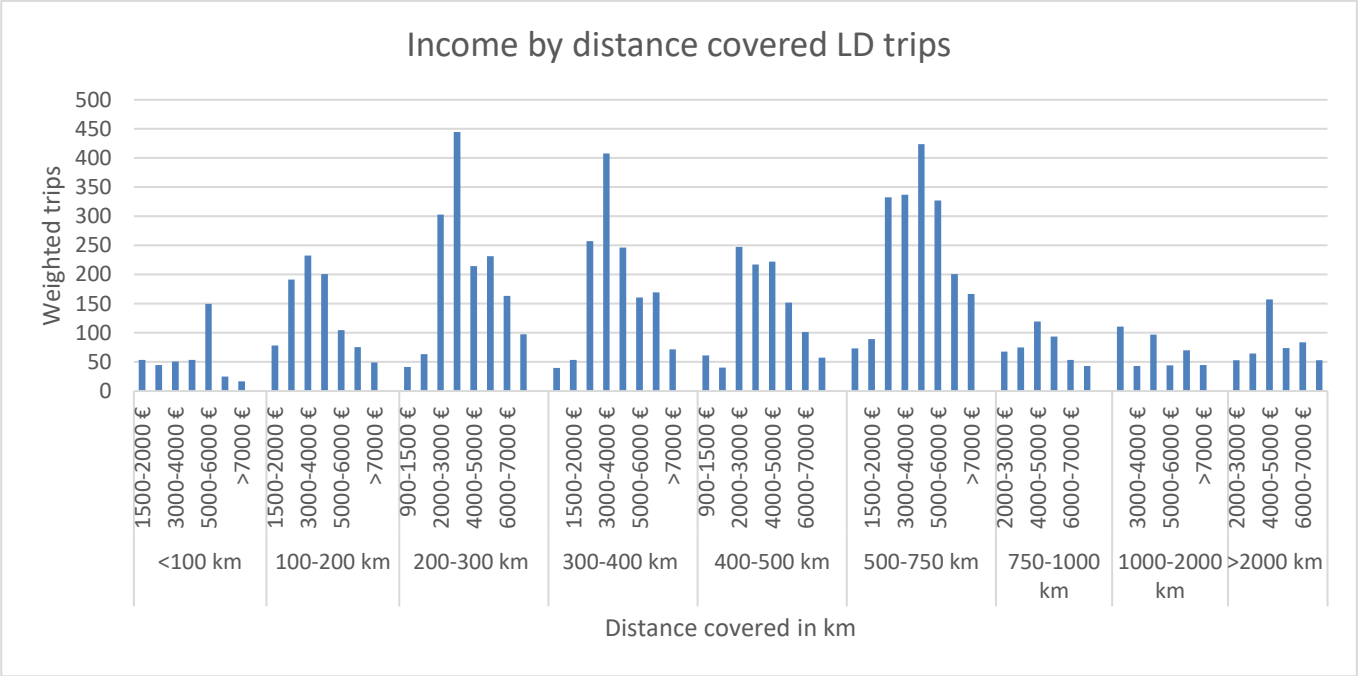

Figure 27: Income by distance covered LD trips

The trend for the previous two graphs looks similar; there seems to be a light "shift" of the peak of the graph with an increasing distance, suggesting that that the longer the travel, the higher will be the salary. However, there does not seem to be a clear relationship between the two variables, it would indeed need additional data to provide a more reliable statement.

In conclusion, the bi-variate analysis provides the combination of the most relevant parameters reported in the data description. The choice of the variables to combine has been partly determined by the literature analysed and partly by a "trial-and error method". Other 'pairs' of variables have not been considered since not effective for the analysis.

The analysis of the MiD data set helped to obtain an overview of the most important demographical and situational variables which characterize business travellers in Germany. Another significant aspect to consider is related to the environmental impact of business travellers in terms of emissions released in the atmosphere. The next chapter will provide, as already mentioned, an estimation of the emissions from the same data set of the previous analysis.

4 Calculation of emissions from LD travel

The following chapter will deal with the calculation of the CO_2 emissions caused by the long-distance travellers. Short-distance travellers will not be evaluated since the majority of the GHG emissions is emitted by trips on a large scale.

