TravelViewer Travel Behaviour Report

Demo site Denmark

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TravelViewer - Travel Behaviour Report - Demo site Denmark

Report
2020

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Summary

This report presents the work and results of the TravelViewer project for the Danish case area. The recruitment methods and results are presented and discussed. At the Danish demo site, data for 563 respondents validating at least one day of travel were collected.

In the analysis part of this report, the survey statistics is presented followed by an analysis of the travel behaviour of the respondents. The travel behaviour analysis is divided in analyses for full sample, gender, age groups, region, and location data.

Finally, the analyses, the data and the project is discussed and concluded.

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1. Background

In October 2018, the EIT Climate KIC project TravelViewer was kicked off with a project meeting in Stockholm. The project was run by Swedish Trivector with test sites in Denmark, Norway, Germany, and Italy and other project members in France, and UK. The project objectives are to demonstrate the use a travel survey application for smartphone, to design, conduct and analyse recruitment campaigns, to analyse the data collected and to improve the app and the analysis service TravelViewer.

This report presents the travel behaviour analysis from the Danish test site. The analysis is performed partly by using the analysis tool TravelViewer developed and improved during the TravelViewer project, and partly by our own analysis.

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2. Method

2.1 Recruiting

For the Danish case study, three main recruitment methods were used:

- Letter in electronic mailbox to random sample from Danish civil register
    - 22,000 invitations sent
- Distribution through networks (ambassadors)
- Invitation link shared at social medias and internet homepages

In order to keep track of the recruitment method, a question was added to the background survey in the app. These answers are used for analysis of the response rate and to investigate respondent characteristics of the various recruitment methods.

The three methods will be briefly described below. For more details please refer to the recruitment report from the project.

2.1.1 Random sample from Danish civil register

Center for Transport Analytics at Technical University of Denmark are in charge of running the Danish National Travel Survey (TU), which is a traditional travel survey collecting travel diaries by internet and telephone interviews. In the TravelViewer project, previous built skills from recruiting in TU were used when planning the civil register recruitment.

This recruitment method had three phases: (1) draw a random sample of individuals from the civil register -> (2) send electronic invitation letters -> (3) monitor the response rate.

1) Draw random sample

From the Danish population we sampled individuals from 18-79 years. We defined 30 strata based on age, gender and geographical location.

2) Invitation letter in electronic mailbox

To reach the selected individuals, invitation letters were distributed using the Danish electronic mail E-boks (official mailbox used by Danish public authorities, it is mandatory for individuals from 16 and up). Individual letters were created with information such as name, address, and a unique identification code.

3) Monitor response rate

In total 22,000 invitations were sent out with this method. Individuals were invited in batches sent weekly from Wednesday October 23rd until Monday 25th November 2019. The response rate for the first 10,000 individuals was lower than expected and in the final 12,000 invitations and lottery incentive was added.

Based on experiences from TU a response rate of up to 10-13% was expected.

2.1.2 Distribution through networks (ambassadors)

Invitations were also distributed among collaboration partners of CTA, DTU. At 12 workplaces, one or several ambassadors / representatives were contacted. At 10 workplaces, ambassadors helped forwarding the invitation letter to a total of approximately 1,170 colleagues. At seven workplaces, the invitation was shared at the company intranet for more than 9,300 colleagues to see.

This sample is expected to be very biased because several of the collaboration partners have a large interest in the project. However, for the same reason, a large response rate is expected.

