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TravelVu and TravelViewer

New Ways of Collecting and Evaluating Travel Survey Data

A Site Report

from Dresden, Germany

Part of the European Research Project:
Travelviewer – Data for Low-Carbon Sustainable Transport Systems

Dresden, 16 September 2020
https://tu-dresden.de/in-bewegung

DRESDEN IN BEWEGUNG

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Travelviewer – Data for Low-Carbon Sustainable Transport Systems

Prepared by

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Climate-KIC

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1 Introduction

Travel surveys have a long tradition and are regularly applied in many countries. They provide important basic data for both urban and transport planning — also enabling to see emerging trends in travel behaviour over time, when repeatedly conducted.

One of the main challenges facing large-scale travel surveys is the fact that response rates in register-based sampling are declining—this can be observed in Germany and beyond. Consequently, risks of selectivity as well as costs and efforts for obtaining high-quality data increase[1].

1.1 2017 Dresden Pilot Survey

Travel surveys are carried out in several formats: common traditional medias are postal questionnaires and telephone interviews, but also advanced formats such as e-mail and web questionnaires, or innovative ones by means of GPS-devices and smartphones are more and more in use.

Unlike previous data-collecting methods, innovative tools such as tracking apps collect data in real time, lowering the overall respondent burden and offering quality framework for a longitudinal survey design.[2]

Released by the Swedish company Trivector in September 2016, the digital travel survey app "TRavelVU" started with a couple of early pilot surveys carried out through universities in Europe.

One of them was conducted in the Saxonian state capital city of Dresden (Germany), recruiting about 70 participants via a voluntary convenience sample in spring 2017 to evaluate mobility characteristics and user experience with an app-based travel survey: as one of the key results, it showed that a survey period of seven days was sufficient to display variations in participants' multimodal travel behaviour.[3]

[1] HUBRICH AND WITTWER (2017)

[2] VERZOSA ET AL. (2017); WANG ET AL. (2018)

[3] VINCENT (2017)

1.2 2019 Dresden TravelViewer Test Site

In light of growing interest in new data-collection methods and their integration into traditional survey designs for enhancing data content, a further question arises: Do more targeted sampling and recruitment strategies exist for obtaining adequate sample sizes within an acceptable quality and cost range? Non-probability samples offer various promising approaches; yet they also entail challenges regarding systematic sample losses, representativeness, and sample bias.[4]

As part of the European research project "Travelviewer – Data for Low-Carbon Sustainable Transport Systems", smartphone-based travel surveys were conducted in Norway, Denmark, Germany and Italy — with a "2.0"-version of the app released in September 2019, especially entailing a new user interface for the primary purpose to improve user experience (UX). This led to the modified app name "TravelVu". Dresden is one of these sites where a survey was carried out in October and November 2019.

Besides the goal to collect a unique and high-quality travel behaviour database for future transport planning, it was also pursued to learn more about the performance and effects of different recruitment approaches in terms of sampling composition, costs and survey response.

Aiming for a representative sample that consists of all relevant person groups, a both broad-based and individually tailored recruitment concept was applied, combining different accessed resources (e.g., news, social media, local ads, printed materials) with various non-probability sampling techniques.

The results of the survey were analysed with an interactive dashboard called *TravelViewer* which was developed as part of the project by Trivector. The use of the TravelViewer-dashboard is powerful, modern, flexible and low-threshold way of analysing this new type of data.

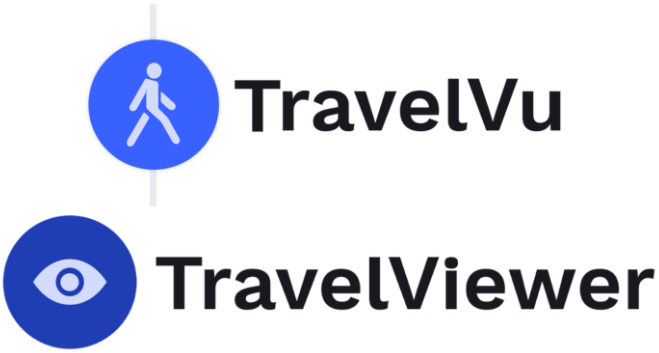


Figure 1: Logos of the TravelVu-app and the TravelViewer-dashboard

[4] KUHNIMHOF ET AL. (2018)

2 Facts about Dresden

The City of Dresden, capital of the Free Federal State of Saxony, is located in the central eastern part of Germany. Within a 200 km range, Dresden is related with the federal capitals Berlin and Prague:

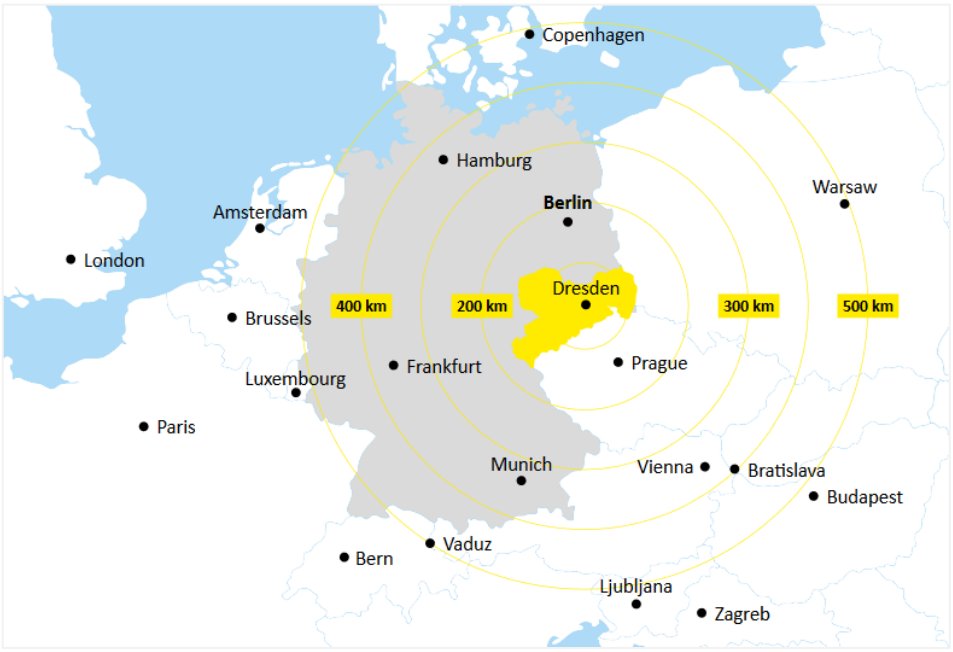


Figure 2: Geographic location of the state capital City of Dresden
Source: CITY OF DRESDEN (2018)

2.1 Geography and Population

Dresden has a total population number of **561,358 inhabitants** (primary residence, as of September 2019), with a share of foreigners of **about 8 percent**.

The federal state capital ranks 12th compared to the German largest cities. Since 1999/2000, the population has continually increased by about **4,300 persons per years** on average. A growing tendency is also forecasted for the coming years until 2035, with an expected number of **595,000 inhabitants**, outlining future challenges for urban and transport planning that need to be faced.[5]

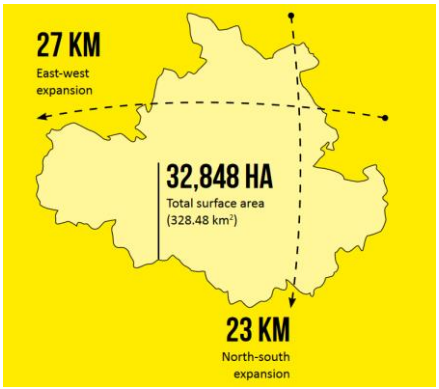


Figure 3: Surface area of Dresden
Source: CITY OF DRESDEN (2018)

In terms of total surface, though, it has 4th position, covering a surface **area of 328.48 km²** — behind the cities Berlin, Hamburg and Cologne.

[5] CITY OF DRESDEN (2019a)

With a look to the city's household structure, one may see in **Figure 4** that the vast majority consists of **single person households** (51 %), which has been increasing over the last three decades. 2-person-households form the second largest share (29 %).

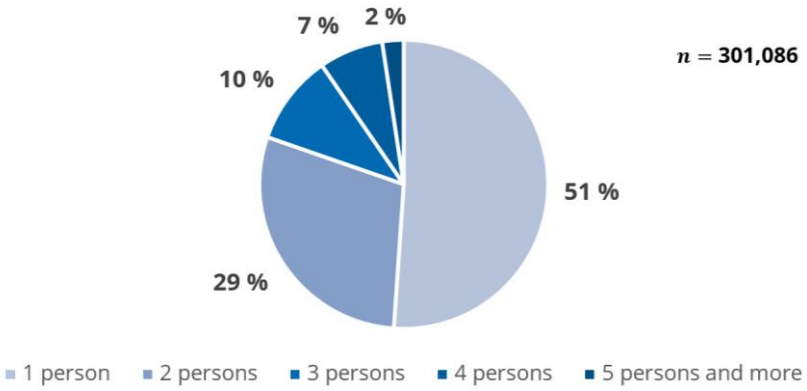


Figure 4: City of Dresden household structure 2018
Source: Own illustration with register data from CITY OF DRESDEN (2020a)

Focussing on the distribution of the different age groups within the city's population, approximately **27 percent** of the inhabitants are 60 years old or more, about **18 percent** are younger than 18 years.

The greatest discrepancies according to gender can be found especially in the groups **25 to 34 years** with a surplus of men, as well as **70 years and more** of age, with a surplus of women:

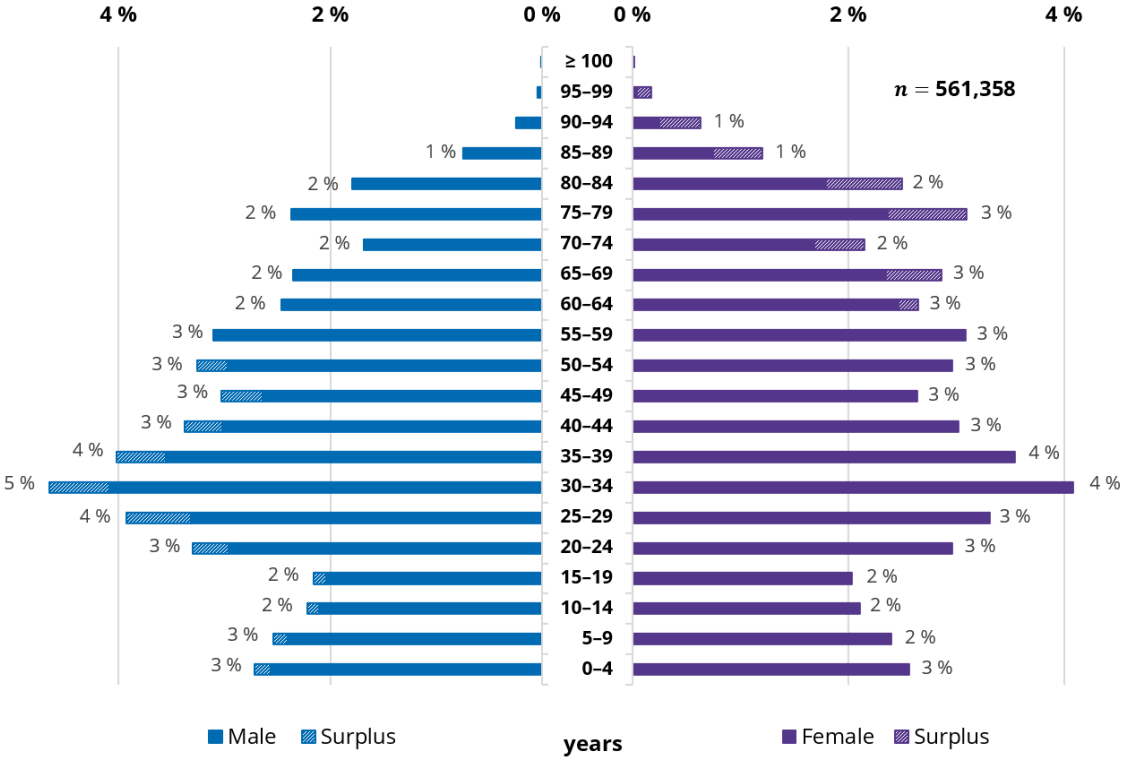


Figure 5: Age-gender-distribution in the City of Dresden in Sept. 2019
Source: Own illustration with register data from CITY OF DRESDEN (2019b)