The references from the article by Pukhova et al. (2021) will help to calculate the values thanks to an empirical formula which takes into account the emission factor per passenger for each long-distance mode (auto, air, bus and rail). Unfortunately, it was not possible to use the CO_2 equivalent emissions, which considers the global warming potential from CO_2, CH_4, and N_2O gases.

On one hand, ground transportation (auto, bus, train) emissions are normally calculated as the product of the emission factor with the distance covered (Brand e Preston, 2010); on the other hand, emissions from aviation are more complex, since they include emissions caused by landing and take-off and the activities at the airport. Moreover, the engine of the airplane burns less fuel when reaching a high altitude (Miyoshi e Mason 2009), which results in a higher emission factor for a decreasing distance.

The emission factor used in the calculation for auto trips amounts 0,171 $kgCO_2$/km and takes into account the possible presence of many passengers in the car. The emission factor for a long-distance bus (carrying on average 29 people) is equal to 0,045 $kgCO_2$/km. Both data were taken from HBEFA, 2020. The rail emission factor per passenger in Germany is 0,014 $kgCO_2$/km (DeutscheBahn, 2010). The emission factor for air travel used by the study is equal to 1,8453 x air travelled distance$^{-0.401}$ x 1,9, with the negative exponent remarking the inverse proportionality between distance and the emission factor.

After presenting the emissions factors used for the calculation, it is important to clarify that the long-distance travel data from the MiD does not give exact distances for each trip, but provides instead distance classes (e.g., 100-200 km). Therefore, it is necessary to assume that the mean values are plausible enough to obtain a reasonable result for the calculation. For the long-distance trips under 100 km and over 2000 km, the values of 80 km and 3000 km will be considered.

The absolute number of emissions is the result of the multiplication of the emission factor with the distance and the weighted values of LD trips. The results of the emissions (in kg CO_2) for the different distance classes will be summarized in the following table. You can see in parenthesis the distance used for the calculation. In the upper part of the table the sample size and the weighted values of the four transport modes are indicated. The outcomes will also be illustrated with a graph.

	Auto	Rail	Bus	Air
Weighted trips	4894,348	1794,756	154,928	1865,011
Sample size	2969	1511	105	1571
Emission factor (kg/passenger-km)	0,171	0,014	0,045	1.8453 x air travelled distance$^{-0.401}$ x 1.9
	Emissions per mode (in kgCO_2)			
Distance (km)	**Auto**	**Rail**	**Bus**	**Air**
<100 (80)	4.433,77	78,55	26,31	0,00
100-200 (150)	15.546,30	547,96	161,98	138,34
200-300 (250)	50.835,40	1.126,59	210,32	2.674,32
300-400 (350)	62.223,84	1.511,14	101,66	2.447,24
400-500 (450)	53.770,64	1.878,28	295,05	11.498,31
500-750 (625)	92.041,41	4.095,21	987,98	97.689,39
750-1000 (875)	17.556,73	379,47	1.026,30	53.169,93
1000-2000 (1500)	7.974,83	531,94	1.532,98	94.545,84
<2000 (3000)	1.888,66	0,00	0,00	210.179,02
Total	306.271,6	10.149,14	4.294,24	472.343,39
Total emissions	**793.067,35**			