2.1.3 Registering recruitment method

In the app background questionnaire for the Danish survey, the respondents were asked to indicate through which recruitment distribution channel they received the invitation, see Figure 1. The channels to choose between were:

- Social medias (LinkedIn, Facebook, Twitter)
- E-boks digital letter
- Email (at work)
- Email, private
- Intranet or homepage
- Other

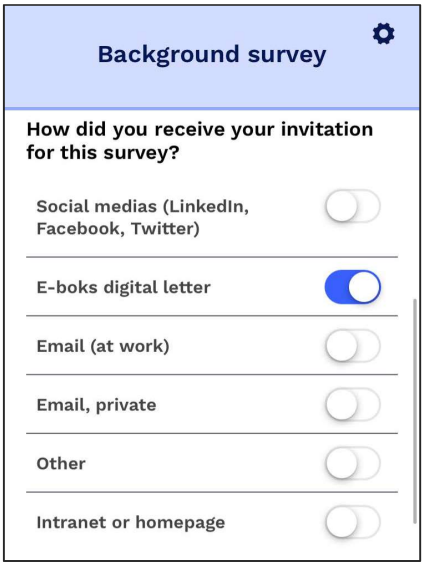

Figure 1: Background survey question

2.2 Analysis

This report presents the analysis of the travel behaviour from the data collected in the survey. In the data, only individuals validating at least one day of travel are included. Most of these individuals validates more than one day.

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3. Results

In the following, the results are presented. The survey statistics is presented in short and the analysis of the travel behaviour follows.

3.1 Survey statistic

In the Danish case area survey, a total of 563 individuals signed up and validated at least one day of travel. The statistics are presented in Table 1.

Table 1: Respondent characteristics, signing up, validating minimum one day, validating minimum three days

	Digital letter, E-boks	Email (work)	Intranet or home-page	Email (private)	Social medias	Other	(Blank)	Total
Invited persons (N)	20,756	1,170	9,320	-	-	-	-	
Signing up (N)	872	138	86	13	30	16	71	**1,226**
Signing up (% of invited)	4%	12%	1%	-	-	-	-	
Started tracking (N)	807	132	82	13	27	14	8	**1,083**
Started tracking (% of invited)	4%	11%	1%	-	-	-	-	
Started tracking (% of sign. up)	93%	96%	95%	100%	90%	88%	11%	**88%**
Min 1 validated day (N)	380	95	57	7	17	6	1	**563**
Min 1 val. day (% of invited)	2%	8%	1%	-	-	-	-	
Min 1 val. day (% of sign. up)	44%	69%	66%	54%	57%	38%	1%	**46%**
Min 3 validated days (N)	346	86	55	6	17	6	0	**516**
Min 3 val. days (% of invited)	1.7%	7.4%	0.6%					
Min 3 val. days (% of sign. up)	40%	62%	64%	46%	57%	38%	0%	**42%**

The sociodemographic of the respondents are compared to the statistics of the population and the Danish National Travel Survey (TU) in
Table 2. We see that the gender distribution in the survey is close to the population and the TU. The distributions of age and driver's license are skewed compared to the TU and to the population. The TravelVU survey data is characterized by the large number of respondents from partner organizations (13%).

Table 2: Sociodemographic of the respondents, compared to the population and the National Danish Travel Survey (TU)

	Survey	Population (18-79 years)	TU (2019) (18-79 years)
Gender			
Male	**51.2%**	50.0%	51.2%
Female	**48.2%**	50.0%	48.8%
Other/not say	**0.6%**		
Age			
0-17	**0.1%**		
18-34	**20.7%**	29.1%	26.3%
35-54	**41.5%**	34.3%	34.1%
55-79	**37.5%**	36.6%	39.6%
80+	**0.3%**		
Driver's license			
Yes	**93.2%**	88.0%	88.6%
No	**6.8%**	12.0%	11.4%

The education level of the respondents compared to the Danish population is seen in Table 3. We see that the TravelVU survey respondents have a higher level of education than the population in general. The skewness is most likely explained by the non-randomized recruitment method of using ambassadors at partner organizations. Please notice that the population numbers are for people aged 16-69 years.