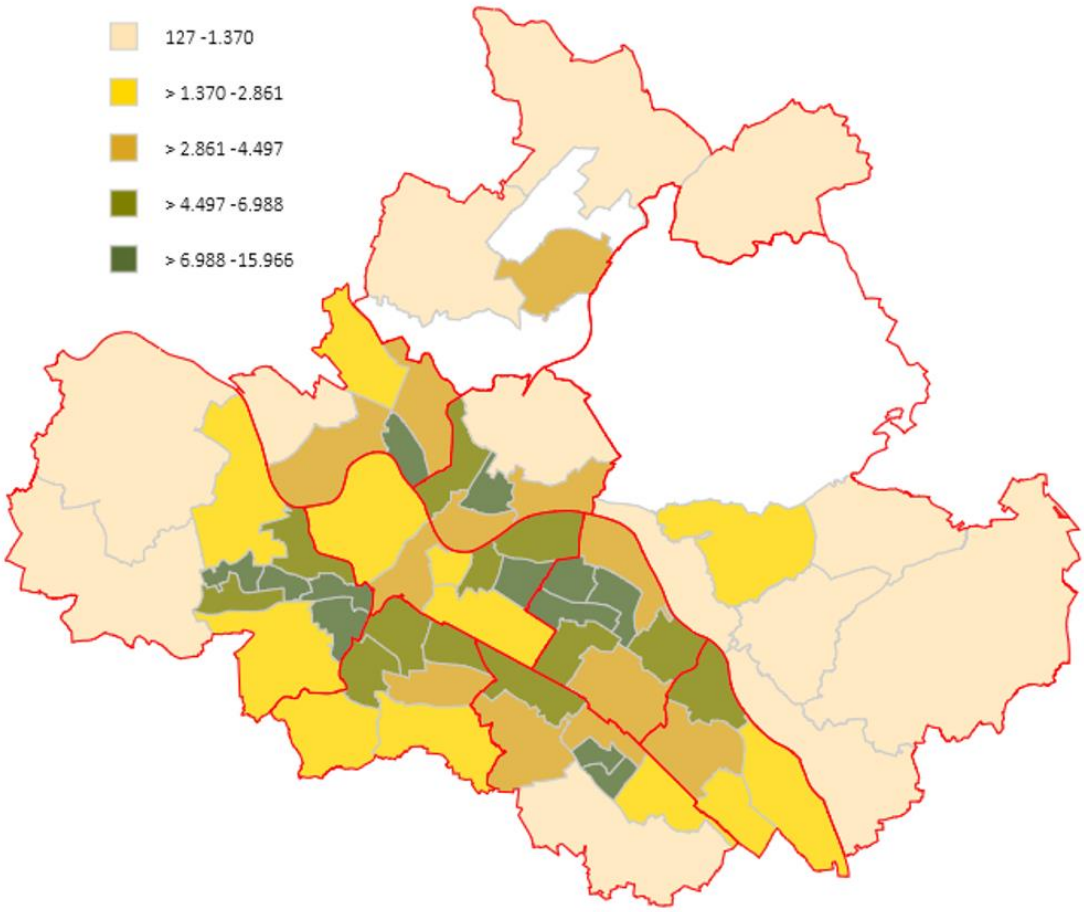


Figure 6: Inhabitants per square kilometre by neighbourhoods in 2019
Source: © City of Dresden, Municipal Statistical Office

When one looks at the distribution of the population across the city, one may see that there are two larger **concentrations with a high density** (dark green areas). It is also worth noticing that the city's population is more situated **towards the south side of the river** *Elbe*, which streams from south-east along the historical centre to west.

2.2 Economics

With an increasing tendency for the last couple of years, Dresden as a work location counted **269,422 employees** in year 2019, whereof **96,812 were commuting into the city**.[6]

The overall purchasing power in the City of Dresden in 2019 rose to EUR 11,916 million, counting **EUR 21,623 per inhabitant**.

This corresponds — as measured by the purchasing power index — to **90.9 points in Germany** (average value equals 100). In context of the federal state Saxony, Dresden is situated in mid-range, between the cities Chemnitz and Leipzig.[7]

[6] CITY OF DRESDEN (2020b)

[7] CITY OF DRESDEN (2020c)

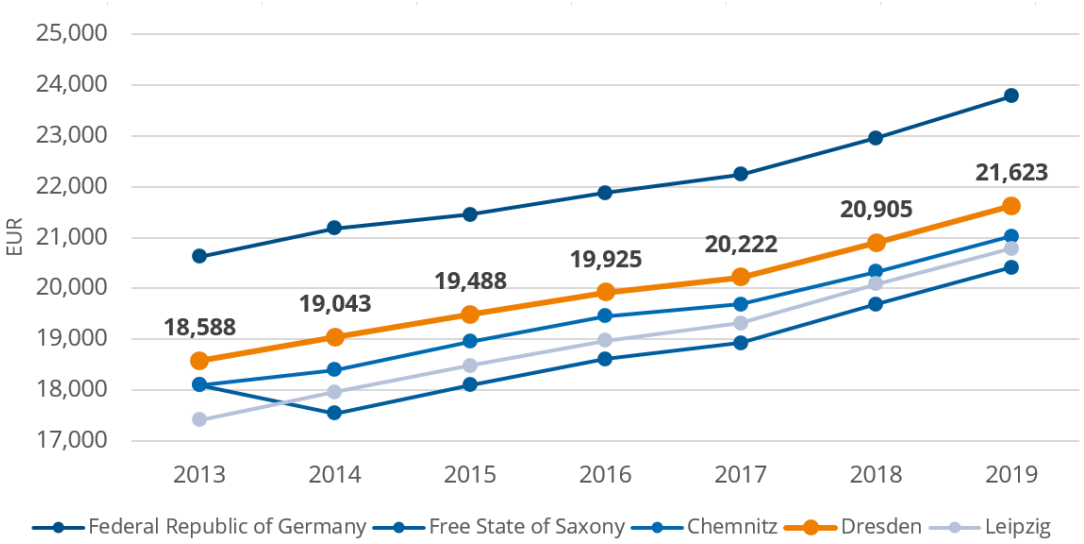


Figure 7: Purchase power by region from 2013 – 2019
Source: Own illustration with data from: CITY OF DRESDEN, dl-de/by-2-0 (www.govdata.de/dl-de/by-2-0), opendata.dresden.de

Unemployment in Dresden in year 2019 amounted to **15,699**, which corresponds to a ratio of **5.3 percent** related to inhabitants in civilian employment.[8]

[8] CITY OF DRESDEN (2020d)

2.3 Transport in the City

The City of Dresden offers a broad transport system with various interacting modes — roads and streets, railways, busses and tramways, ships and ferries, cycling and pedestrian paths and the Dresden airport.

The fact sheet below puts all important pieces of information into the perspective of each mode available in the city and provides some key figures to it:

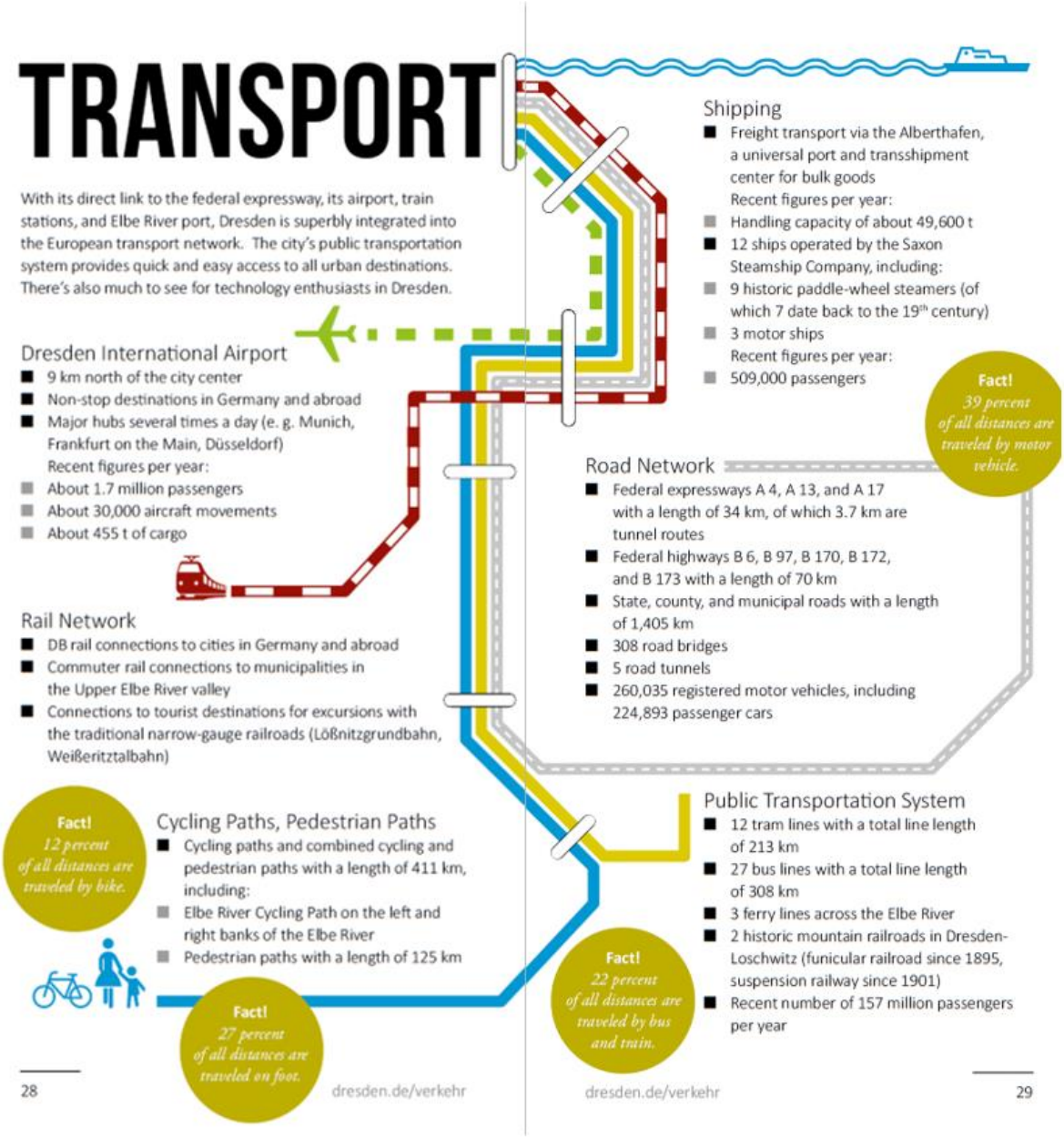


Figure 8: Overview of the Dresden transport infrastructure
Source: CITY OF DRESDEN (2018)

Figure 9: "MOBIPunkt" at TU Dresden
Source: © TUDBildPool | Crispin-Iven Mokry

In order to better link existing public transport services and car- & bikesharing as well as to simultanously support electric mobility by charging stations, a broad-based consortium — including the City of Dresden, the municipal transport company *DVB AG,* the municpial utilities *DREWAG* together with both a car- and a bikesharing company — continues to set up various **intermodal mobility points**.

Called "MOBIPunkte" in German, these hubs are placed at frequented places, also actively promoted by media campaigns to raise awareness for multi-modality. Furthermore, the mobility hubs are embedded into the European Smart City Project *MAtchUP*[9].

So far, **16 stations** have been put into practice (black icons), a lot more are planned to be implemented during the years 2020/2021 (yellow icons):

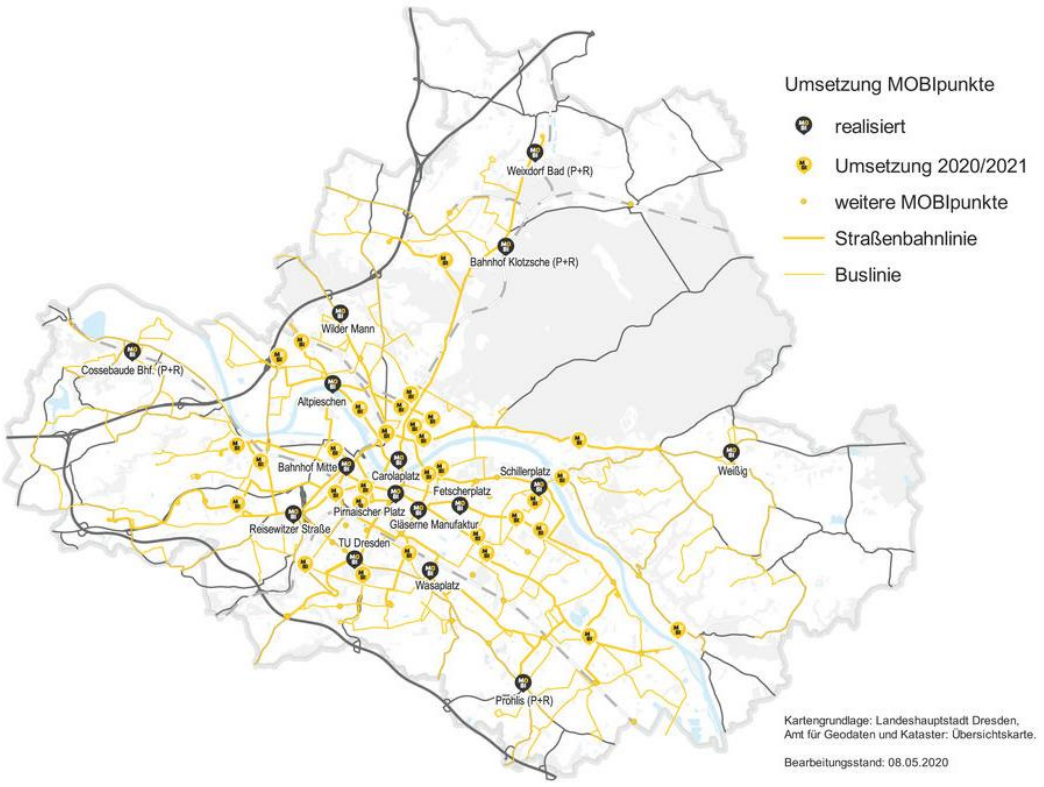


Figure 10: Implemented and planned mobility points
Source: © DVB AG

[9] Stands for "MAximizing the UPscaling and replication potential of high level urban transformation strategies", see also:
https://www.dresden.de/en/business/location/matchup.php

2.4 SrV Mobility Characteristics

Since 1972, Dresden takes part in the cross-sectional household travel survey **"Mobility in Cities – SrV"**, which is normally carried out by the *TU Dresden* every five years in many municipalities and metropolitan areas in Germany.