Table 1: Emissions by means of transport

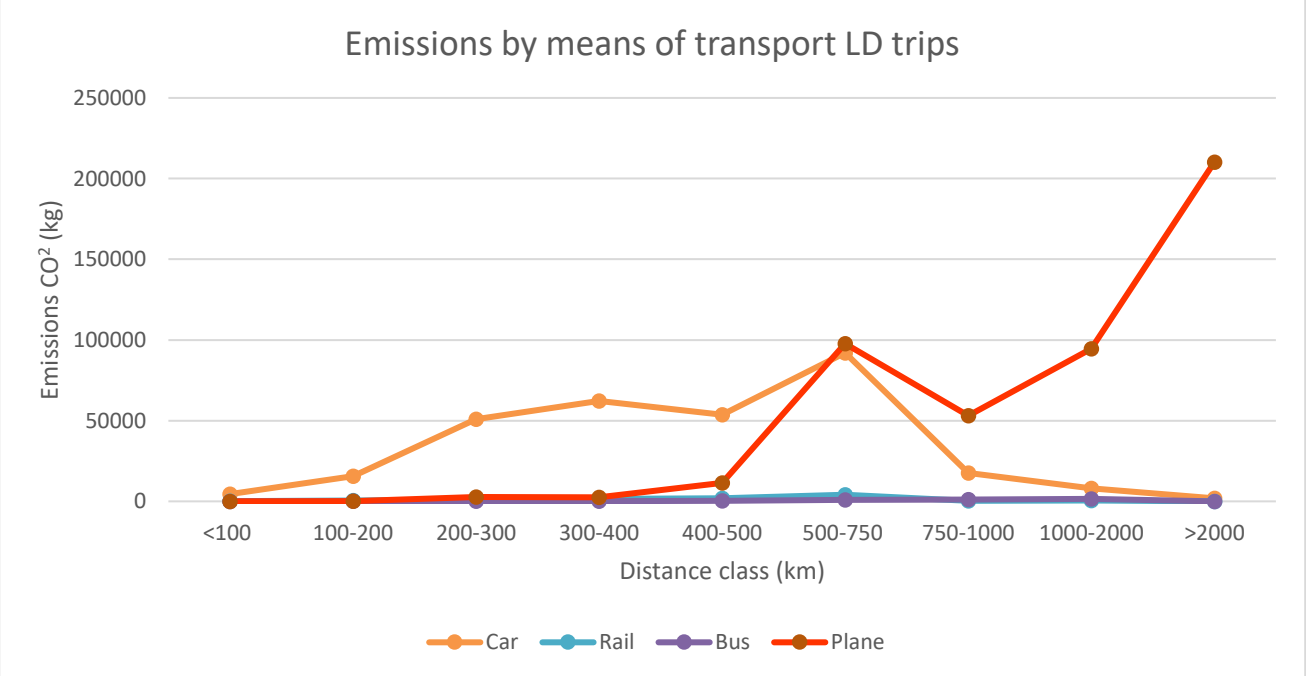

Figure 28: Emissions by means of transport LD trips

As expectable (also from the previous analysis indicating the car to be the most preferred means of transport) most of the emissions from LD business trips were caused by the car for all distance classes up to 500 km. From 500 km emissions caused by air travel overtook the emissions released by the other means of transport. Indeed, the previous bi-variate analysis reported that the plane became the most used transport mode up from 750 km.

The emissions caused by rail and bus are instead less relevant compared to car and air traffic. The calculation indicates again that rail was preferred to bus for business purposes. An interesting aspect is that the emissions from rail transport reached their peak in the 500-750 km distance class and rapidly decreased from 750 km while the emissions by bus gradually increased up to the 1000-2000 km class.

The emissions per kilometre and per trip differentiated for each means of transport will be illustrated in the following graphs.