Table 3: Highest level of education of respondents and in population

Highest level of education	TravelVU Survey	Population (16-69 years)
Elementary school	**3.9%**	24.8%
High school & Higher commercial education	**9.1%**	10.8%
Vocational training (apprenticeship)	**12.3%**	29.1%
Short college education (1.5-2 years)	**6.8%**	5.1%
Medium-length higher education (2-5 years)	**30.0%**	17.6%
Long higher education (at least 5 years)	**32.1%**	10.4%
Post graduate qualification	**5.2%**	0.9%
Other school education	**0.5%**	1.3%

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3.2 Travel Behaviour

3.2.1 Full sample

The data collected in the survey is distributed differently from the distribution in the population. The TravelViewer tool is able to account for this when given the population distributions. For this report, we have weighted the collected data with the population share for gender, age and driver's license.

For an overview, the TravelVU data shows:

- 4.3 trips per person per day
- 50 km per person per day
- 145 min per person per day

Whereas the 2019 numbers for the Danish National Travel Survey are (all from 6 years and up):

- 3.1 trips per person per day
- 42 km per person per day
- 124 minutes per person per day

Figure 2 shows the distribution of the modal split in the full sample. The bars represent modal split distributed by: number of trips, trip distance and trip duration. We see that by number of trips walking and biking represent approximately 40% of the trips, while in terms of distance the number is approx. 5%. As expected the share for public transport is larger in terms of trip distance (18.6%) and duration (20.7%) and lower (8.5%) for number of trips.

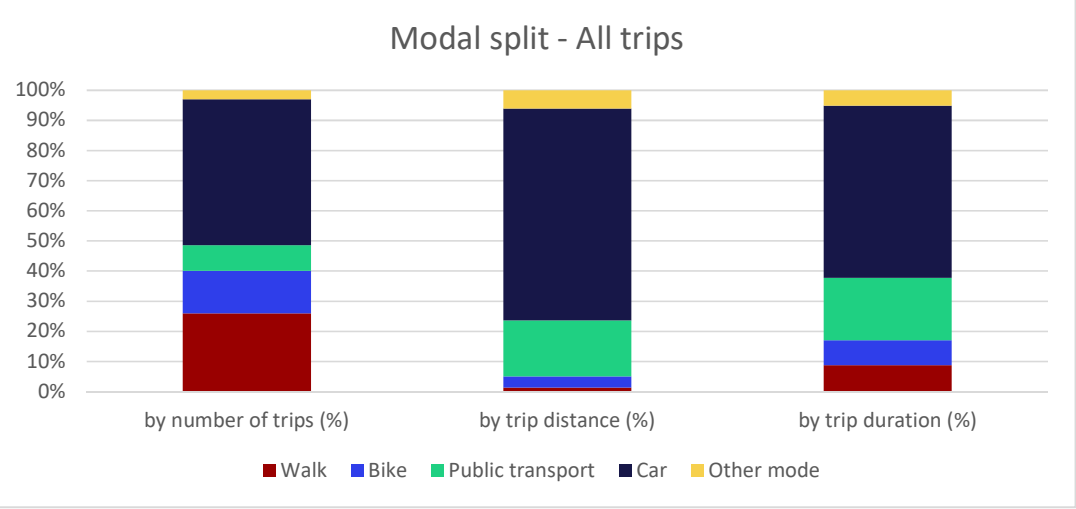

Figure 2: Modal split for TravelVU survey, full sample

Figure 3 presents the same result from the Danish National Travel Survey. We see that the distributions for the TravelVu sample and the traditional Travel Survey have many similarities. However, the share of public transport in terms of number of trips, distance and duration is

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significantly lower in the traditional survey. In the National Travel Survey, the Other mode share is lower in terms of both number of trips, distance and duration. This can be due to the fact that only trips within the national borders are accounted for in the traditional survey, while in the TravelViewer survey all trips are registered.