This enables cities such as Dresden to quantify a population's travel behaviour (already emerging in **Figure 8** on page 7) by means of **mobility characteristics** and to monitor trends thanks to a continuous design.

In the case of the City of Dresden, it can be observed clearly that trip shares performed with **environmental-friendly modes** of transports have been growing without exception for the last 20 years, to **64 percent** in the lasted survey wave in 2018:

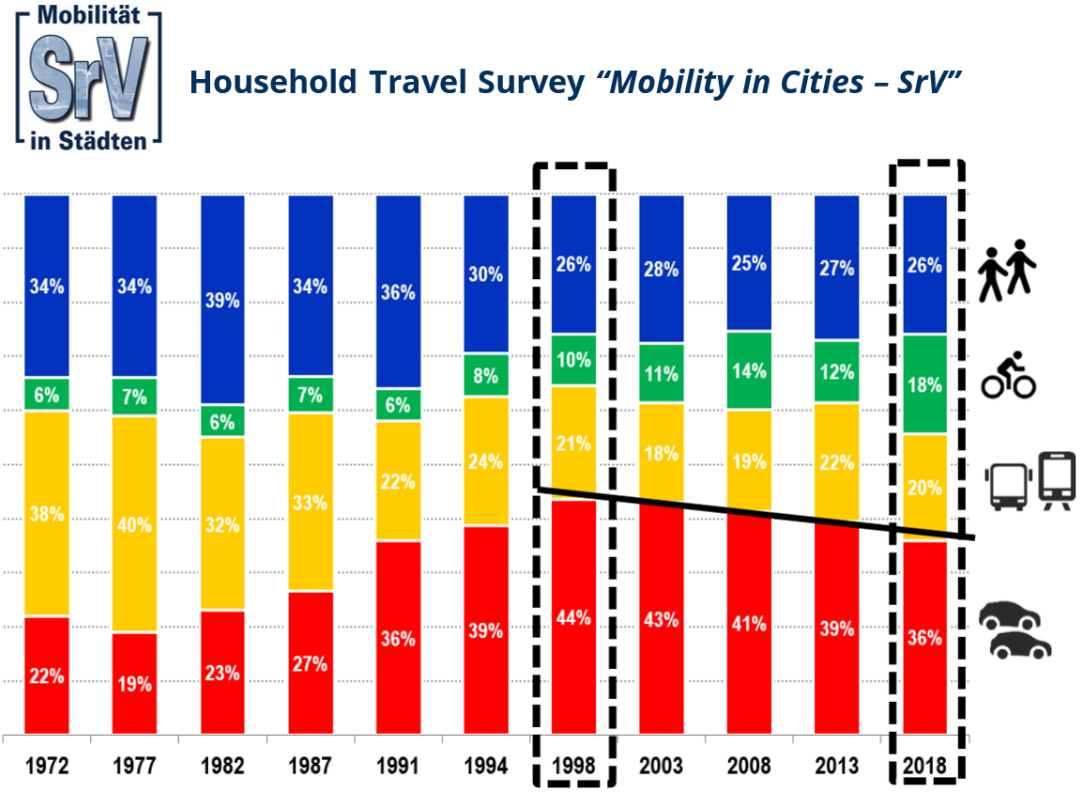


Figure 11: Dresden modal split in continuous design
Source: CITY OF DRESDEN (2020e)

In 2018, a person performed on average 3.6 trips per day. A trip had a length of 5.3 kilometres on average and a duration of 21 minutes. As another example of observable trends in travel behaviour, a majority of the Dresden population (57 %) changes the (main) transport mode on a regular basis during weekdays.[10]

[10] CITY OF DRESDEN (2020e)

Also, the user acceptance towards car and bicycle sharing has been increased from 5 percent in 2013 to 13 percent in 2018:

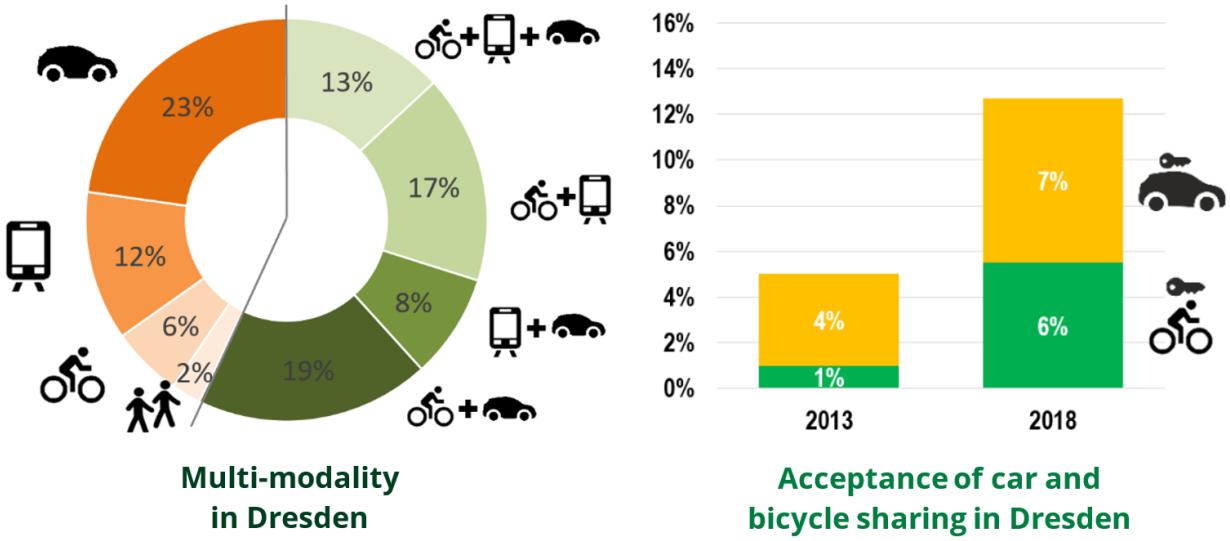


Figure 12: Multi-modality and acceptance of sharing systems in Dresden
Source: CITY OF DRESDEN (2020e)

These values can be seen as good preconditions for the growing number of intermodal mobility points being set in place, serving as possible indicators to monitor the further user acceptance as well.

3 Methodical Approach

This chapter describes general decisions on the design of the TravelVu-survey. After a short overview on non-probability sampling techniques, a general framework is set, regarding the overall topic of the survey, but also concerning space, time as well as the population to be targeted. The chapter's main part focusses on the chosen recruitment strategy.

3.1 Using the Digital Travel Survey App TravelVu

Developed by the Swedish company Trivector, the smartphone app TravelVu gives users the possibility to GPS-track their everyday **movements and activities in a personal timeline**. Thus, in contrast to conventional survey modes, participants do not need to remember their trips (and segments of trips) they made. This provides higher levels of accuracy and data quality, due to the fact that each trip is geo-referenced.

In semi-automatic manner, used modes of transport and activities are recognised and inferred, based on the data collected. This means that the user needs to check and, if necessary, to adapt one's day with several **editing functions** available in the app. Trips and activities can be split, joined or moved.

Each travel day needs to be confirmed by tapping on **"Mark my day as correct"** for being able to contribute to a survey. In doing so, users get a summary of their trips made, shown both in length and time depending on the modes of transport they have chosen (modal split). In addition, a **questionnaire** can be implemented in order to receive socio-demographic data on the respondents:

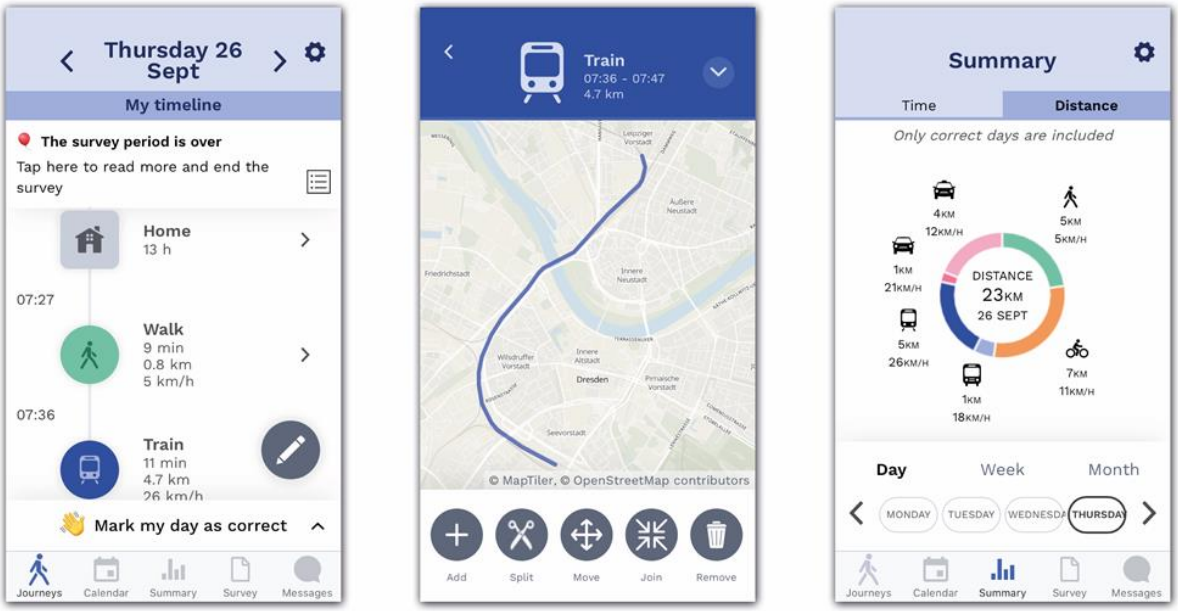


Figure 13: Main functions of TravelVu (version 2.1.0)

3.2 Sample Recruitment

3.2.1 Non-Probability-Sampling Techniques

Looking at the key features of non-probability sampling, it can be noted that these sample methods allow to select participants more freely so that in many cases, the question of sample size is ambiguous and no complete sampling frame exists (or needs to exist). In reverse, this means that the probability of each case being chosen from the target population is not known (it may even be zero percent).[11]

Even if advantages and disadvantages are quite specific, general **benefits** of non-probability sampling can be seen in higher cost- (and time-) effectiveness and in its effectivity if random sampling is not feasible or practical (such as in exploratory stages of research projects).[12]

Drawbacks are that research issues may not be directly generalisable compared to probabilistic approaches. Additionally, samples may be more affected towards biases and less reliable as assumptions of probability theory as well as sampling error do not apply any longer.[13]

Several **non-probability sampling approaches** have been gathered through a literature research: although some terms are varying or hard to separate from others, it has been shown that sampling techniques differ in type of selection, likelihood to be representative, extend of sample control as well as overall costs and efforts:

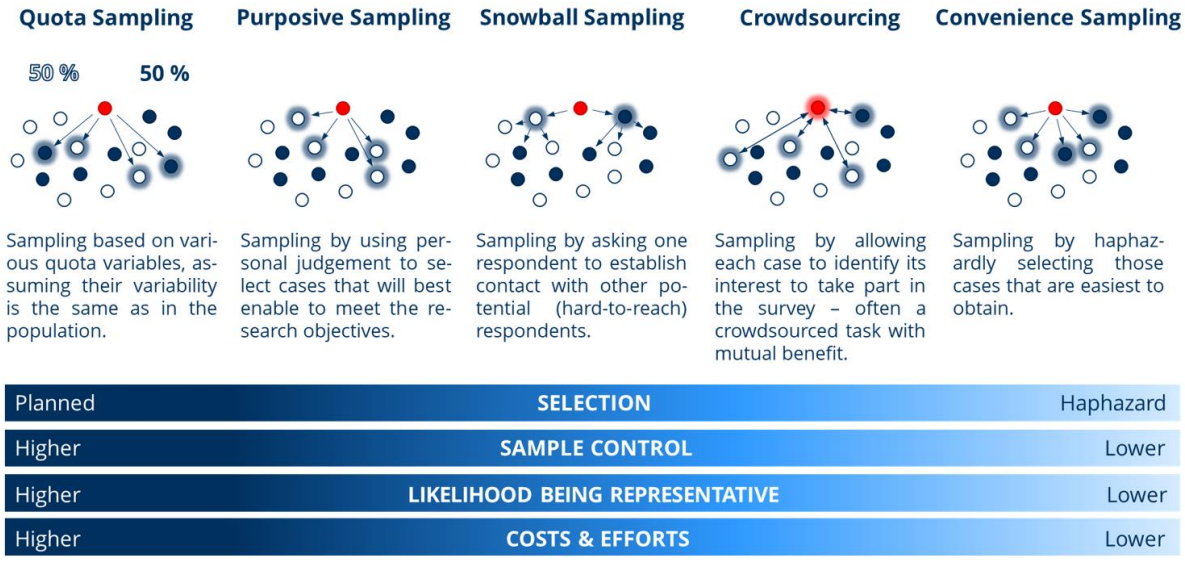


Figure 14: Applied non-probability sampling techniques
Source: own illustration based on SAUNDERS ET AL. (2016), ESTELLÉS-AROLAS UND GONZÁLEZ-LADRÓN-DE-GUEVARA (2012), images based on SCRIBBR.COM (2019)

[11] From ADAMS UND BRACE (2006) and SAUNDERS ET AL. (2016)

[12] Ibid.

[13] SAUNDERS ET AL. (2016) and FOWLER (2008)

3.2.2 Survey Frame

To generate a certain media impact and establish contact to the general urban public, the project team decided to link the survey to climate-friendly transport as a current issue.