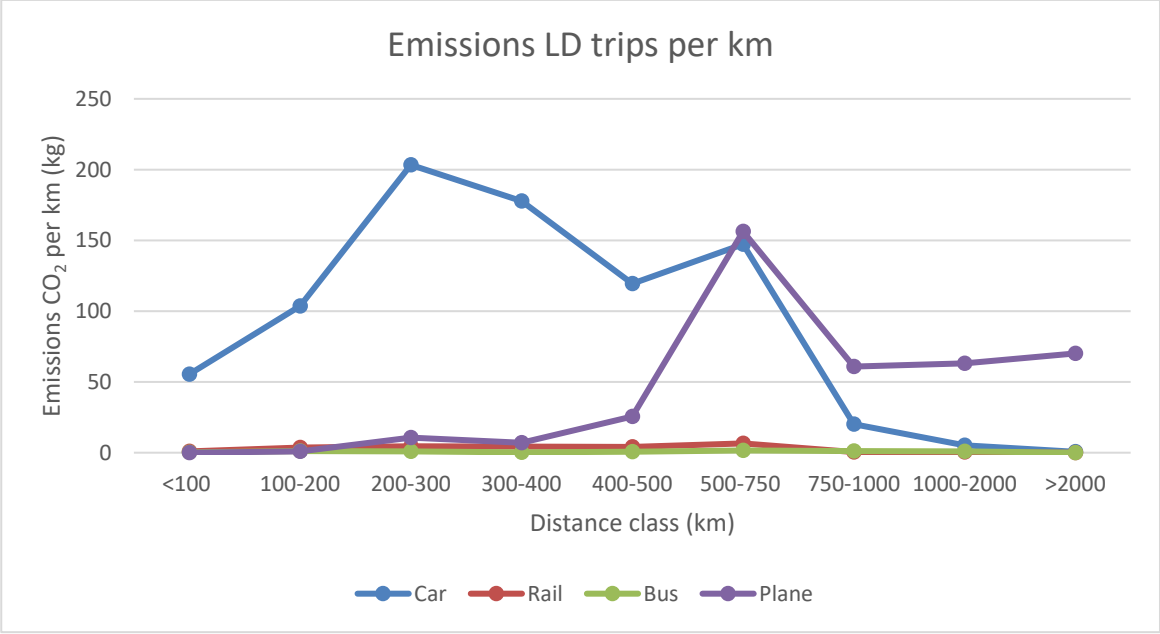

Figure 29: Emissions LD trips per kilometre

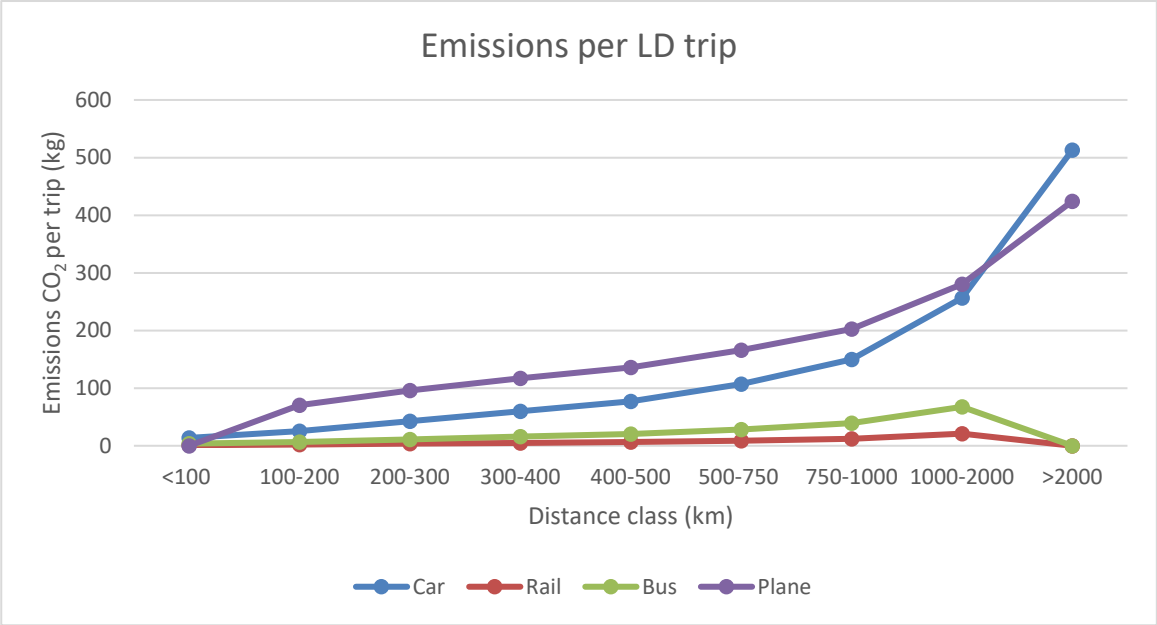

Figure 30: Emissions per LD trip

The first graph indicates that up to 500 the main emissions per km were caused by the car, with the peak reached in the 200-300 km distance class. From 500 km the plane released the most emissions per km with the 500-750 km distance class representing the peak of the graph. This aspect remarks the high emissions impact of air travel for short trips. As expectable, on the other side, bus and rail were more 'environment friendly'.