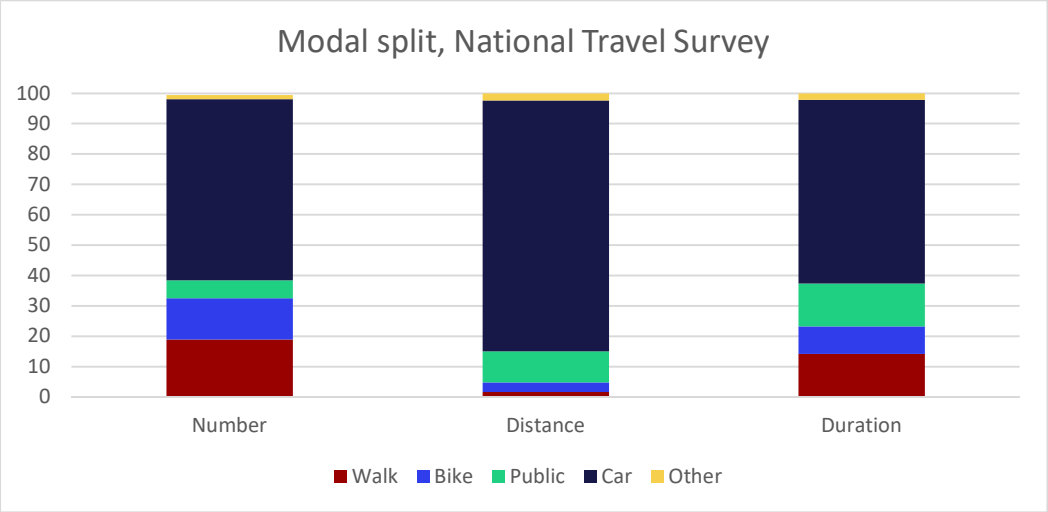

Figure 3: Modal split in TU sample. 2019, not commercial transport

Figure 4 presents the activity distribution for the full TravelVU sample. The distribution is calculated in terms of numbers of trips, trip distance and trip travel time. A general tendency is seen in the three distributions. Work trips are lower in numbers but longer in distance and time whereas shopping is shorter in distance and time. Please notice that “Home” is defined as a trip activity.

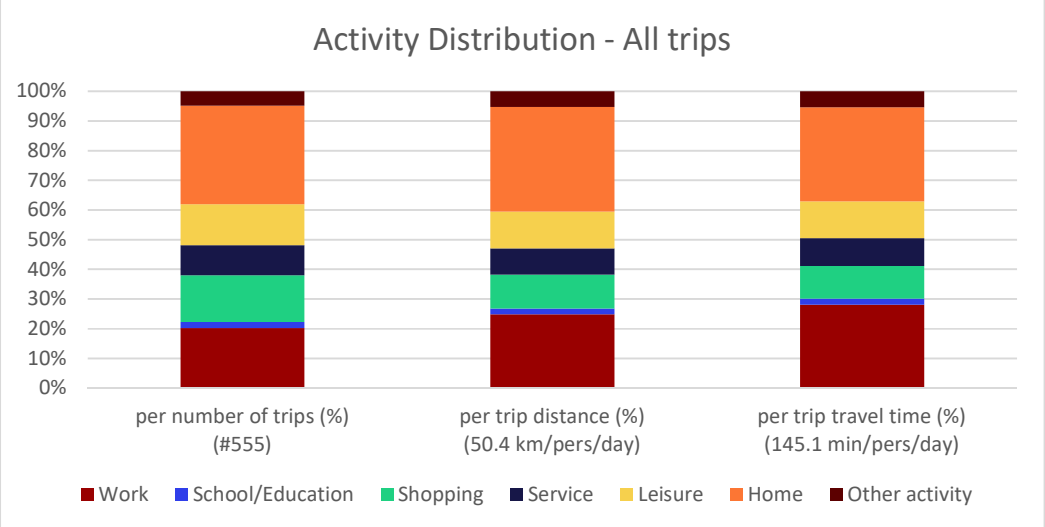

Figure 4: Activity distribution in full sample.

In Figure 5, a similar presentation of the activity distribution is made with data from the National Travel Survey. In order to make the results comparable the activity Home is inferred from the trips with an endpoint at an activity. As the Service activity is not defined for this report, the Leisure activity covers both Leisure and Service activities.