By this, special attention was payed to the necessity that climate-friendliness as key topic needs to be put into practise in a completely neutral way. No attitudes or even instructions on how to travel sustainably were intended to be communicated through any kind of recruitment material.

Instead, it was aimed to encourage both contribution to a unique data basis for a better and more sustainable urban transport in the future and to conversations on the topic.

Through this, the international project framework "Data for low-carbon sustainable transport systems" supported by the Knowledge and Innovation Community Climate-KIC could be taken up as well.

The survey was named "Dresden in Bewegung" with the two-language slogan "Per App zum klimafreundlichen Stadtverkehr" in German, and English "Towards climate-friendly urban transport by app".

Figure 15: Survey logo and slogan

The addressed target population within this survey was everybody who considers oneself to be predominantly located in Dresden. Besides the city residents, this also allowed all those living in the surroundings or even further outside of Dresden to be part of the survey, depending on a personal assessment whether one's travel behaviour would be relevant according to an urban context.

This expanded the potential group of individuals with the effect that no real sampling frame existed.

The spatial borders of the investigation area are defined by the city's boundaries. For more detailed spatial reference, the city's districts and incorporated villages have been used (see **Figure 16** on the following page).

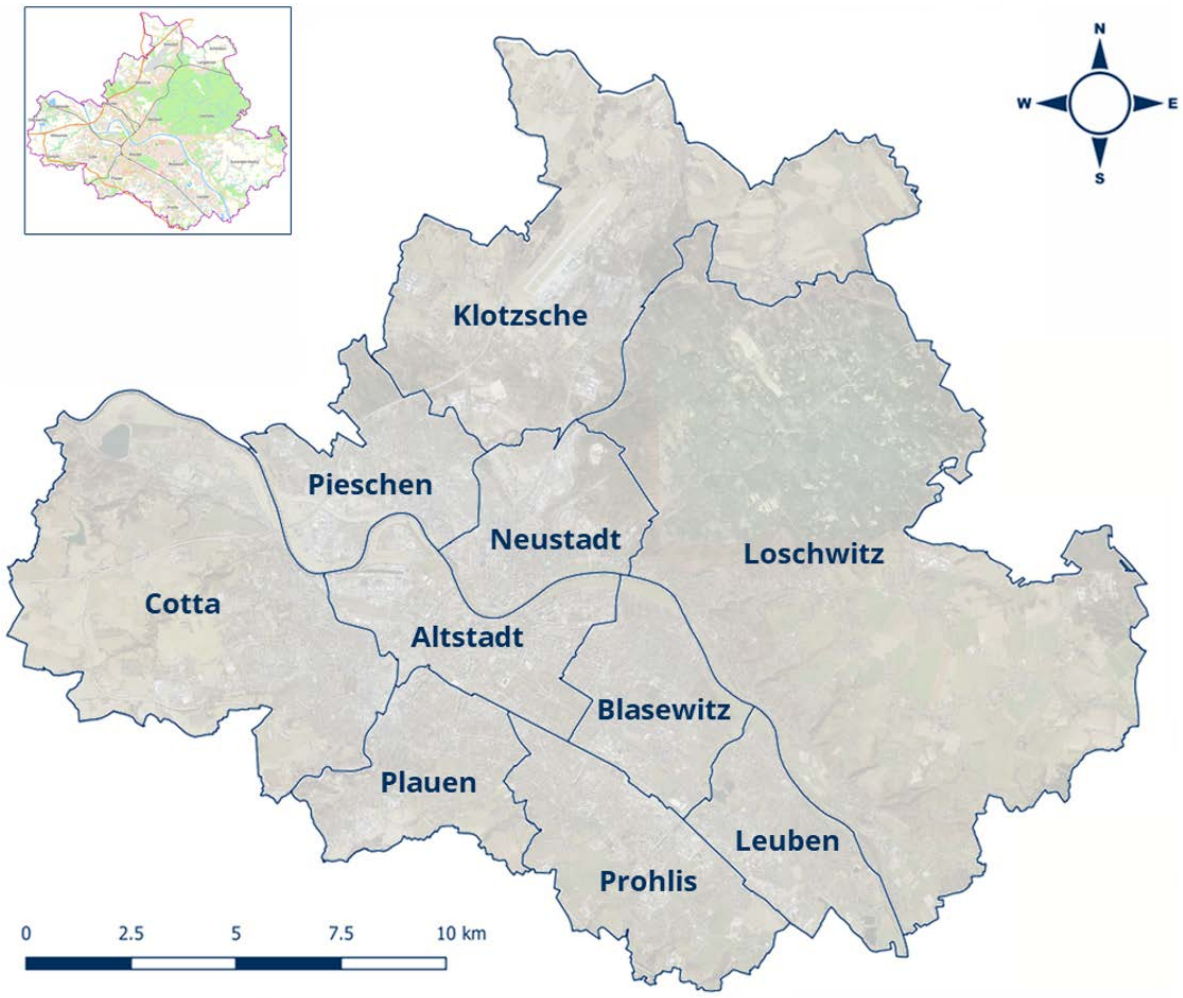


Figure 16: Dresden and its city districts
Source: CITY OF DRESDEN

In addition, the target group was set with an age limit of at least 18 years at the very beginning of the survey instructions within the app.

Even though a lower age limit of 16 years would not have been completely impossible, this was done in order to avoid a certain grey zone as well as discussions on parental consent.

The survey took place from 14 October until 24 November 2019, with additional three days to correct one's data. Potential participants were asked to answer an in-app questionnaire and to be part of the survey for 7 days.

The questionnaire contained questions on e.g. socioeconomic attributes, where people live (post code) or how they found out about the survey (see **Appendix** on page 2). There was no registration required as one could download and join the survey directly.

3.2.3 Recruitment Strategy

It was aimed to reach a sample of at least 1,000 individuals by targeting all relevant person groups of the city's population. To reach the favoured sample size and to address all segments of the city's population, it was decided to choose a two-stage sampling approach, combining the advantages of different techniques.

Each demonstration site was provided recruitment material templates by Trivector and suggested channels of communication on how to use developed material in case of non-probability sampling.

By combining these channels with the sampling techniques above, specific recruitment instruments were developed and assessed qualitatively according to estimated costs, expenses, expected range and whether a specific group would be addressed.

(1) In a first step, more **haphazard sampling** approaches were employed in order to reach the favoured sample size, including mainly crowdsourcing and convenience sampling as well as techniques similar to snowball sampling:

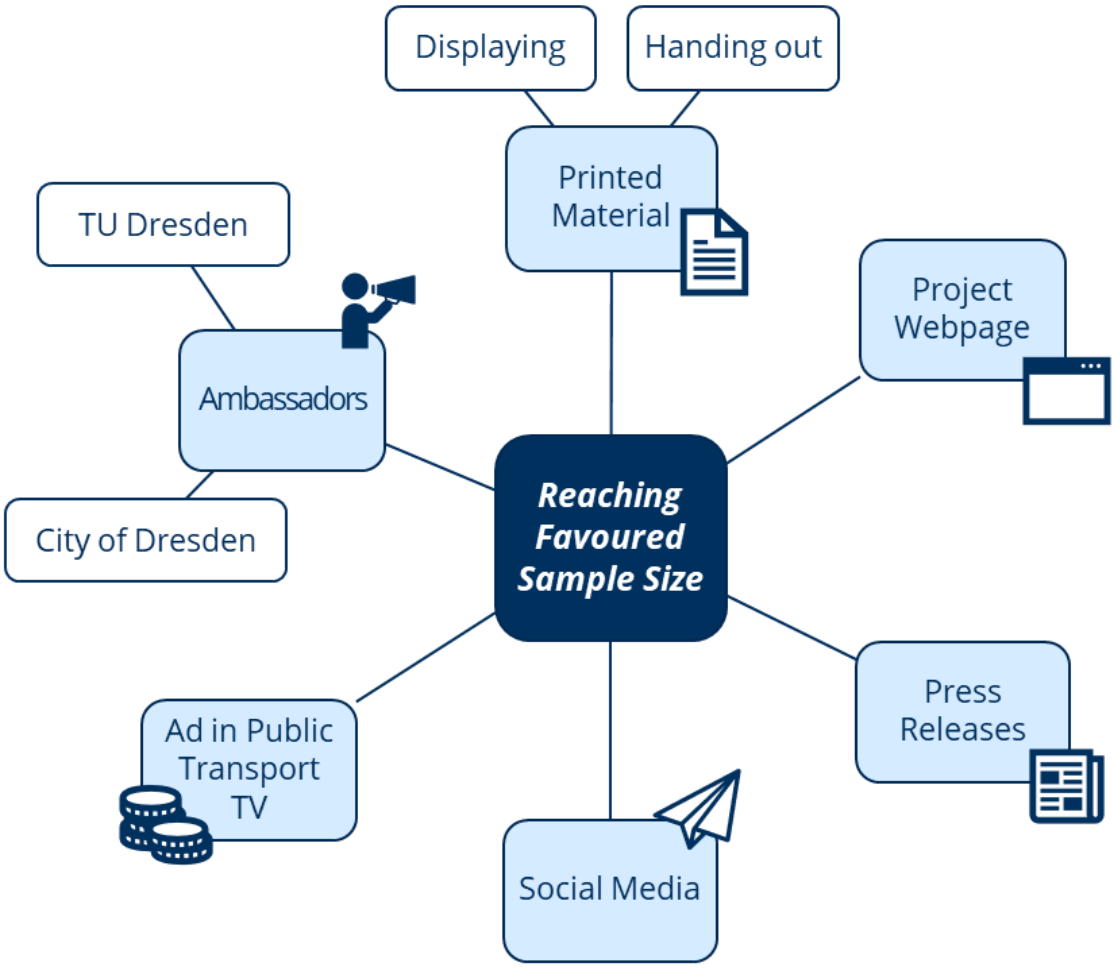


Figure 17: Recruitment instruments during haphazard sampling phase

(2) In a second phase -the **dynamic sampling phase**-, techniques with planned selection were used to address specific groups tending to be underrepresented and to minimise risk of skewness. This was mainly a combination of quota sampling as a comprehensive method and purposive sampling:

Figure 18: Recruitment instruments during dynamic sampling phase

The chosen instruments were put together to a recruitment strategy including plans on motivation and support of participants.

All used recruitment material can be found in the **Appendix** from page 5 onwards.

4 Data Analysis with the Interactive Dashboard TravelViewer

TravelViewer, an interactive travel survey analysis-dashboard, has been developed as part of the so-named project — with the goal to give access to organisations for visualising and downloading aggregated data with varying degree of detail (such as mobility characteristics, trip chains, health or CO_2) and for monitoring their travel survey online. Under permanent development, a broad range of functions have been implemented already.

The dashboard is structured in the **four** overall tabs as working steps to be done:

- **Survey:** here, all available surveys including key facts are listed
- **Sample:** overview on sample composition according to background variables; the possibility is given to include secondary data
- **Weighting:** weighting of the sample can be performed according to specific background variables included
- **Analysis:** within the TravelViewer's actual main section, analyses can be performed by filtering the data e.g. depending on mode, activity, background questions, date and time or the participants home area (based on the stated home-activities in the app).

  The results shown are grouped into three categories: a short overview with key values on mobility, a detailed section on trips and activities and an evaluation chapter on the background questionnaire.

  All results are presented both as chart (pie or bar available) and as the data behind it, giving a brief explanation on how the data was calculated as well as the possibility to export aggregated table data into a calculation program.

  In addition, the results showed in the dashboard can also be aggregated by both main modes of transport and main activities.

Figure 19 on the following page gives an impression of the TravelViewer's user interface, showing an example of visualised results possible to filter by several variables available.

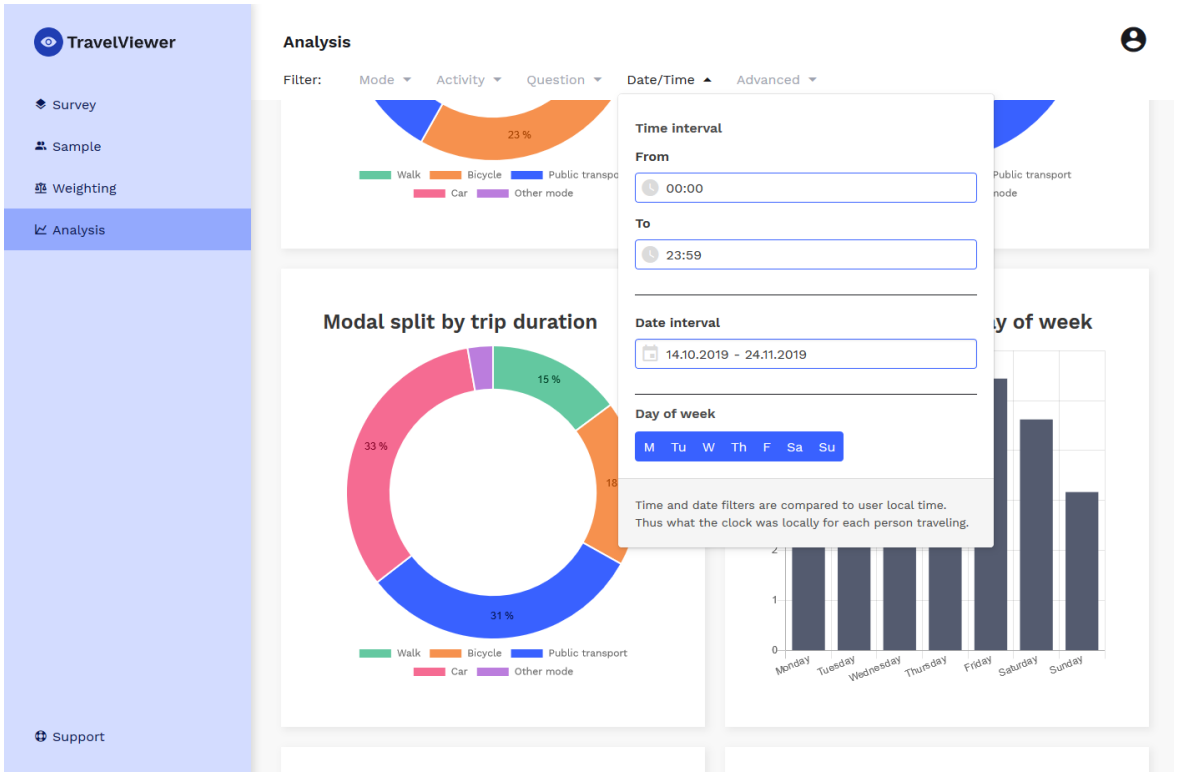


Figure 19: Interface of interactive analysis-dashboard TravelViewer

Various analyses have been done by means of the TravelViewer-dashboard. **Table 1** gives an overview, whether data from both the background questionnaire and collected travel behaviour have been weighted[14] and how these have been analysed. Weighting refers to gender and age[15] distribution, as well as the distribution across the city's 10 districts.