Considering the emissions per trip, it emerges that bus normally polluted more than rail for every distance class. In general, a trip made by plane released more CO_2 than car. Nevertheless, it is interesting to notice that, on average, a car trip with over 2000 km released more emissions per person than the one made by plane.

After these observations, it is meaningful to compare the emissions by LD business travel with the general emissions from the transport sector in Germany. As showed earlier in the table, the total emissions calculated were around 793 tons of CO_2. The emissions from the transport sector in Germany in 2017 amounted to around 168 million of tons of CO_2 equivalents (source: Umweltbundesamt). It means that the sampled long distance business travel in Germany accounted for only 0,000472% of the total emissions.

There could be different reasons for the small number: firstly, only long-distance travel has been considered to calculate the emissions. Secondly, the survey could sample only a part of the business trips in the country (6235 LD trips precisely) and only around 1200 trips were made by plane. Another aspect is related to the fact that the MiD sampled only the last three long-haul trips which took place in the three months antecedent of the survey.

Furthermore, the formulas used took into account only the CO_2 emissions neglecting the impact of the other greenhouse gases, such as CH_4, and N_2O.

Nevertheless, this seems to be a surprising result, considering the high environmental impacts of long-distance travel explained in the first part of the thesis. These aspects will be treated again in the section regarding the limitations of the work.

5 Conclusion

The conclusive chapter will provide a summary of the results and the "take-home messages" obtained from the data analysis. There will also be an extra subchapter with the limitations and difficulties met during the writing period of the thesis together with some proposals of future research in the business travel field.

The thesis showed the recursive distinction between short and long-haul business trips. As evidenced earlier, the two categories mainly differ in frequency and distance covered. In the literature considered there does not seem to be a strict boundary which defines short and long-distance trips. Nevertheless, the MiD survey indicated 100 km to be the 'break point' distance between the two data sets. Furthermore, short-distance trips stretched themselves over a short period of time (mostly up to 2 hours) and a limited distance, while most of the respondents undertaking LD travel travelled for more than 100 km and spent more days for the trip.

In general, the data analysis was coherent with the literature evaluated in the first chapter. Indeed, most of the business travellers (both SD and LD travellers) were in the middle working age (especially between the 40 and 50 years of age), confirming that employers need experienced people to undertake business activities. However, it was also surprising to notice how many young respondents (between 20 and 29 years of age) travelled for business reasons, deducing the fact that young executives are sometimes more mobile and prone to travel than elder ones.

From the income analysis, it emerged again that a major part of SD and LD travellers had a high monthly salary. Further on, it was expectable that LD travellers tended to gain more than the SD ones, since they may have had a high position in their company and more responsibilities. Another factor is related to the fact that most of the LD travellers were full-time employed, while a more considerable part of SD travellers worked part-time. The high salary of LD travellers was also highlighted when relating business with non-business travellers, as business travellers represented a high share in the higher income classes.

Concerning the means of transport, the car was the preferred mode choice for both categories of business travellers. Indeed, the literature confirmed that business travellers almost took into consideration the quickest and most comfortable means of transport to reach their business location. Rail and plane were considered especially for longer trips outside of the country; bus travel was instead less frequent. However, it is worth mentioning that a considerable share of SD travellers often used other means such as bike, motorbike and considered even going on foot. A surprising result was also the use of truck, mostly used for short-haul trips.

From the last chapter, it emerged that car and plane were the most polluting means of transport in terms of absolute emissions and emissions per km and per trip. From around 500 km of distance the emissions released by air traffic overtook the ones from car since, as shown by the previous analysis, the plane became the most used means of transport. Nevertheless, with the use of these formulas, the emissions calculated seem to be low when comparing the result with the whole emissions from the transportation sector in Germany (the value amounted to around 793 tons of CO_2). This is somehow in contradiction to what has been found out in the literature analysed, as long-distance travel is 'high-environmentally impacting' in terms of emissions produced. The next section will provide the limitations of the work and a possible explanation for this outcome.