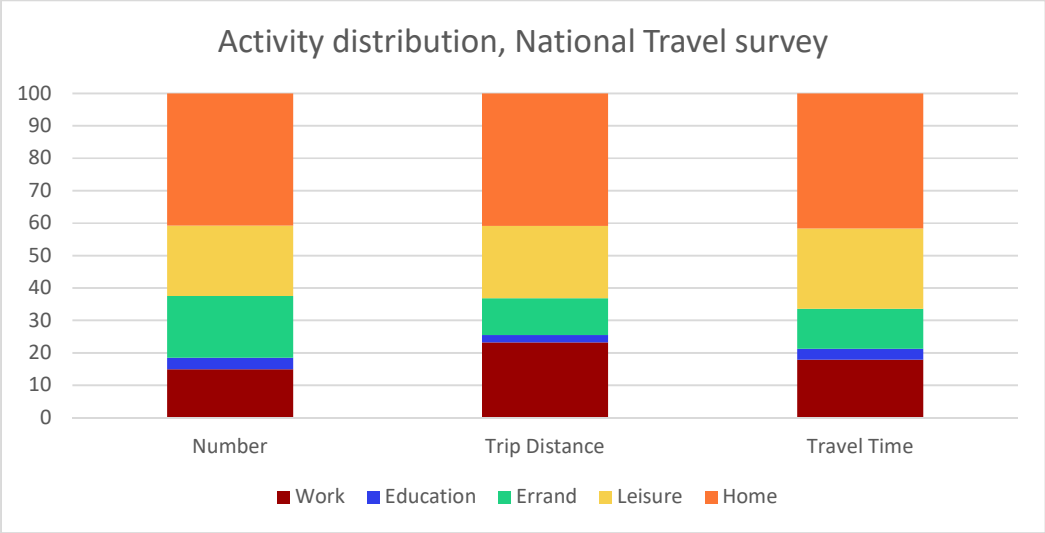

Figure 5: Activity distribution in the National Travel Survey, 2019, excl. commercial trips

For the TravelViewer data the Work trips have a higher share of trip distance (24.9%) and trip travel time (28.1%) than number of trips (20.3%). In the National Travel Survey data, the trip distance share for Work trips (23.2%) is higher than the share of travel time for Work trips (17.9%). This implies higher travel time for Work trips in the traditional National Survey data.

For the National Survey, the Home trips have an almost equal share of Number (40.8%), Trip distance (40.9%), and Travel Time (41.6%). For the TravelVU data, the shares range from 31.7% (Travel Time) to 35.2% (Trip Distance).

For both datasets, the Shopping trips have a lower share in terms of distance and travel time, compared to number. This is due to the fact, that Shopping activities take place closer to the trip origin.

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3.2.2 Analysis based on gender

In order to investigate the choice of transport mode based on gender, Table 4 is presented. We see that for both genders, Car is the most often used transport mode in terms of number of trips, then: Walk, Bicycle, PT and Other mode (for both genders). However, men use Car for a slightly higher percent of the trips than women do. Women use Public Transport for a higher share of the trips than men do. The share of Trip Distance is high for Other mode since it contains transport modes such as motorcycle, ferry, airplane etc.

Men has a higher number of daily trips and a higher sum of travel distance and travel time than women do. This is similar to findings in the traditional travel survey.

Table 4: Modal split for men and women. Percentage of total number of trips, total trip distance and total trip duration

	Average sum/day	Walk	Bike	Public transport	Car	Other mode
Number of trips						
Men (#282)	4.4	26.9%	13.8%	7.5%	48.8%	2.9%
Women (#270)	4.1	25.0%	14.5%	9.5%	47.9%	3.1%
Trip Distance	**[km]**					
Men	54.2	1.2%	3.9%	18.2%	70.7%	6.0%
Women	46.7	1.3%	3.6%	19.1%	69.8%	6.2%
Trip duration	**[min]**					
Men	147.2	8.7%	8.3%	19.7%	58.1%	5.1%
Women	143.8	8.9%	8.2%	21.7%	56.0%	5.3%

3.2.3 Analysis of age groups

Figure 6 shows the modal split by number of trips divided by age group. We see that the youngest (below 25 years) have the highest share of Walking, Biking and Public Transport trips. The share of Car trips increases until age group 45-64 years and then increase slightly. The 65+ has the lowest share of Public transport and Other mode trips.