To avoid overcompensation of underrepresented elderly people (only about 3 % of the input sample size N=619), it has been decided to exclude the age group of 60 years and above, resulting in a sample with participants between 18 and 59 years of age for evaluating mobility characteristics.

Divided into the subsections *socio-demographic data* from the background questionnaire, overall citywide *mobility characteristics* and *in-depth analysis* approaches demonstrating the potential of TravelViewer, the following analyses have been performed in the travel survey analysis dashboard (see following page).

[14] By secondary data from register of residents from 09/19, CITY OF DRESDEN (2019c)

[15] Based on four age groups: 18–24 years, 25–44 years, 45–59 years (and 60+ years)

Table 1: Analyses done in the dashboard

	Analysis	Unweighted	Weighted *by Gender, Age & District (only 18-59)*
Socio-Demographic Data	Gender Distribution	x	
	Age Distribution	x	
	Place of Birth	x	
	Driver's License (per Age Groups)	x	
	Type of Accommodation	x	
	Owning/renting Property	x	
	Size of Household	x	
	Main Occupation	x	
	Level of Education	x	
	Professional Training	x	
	Home Area	x	
	Survey Recruitment	x	
Mobility Characteristics	Trips per person and day		x
	Kilometres/Minutes per person and day		x
	Modal Split by Number of Trips		x
	Modal Split by Trip Distance		x
	Modal Split by Trip Duration		x
	Number of Trips per Day of Week		x
	Activity Distribution (per Number of Trips)		x
	Activity Distribution (per Trip Distance)		x
	Activity Distribution (per Trip Travel Time		x
	Average Distance per Trip		x
	Average Travel Time per Trip		x
In-Depth Analyses	Trips per Person and Survey Day		x
	Mobility Characteristics by specific attributes – Gender – Age – Primary occupation: *employees and students* – Professional training: *vocational training and academic degree* – Selected city districts		x

5 Survey Results

In this chapter, main results of the survey are presented. This includes an analysis of the survey's background questionnaire giving an overview of the sample's composition, evaluations of mobility characteristics and impulses for more in-depth analyses through the TravelViewer-dashboard.

The following data served as a starting point for follow-up analyses, including all those participants who corrected at least one travel day:

Table 2: Input sample data

Attribute	Value
n individuals	619 (whereof 588 are under 60 years)
n corrected days	8,466
n trips	> 40,000

The sample size in each diagram on the next pages refers to the number of individuals that provided information to the data queried.

5.1 Questionnaire

The following figures refer to the background questionnaire implemented in the Dresden-survey, these are unweighted.

Figure 20 shows that there is **a tendency** towards male participants to some extent. In terms of age, more than a third of the participants stated to be between 18 and 24 years, almost half of the sample refers to the group 25–44 years and 13 percent was 45–59 years old. The smallest share with three percent was 60 years and older. **The majority** of those who participated in "Dresden in Bewegung" is born in Germany:

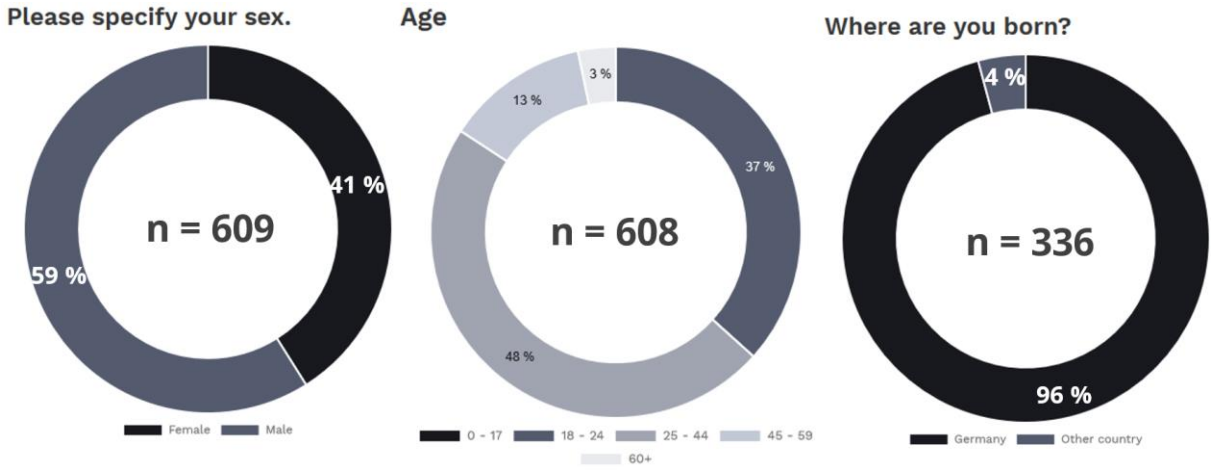


Figure 20: Composition of the sample 1

Figure 21 provides information on the possession on driver's license, type of accommodation as well as data on the primary occupation and highest level of education and profession.

93 percent of the participants stated that they possess a driver's license. With regard to the housing situation of those who participated, a share of **87 percent** stated to live in a multi-family house, about the same number of people rent their accommodation. Looking at the primary occupation distribution, **almost half** of those who answered to this question were students at university, more than a third is full-time employed:

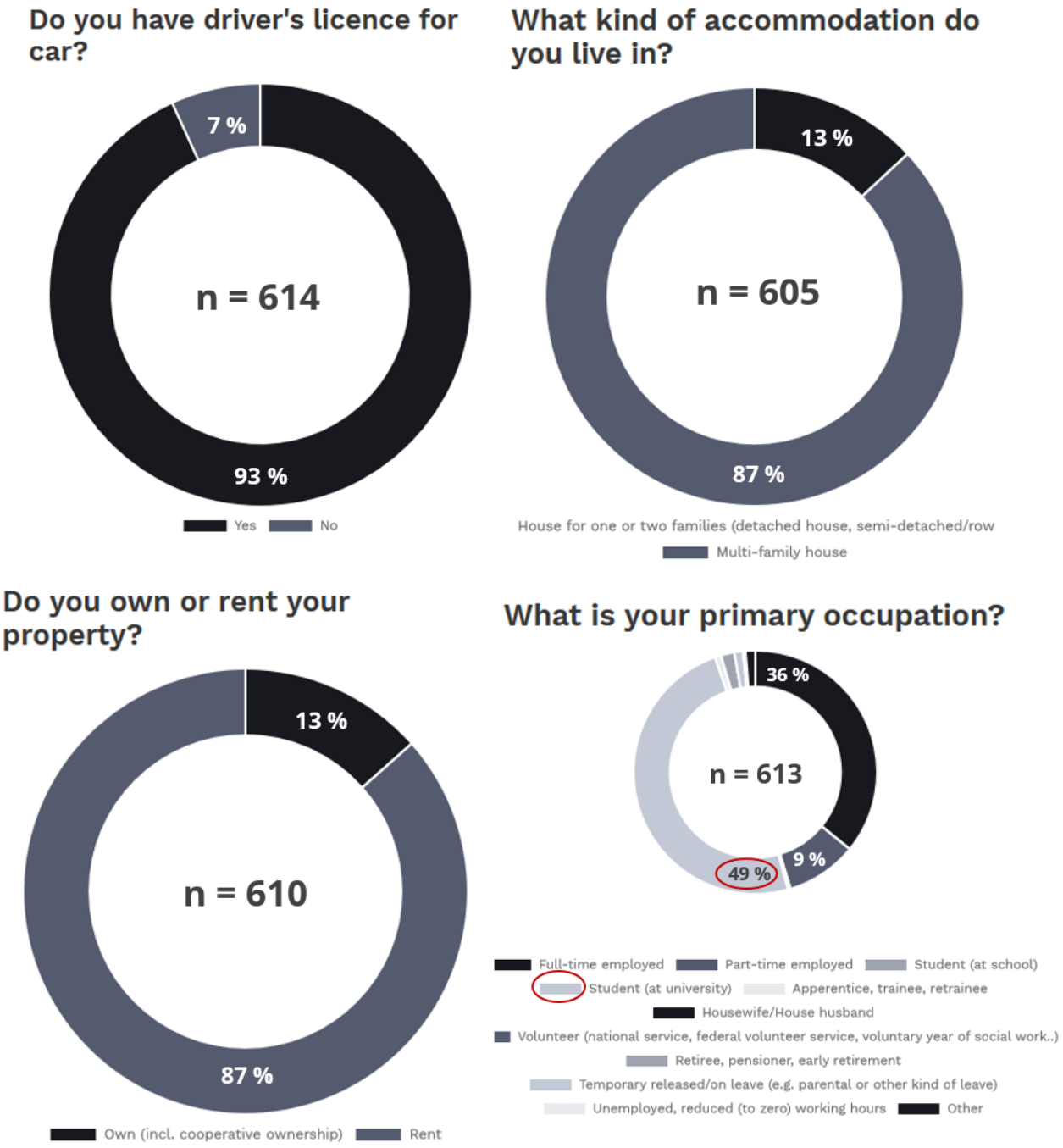
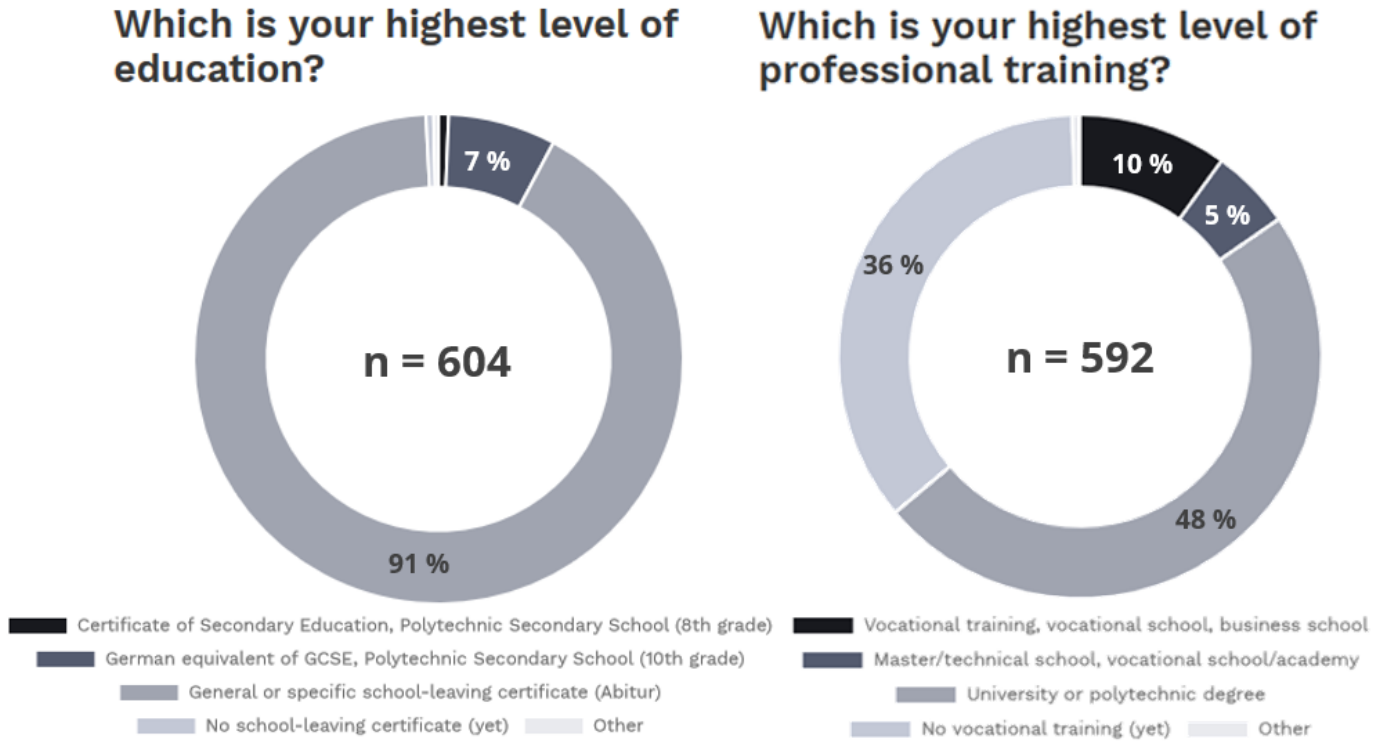


Figure 21: Composition of the sample 2

Evaluating the highest level of education, **nine out of ten** stated to have acquired general or specific school leaving certificate (in Germany: Abitur), **7 percent** a German equivalent of GCSE.