5.1 Limitations of the work and future research

In this subchapter, the limitation of the work will be expressed together with some self-criticism and proposal for future research in the business travel field.

Firstly, the goal of the literature review was to find scientific articles related to business travel and to gather as much information as possible for the data analysis. The first difficulty met was related to the limited availability of literature in the business travel field. Indeed, as mentioned in some articles, studies in the business travel area are limited compared to studies about leisure travel.

Another aspect was that the articles treated different aspects of the phenomenon, and some of them were not relevant or compatible with the goal of the thesis. It was therefore difficult to find correlations between the articles analysed, since the case studies were almost not connected to each other. Therefore, it was an important step to find topics which would be significant for the thesis and try to connect them in the best way possible.

The data analysis evaluated the data set from MiD 2017, downloaded in form of excel tables. About the data collection itself, it is meaningful to say that the survey MiD 2017 represented a high number of households in Germany (more than 100,000), resulting in a sample of 6235 long-distance and 19894 short-distance business trips. Therefore, the analysis evaluated a great range of demographical and situational variables which made it extensive and detailed. Nevertheless, other demographical factors such as the comparison between male and female travellers and the "practical" employment (In which sector did the respondents work?) would surely have add significance to the analysis.

The survey interviewed people going on business trips within Germany and to the other parts of Europe and the world; it would be important to consider and analyse the travellers coming to Germany for business purposes as well. In this way there would be a large panoramic about the business travel phenomenon in the country. This can surely represent a future field of research.

For the analysis itself, the data regarding business trips had to be firstly filtered from the "Reisen" and the "Wege" excel sheets since these data sets contained both business and non-business trips.

The instrument of pivot tables allowed to have an overview of the most relevant variables and to "combine" them as well, allowing to perform a bi-variate analysis. As mentioned earlier, the choice of the variables to relate came mostly from the literature analysed. Nevertheless, it was not always possible to find correlations between the variables involved (e.g., for the relation between distance and income).

Despite of that, the instrument of excel permitted to create quickly intuitive graphs to gain a visual representation of each variable considered in the analysis. For some cases the graphs available were not the most suitable but in general they gave a good illustration of the phenomenon. In case the sample size was not enough representative, so it was necessary to "eliminate" some data from the graph to gain a better visualization.

The calculation of the emissions was possible thanks to the use of an empirical formula which represented in a simple way the emission factors per passenger for the different means of transport. As mentioned earlier, it was not possible to obtain the values for the CO_2 equivalent emissions, which would have made the calculation more reliable. Another limitation which affected the calculation was related to the fact that the distances from the data set were represented by ranges. It was therefore necessary to use the mean values and to assume that these were representative enough for the calculation.

The outcomes obtained gave an overview of the impacts of the different means of transport for business travel in Germany. Nevertheless, the share of emissions caused by business travel in relation to the absolute emissions from the transportation system in 2017 was unexpectedly very low. As explained earlier, the sample of LD trips and especially of intercontinental trips made by plane was limited. Furthermore, the 'MiD' collected only the last three long-haul trips within the last three months before the survey.

All these aspects contributed to a low share of emissions caused by business travel in Germany. Therefore, a future estimation of the emissions could include a wider range of business trips with more focus on continental and intercontinental trips. Considering both trips to and from Germany would help to draw a better conclusion of the impacts of long-distance trips on the environment.

In terms of reducing emissions, as demonstrated in previous literature, a separate survey would need to be conducted to determine the willingness of respondents to substitute actual travel and reduce the impact it has on the environment. Investigating the purpose of the trip and its importance on the business activity could represent a significant step towards that direction.

In conclusion, business travel contributes to an important part of the emissions released by the transport sector. Investigating business travel behaviour represents the key to find new solutions which could reduce its high impacts on the environment and on climate change.

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Source for the data analysis:

MiD Processing2017-master B1_Standard-Datensatzpaket

List of figures

Statement of independent work

I hereby confirm that this thesis was written independently by myself without the use of any sources beyond those cited, and all passages and ideas taken from other sources are cited accordingly.

Munich, 20.02.2023