Concerning the highest level of professional training, almost **50 percent** have a university or polytechnic degree, followed by **36 percent** of the participants not having completed a vocational training at the time of the survey:



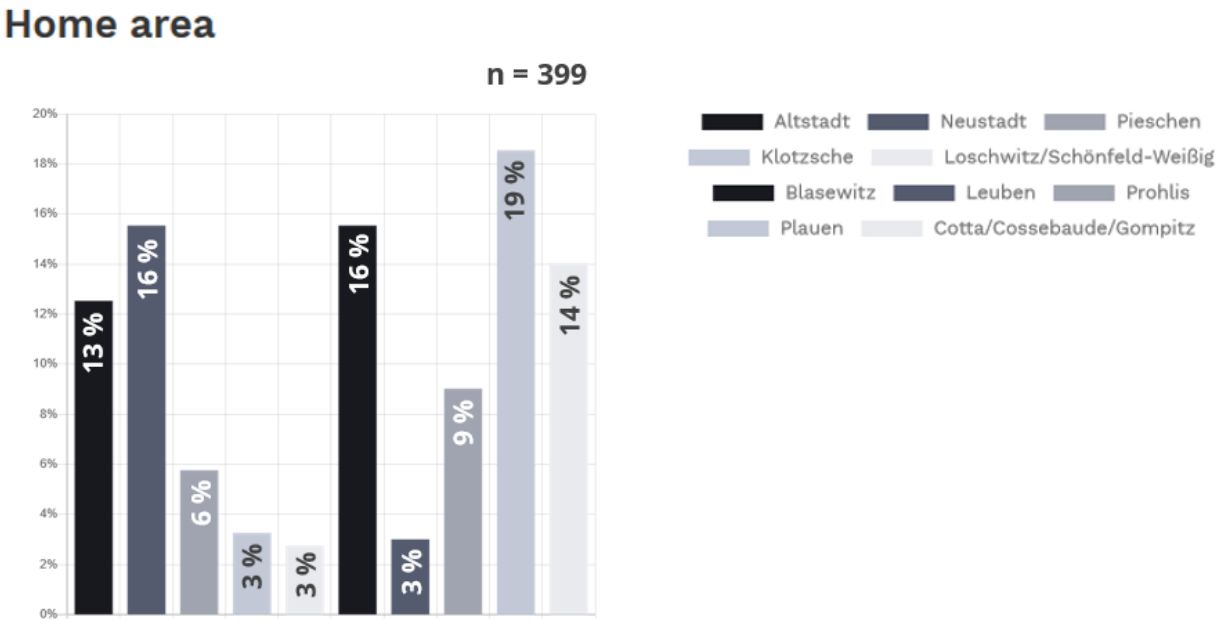


Figure 22: Composition of the Sample 3

Regarding the distribution across the city's districts, most of the participants live in *Plauen* (19 %), according to the stated activity "home" in their personal travel timelines. This is followed by the districts *Neustadt* and *Blasewitz* (both 16 %), *Cotta* (and incorporated villages, 14 %) and *Altstadt* (13 %). Fewest are situated in the districts *Klotzsche*, *Leuben* and *Loschwitz/Schönfeld-Weißig* (3 %).

The last part of the background questionnaire concerned the question on how people have found out about the survey. Here, multiple answers per individual were possible:

Many participants stated that they found out about the survey by one of the newsletters/circulars sent to all TU Dresden-students during the survey period (42 %), followed by news media (14 %) and Facebook (10 %). Other larger groups consist of people that chose friends, neighbours or relatives, the project and city administration website as answer options:

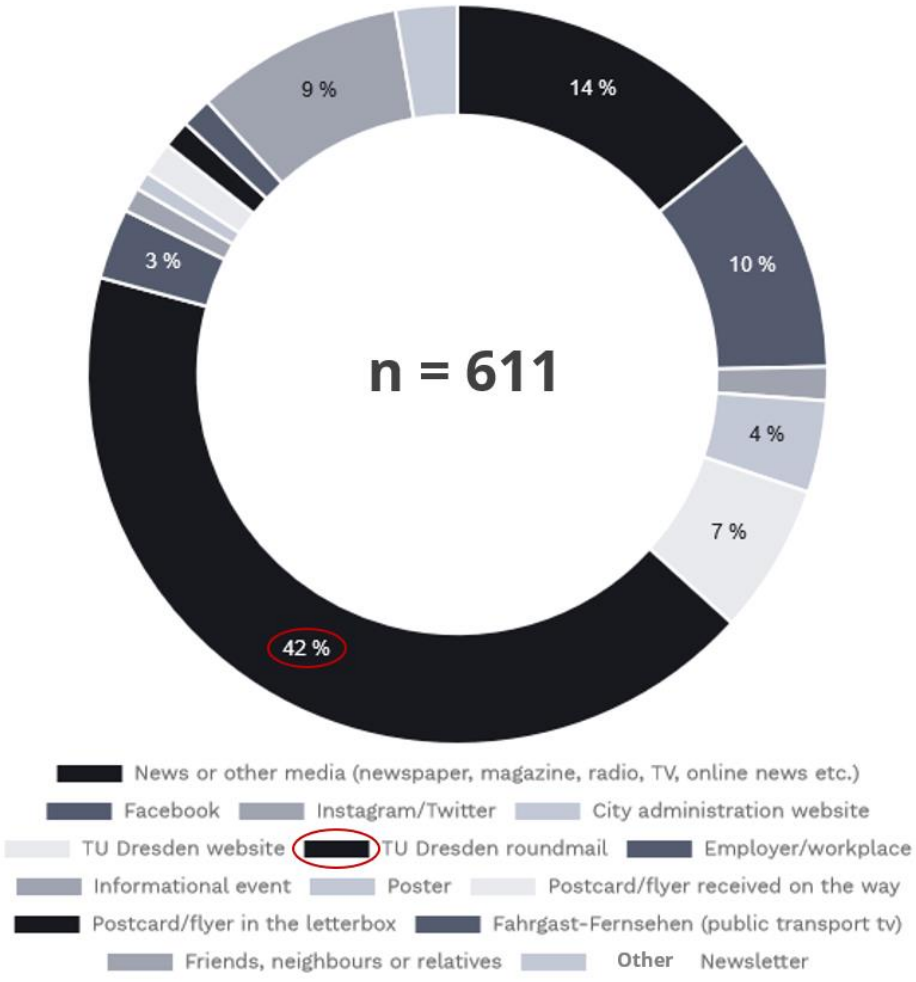


Figure 23: Recruitment instrument naming

Further analyses on **recruitment instruments per age group** concluded that most participants between 18–24 years were recruited by university. Those between 25 and 44 were showing the greatest mix of instruments. A majority of participants between 45–59 found out about the survey via the news, which also applies to people with an age of 60 years and more, showing higher shares regarding printed material, even though this group comprises the smallest number within the sample.

An assessment on the cost-effectiveness of both the entire survey and specific recruitment instruments including working hours has been done in WEBER ET AL. (2020), also comparing costs per netted participants towards the traditional household travel survey "Mobility in Cities – SrV" from 2018.

5.2 Mobility Characteristics

The following results have been weighted by secondary data from the Dresden register of residents from September 2019[16]. This refers to gender and age[17] distribution, as well as the distribution across the city's 10 districts.

To avoid overcompensation of underrepresented elderly people (only about 3 % of the input sample size n = 619), it has been decided to exclude the age group of 60 years and above, resulting in a sample with participants between 18 and 59 years of age.

One may note that these values represent **average values per participant**. Thus, confirmed travel days do not count separately but summarised to one average travel day (if no specific filter such as weekdays are applied). This leads to the following key mobility values:

4.8 trips per person and day

125 min per person and day

34 km per person and day

Figure 24: Mobility key values, 18–59 years

On the next page, **Figure 25** provides a comprehensive fact page on the mobility behaviour evaluated with TravelViewer. The first half is dedicated to modal split evaluations, the second one to characteristics of trips themselves.

Looking at modal split evaluations, the greatest share of trips refers to trips on foot (35 %), followed by both bicycle and car trips (23 %), the smallest assignable mode share corresponds to public transport (16 %) — environmental-friendly modes (walk, bicycle and public transport) comprise about **74 percent**, local emission-free or electric trips (walk, bicycle and tramcars) add up to **68 percent**.[18]

Evaluated by distance, the greatest share of trips is done by car (49 %), followed by public transport (34 %) and bicycle (12 %). Evaluated by trip duration, the share of walk and bicycle trips contributes with a higher, the share of private car with a lower percentage.

The number of daily trips during the week is fairly equally distributed. Most of the trips were done **on Fridays with 5.4 trips per person**, the lowest number **3.2 trips per person** were done **on Sundays**.

In terms of average trip lengths and times, both car and public transport trips are dominating.

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[16] See CITY OF DRESDEN (2019c)

[17] Based on four age groups: 18–24 years, 25–44 years, 45–59 years and 60+ years

[18] Electric vehicles have not been included

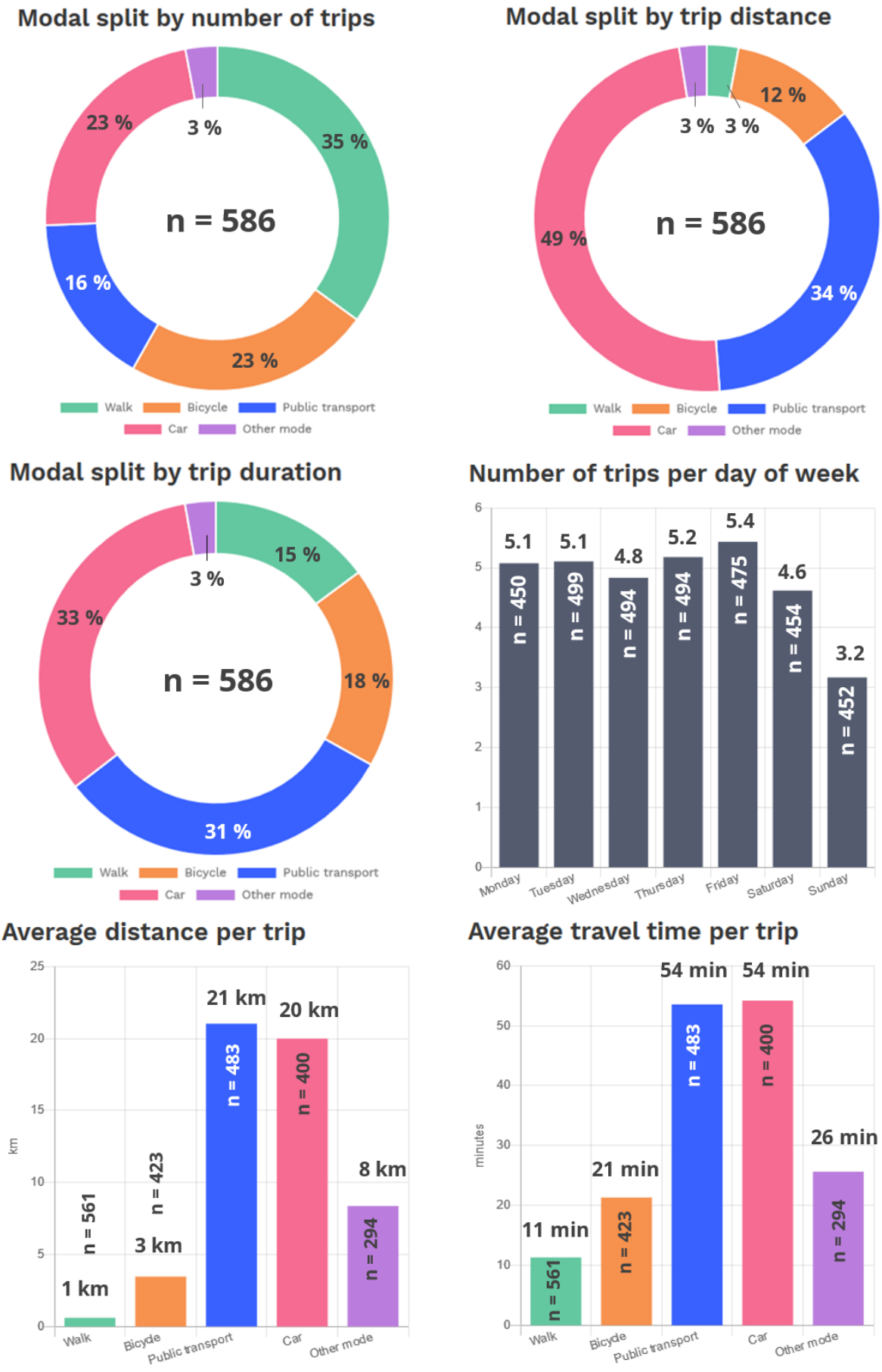

Figure 25: Trip characteristics, persons 18–59 years

Looking at the distribution of activities in more detail, which is done in **Figure 26**, every third trip is home-bound. 20 percent of all trips are connected to leisure activities, followed by 17 percent work- and 15 percent shopping-related trips. Distributions per trip distance and travel time are at similar levels. One may note that trips in connection with other activities than those listed here[19] have been excluded from analysis to make the figures more comprehensible:

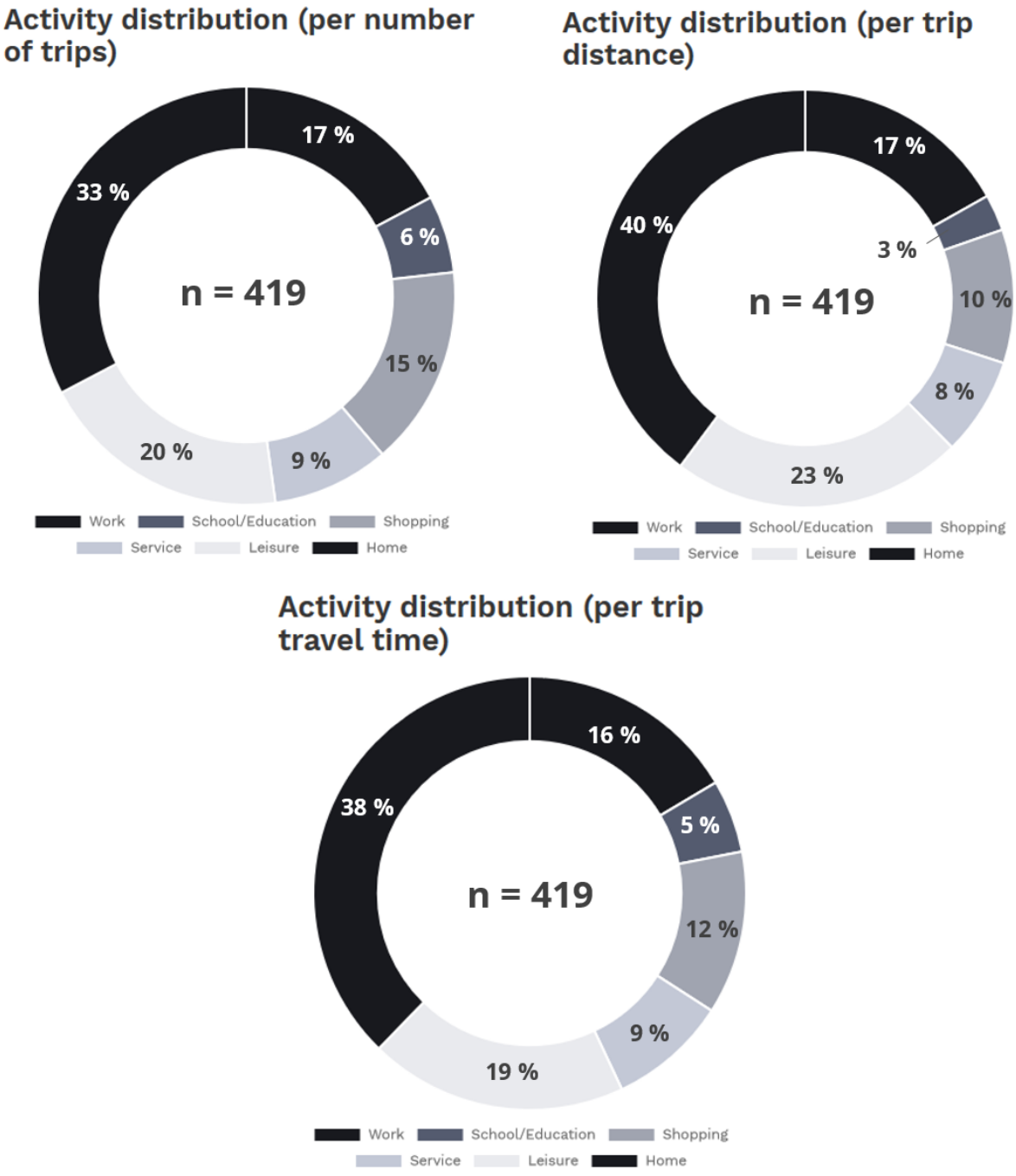

Figure 26: Activity characteristics, persons 18–59 years

[19] These are activities not known or transfer activities such as public transport waiting times or parking

5.3 In-Depth Analysis Approaches

Weighted according to the criteria named above, the results here are to give approaches for more in-depth analyses on travel behaviour. This is done by assessing both single survey days and specific groups of the population:

When looking on the number of trips per person and weekday throughout the field duration period**, three points in time** stand out of the avergae distribution throughout the week (see **Figure 25** on page 26).

Less trips were made at the beginning of the survey period — this may be due to the fact that **participants were joining the data collection gradually** on the one hand, but on the other, **autumn holidays** (14/10/2019–24/10/2019) may have influenced results towards less trips perfomed, too. Taking these two aspects into consideration, weekday averages were at a slightly lower level compared to the overall values.

Two other obvious deviations are due to **two single-day public holidays** — Reformation Day as well as one further holiday for Saxony, as it can be seen in **Figure 27** below:

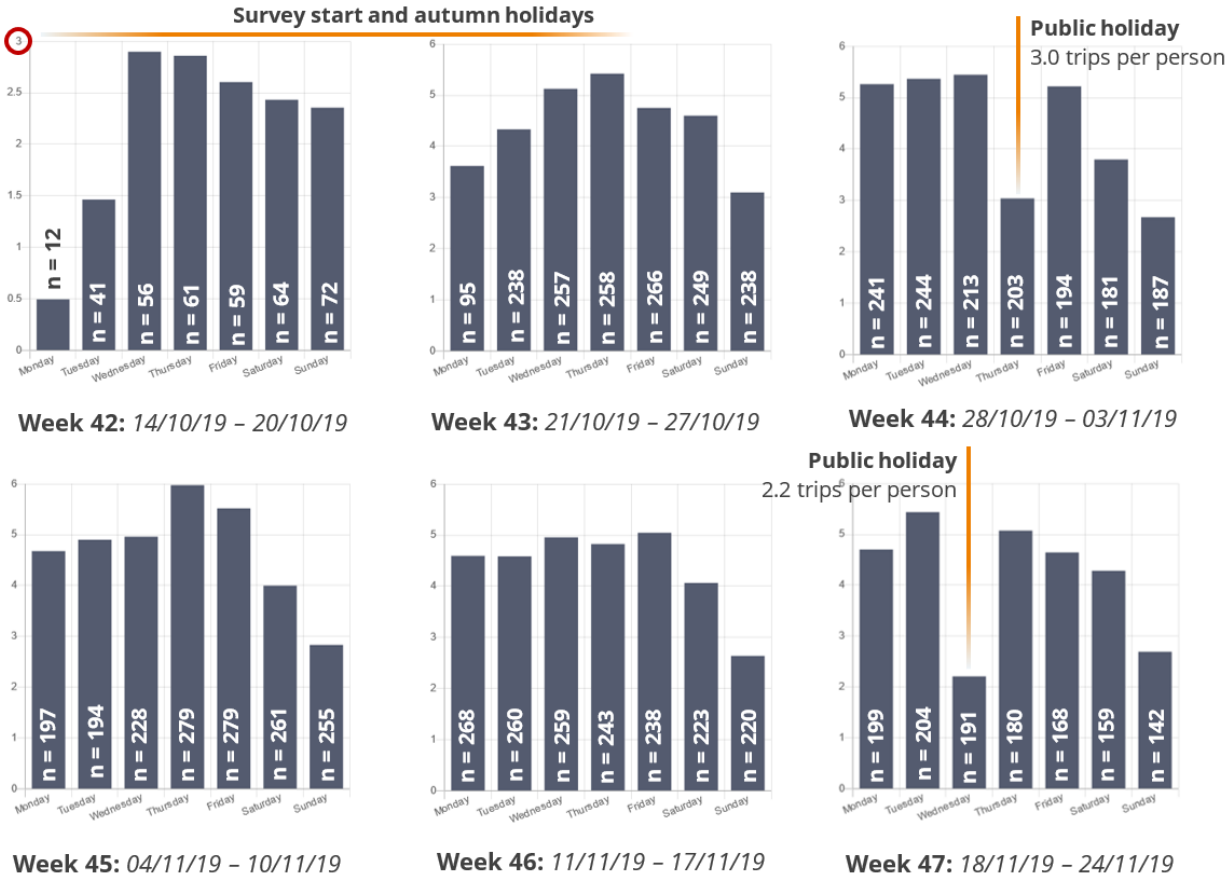

Figure 27: Trips per person and survey day, persons 18–59 years

Enabled by the in-app questionnaire, travel behaviour data could be filtered by background variables in the TravelViewer-dashboard. In doing so, the data being given were assessed in more detail, with regard to specific **sociodemographic, travel demand as well as city structure groups** and their resulting mobility behaviour:

- Gender
- Age
- Primary occupation: *employees and students*
- Professional training: *vocational training and academic degree*
- Selected city districts

Taking a first look at mobility characteristics in terms of **gender**, modal split values of both female and male participants are relatively similar. Yet, certain differences can be identified: female persons tended to make trips more often by public transport and less by car. Also, the share of walking was higher to some extent:

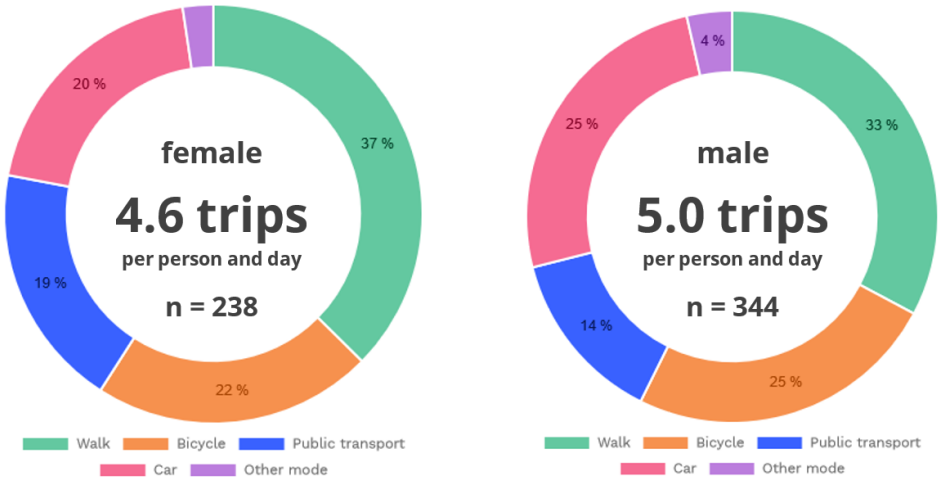

Figure 28: Mobility characteristics by gender, persons 18–59 years

It is interesting to note that men in the selected survey sample performed 0.4 more trips per day on average than women did. This is contrary to the traditional household travel survey "Mobility in Cities – SrV" in 2018, where especially middle-aged women a characterised by a high mobility due to more complex daily routines[20], and might be due to observable tendencies towards younger and more highly educated participants.

Investigating the three **age** groups introduced in **Chapter 5.1** on page 20, a clear tendency can be observed (see the following page):[21]

[20] GERIKE ET AL. (2020)

[21] The age group of 60+ years was excluded from analysis due to an insufficient number of individuals within this group.

While the share of trips performed with public transport is quite high (28 %) and by car quite low (6 %) in the youngest age group, these are more equally distributed for the ones between 25–44 and even turn around in the group of 45–59.

The proportion of walking and cycling trips, however, remain similar. Only exception occurs within the age group 45–59 years, where the share of trips by foot is descending to 29 percent.

Furthermore, one may see that there is a slight decrease in the number of trips per person and day along the three defined age groups:

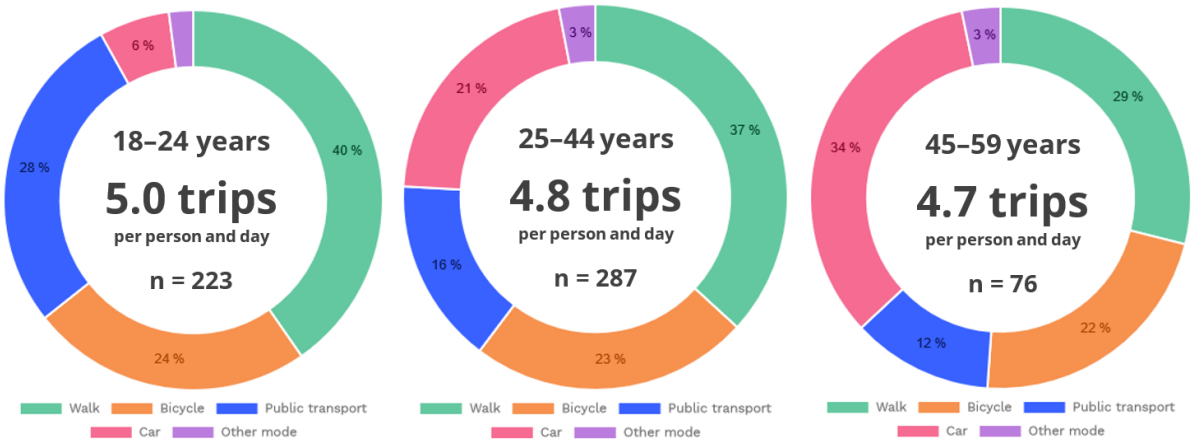

Figure 29: Mobility characteristics by age groups, persons 18–59 years

Focussing on **primary occupation**, two participation groups, estimated to be suitable for further analysis, have been selected: (half-time & full-time) employees and students. One may see that participants in employment made on average one trip more per day than student participants with 3.2 trips per day:

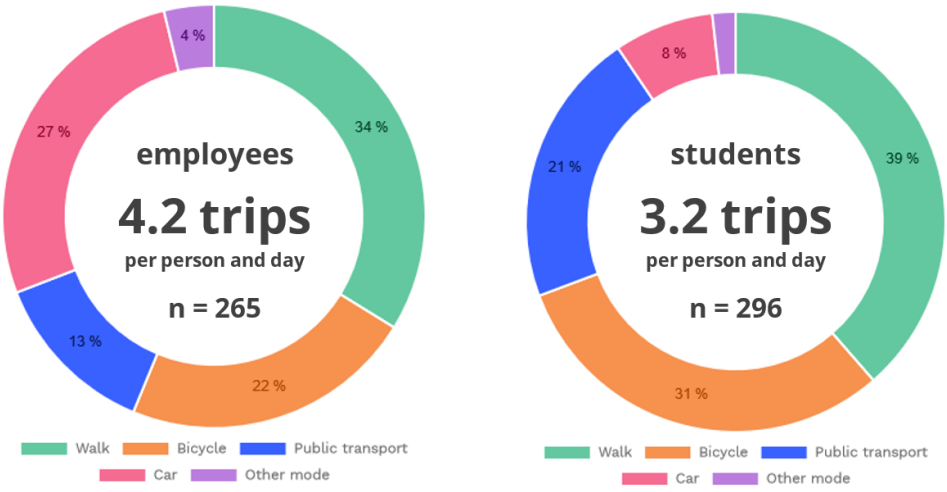

Figure 30: Mobility characteristics by occupation, persons 18–59 years

Regarding choice of transport modes, employees performed more trips by car (27 %), compared to students (8 %) who had a higher share of trips by bike (11 % difference) and public transport (8 % difference).

Analogous to the participants' primary occupation, two groups, applicable for in depth-analysis, were chosen according to the highest level of **professional training**: in doing so, mobility characteristics of participants with vocational training were compared with those of participants with an academic degree:

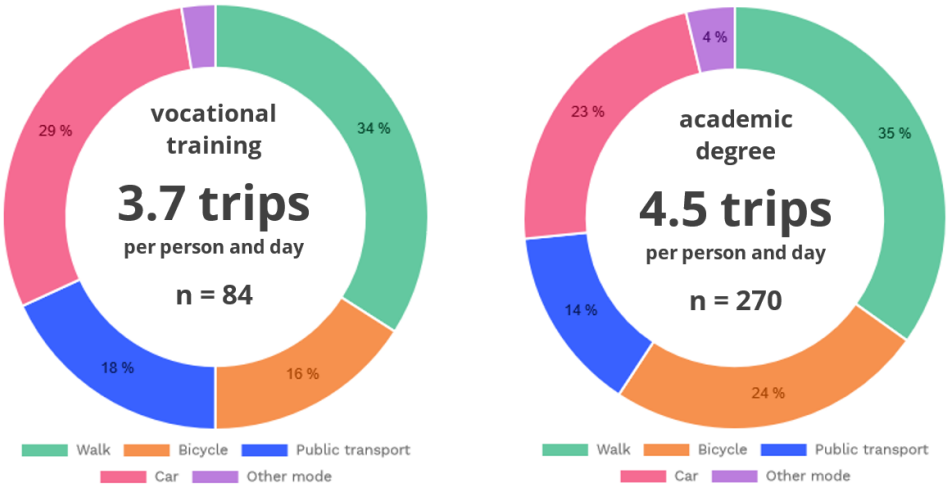

Figure 31: Mobility characteristics by profession, persons 18–59 years

Besides the fact that surveyed people with an academic degree performed 0.8 more trips than those with vocational training, differences between the two selected groups in terms of mode selection turn out to be smaller than those observed in the primary occupation comparison:

Participants with vocational qualification had slightly more trips done by car (6 % difference) and public transports (4 % difference), whereas persons with academic graduation cycled more frequently (8 % difference).

As a last category of more in depth-analyses, travel behaviour has been assessed according to the participants' home area. Using the city's districts as a spatial reference, four **districts** have been chosen:

- Neustadt
- Blasewitz
- Plauen
- Cotta

Due to lower numbers of participants per district, analyses were limited to percentage distributions of transport modes.

The city district **Neustadt** consists to a large part of the *Outer Neustadt*, known to be Dresden's heart of alternative culture with a closed and densely built quarter from the Foundation period.[22]

[22] See also https://www.dresden.de/en/tourism/attractions/sights/neustadt_district/outer-neustadt.php

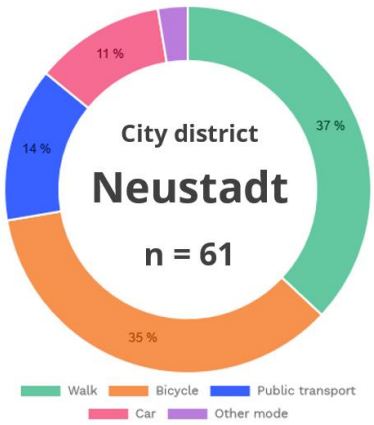

Figure 32: Modal split in city district Neustadt, persons 18–59 years
Source: Own illustration with picture from © TU Dresden

The district's built structure is partly reflected in the inhabitants' mobility characteristics: the share of trips made by bicycle is dominating both the public transport and car trips taken together, showing a difference of 10 percent. Referring to the modal split evaluated for the entire city, there is a surplus of 12 percent.

Blasewitz, a city district with a more open but also dense building structure, is well-known for its high share of multi-family villa houses surrounded by greenery, named "Kaffeemühlenhäuser" (German for 'coffee mill houses', resembling the design of a coffee mill).

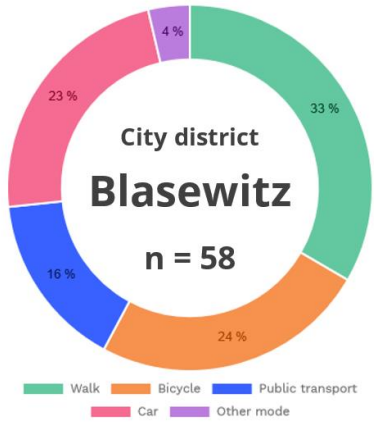

Figure 33: Modal split in city district Blasewitz, persons 18–59 years
Source: Own illustration with picture from © Kalispera Dell / Wikimedia Commons (CC BY 3.0)

In contrary to the district *Neustadt*, car and bicycle trips are on a same level, also reflecting the mode shares of the city as a whole. With a value of 16 percent, trips performed with public transports in turn are comparable with those done by inhabitants within *Neustadt*, in terms of scale.

Closely connected to city centre, the district **Plauen** is one of the more heterogeneous areas in Dresden: semi-connected, modern multi-family houses, high-rise buildings but also historical buildings shape the district. The university's main campus is also situated here.

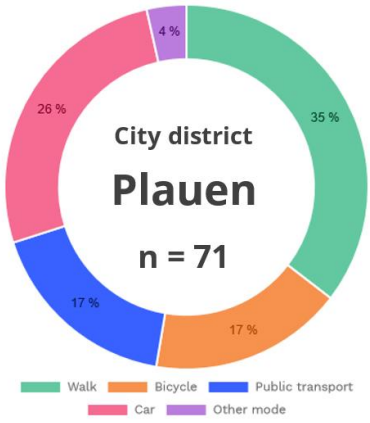

Figure 34: Modal split in city district Plauen, persons 18–59 years
Source: Own illustration with picture from © Paulae / Wikimedia Commons (CC BY 3.0)

Looking at the distribution of transport modes in *Plauen*, one may see that the share of bicycle trips is lower compared to the districts *Blasewitz* and *Neustadt*. More trips were done by car, whereas the proportion of public transport trips is similar.

Cotta is a district characterised by three different surroundings: *Löbtau*, a neighbourhood of older fabrics with increasing attractiveness, is known as one of the student quarters in Dresden. A coherent high-rise structure is characteristic for the large panel system-buildings in *Gorbitz*. A more rural character can be found in the *incorporated villages* in the western parts of *Cotta*.

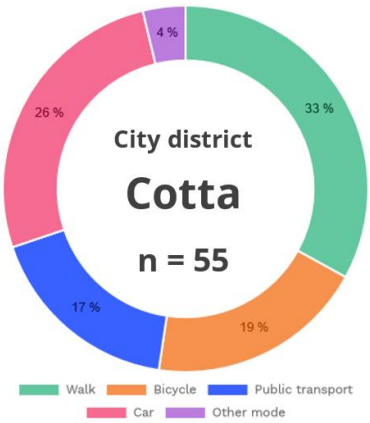

Figure 35: Modal split in city district Cotta, persons 18–59 years
Source: Own illustration with picture from © Jörg Blobelt / Wikimedia Com-mons (CC BY 4.0)

When comparing the modal shares of *Cotta* with the ones from *Plauen*, one may note that these are very similar to each other. One reason for these similarities could be the close geographical adjacency of the two districts.

6 Conclusions and Outlook

As a final chapter of this report, firstly, conclusions are given to the composition of the obtained survey sample and the evaluated travel behaviour data.

The second part of this chapter is dedicated to the digital travel survey app *TravelVu* and the interactive analysis-dashboard *TravelViewer*, also giving a brief outlook on future research areas of interest.

6.1 Non-Probability Sampling

Looking at the sample composition at a glance, it can be noted that there are **certain tendencies** towards younger age groups (18-24 years), towards more highly educated (91 percent with general or specific school-leaving certificate), but also in terms of gender distribution to a considerably extent, as more men (59 %) than women (41 %) took part in the survey.

Taking **Figure 6** on page 5 into account, which shows two distinct concentrations of the population across the city, it is worth to mention that the sample's distribution across the 10 city districts is relatively equal — only one clear exception occurred in the district Plauen, also known as a student district, where the university is situated.

To conclude: even if there is no representativeness in the sense of probability theory, as many population groups as possible could be successfully addressed. All in all, the chosen non-probability sampling approach enabled flexibility, reactivity, cost-effectiveness and a high motivation of participants to contribute to the survey over a longer period of time.

6.2 Travel Behaviour

Focussing on the travel behaviour of participants between 18–59 years of age as output data, **4.8 trips per day** were performed on average.

In terms of distance, participants within the selected age group travelled about **34 kilometres per day,** almost 50 percent of these trip distances were travelled by private car. Average time spent in traffic comprised a duration of **125 minutes**.

When looking at the **average travel times and distances** per trip by mode, both public transport and private car are dominating, also at an equal level (duration: 54 minutes per trip; distance: about 20 kilometres per trip).

When one differentiates performed trips according to the several modes of transport available, the overall modal split values are distributed as follows:

35 percent of daily trips per person were taken **by foot**. Trips by **bicycle** and by **car** have a same share value of **23 percent**, trips done with **public transport 16 percent** and trips with other modes 3 percent.

This results in almost **60 percent** of all trips performed by active transport modes (on foot or by bicycle). Environmental-friendly modes (walk, bicycle and public transport) comprise about **74 percent**. The share of local emission-free or electric means of transport (walk, bicycle and tramcars) comprises **68 percent**.

Common determinants such as different **age** groups, primary **occupation** or level of **professional training** showed clear **effects on the participants' travel behaviour**. Variations could also be noticed depending on the respective weekday (or public holidays throughout the survey period) and the **residential location** determined by the city's districts.

6.3 Digital Travel Survey App TravelVu

The authors of the report consider the development of a travel survey app as a great challenge: smartphone devices are relatively diverse, and even more their operating systems and associated limitations — battery saving or movement logging as given examples only. Trivector truly succeeded in this challenge by creating an app that addresses these topics — this is a remarkable achievement.

Trivector additionally pushed the development forward by releasing a "2.0"-version of the app TravelVu. This provided users a broad range of benefits regarding user experience, as the graphical interface and numerous functions were redesigned. By this, also motivational elements coming from the gamification-concept found entry into the app. Based on these prerequisites, it is difficult to give concrete suggestions on improvement in terms of UI/UX, as very different images and expectations, but also affinities towards such types of apps and, last but not least, distinct hardware challenges are existing.

In the technical sense, as regarding transport mode and start/stop-detection, geofencing or first-trip-detection, TravelVu already works in opinion of the authors relatively well. However, further research in these fields is required.

6.4 Analysis Dashboard TravelViewer

The authors assess the TravelViewer-dashboard as a very useful and intuitive way to monitor, weight, filter and visualise one's travel survey data. The TravelViewer-dashboard appears in a very user-friendly and clearly structured design. All functions are well-explained and easy to perform. Especially the given options to filter one's sample data creates a large number of possibilities for follow-up analyses.

The authors see great potentials in the further development of the dashboard: already by now, plenty of functions both at front- and back-end are given, which hopefully can be continuously extended in the future.

By this, TravelViewer may further evolve into a platform ranging from early survey setup through survey monitoring up to an interface where survey data can be analysed and combined with different supplemental sources (e.g. weather, CO_2, health indicators, non-transport related surveys, traffic-count data, public transport data, network data) and various in-depth analyses on e.g. heatmaps, trip chains, stage data can be conducted.

To conclude, in combination with the app TravelVu, the TravelViewer-dashboard provided very interesting insights into urban travel — beyond the traditional household travel survey data.

Looking ahead, the travel behaviour data collected through the TravelViewer-project generated an important and unique database for future research at the TU Dresden on the one hand, but on the other many ideas and new experiences as well.

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Appendix