Figure 7 and Figure 8 show that in terms of trip distance and travel time, car is even more dominating. Despite showing, that the age group with the highest share of PT trips is the 16-24 years old, the age group does not have the highest share of PT in terms of Trip distance and travel time. This points to a tendency, that the youngest group have shorter PT trips with higher average speed than the other age groups.

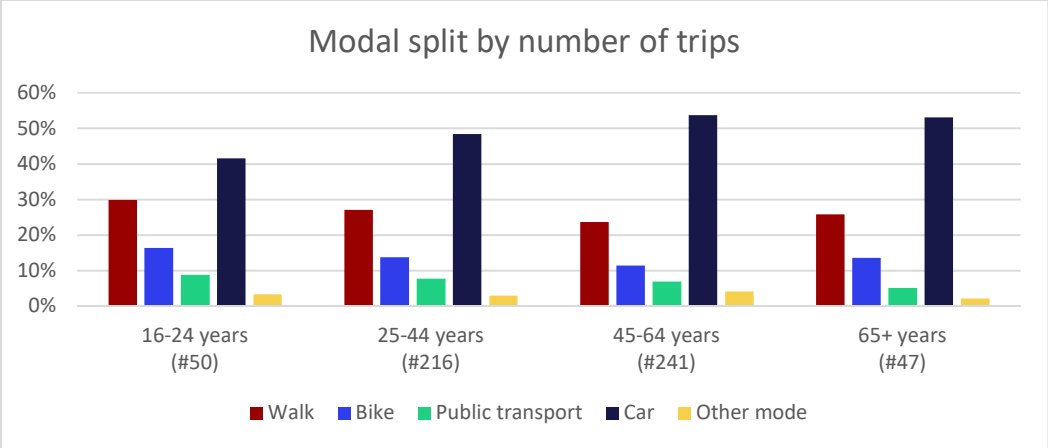

Figure 6: Modal splits by number of trips, divided by age groups

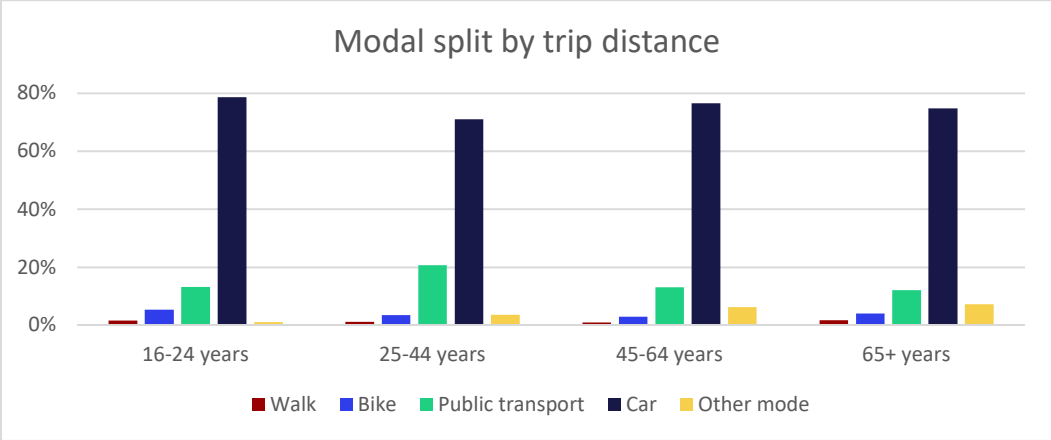

Figure 7: Modal split by trip distance, divided by age group

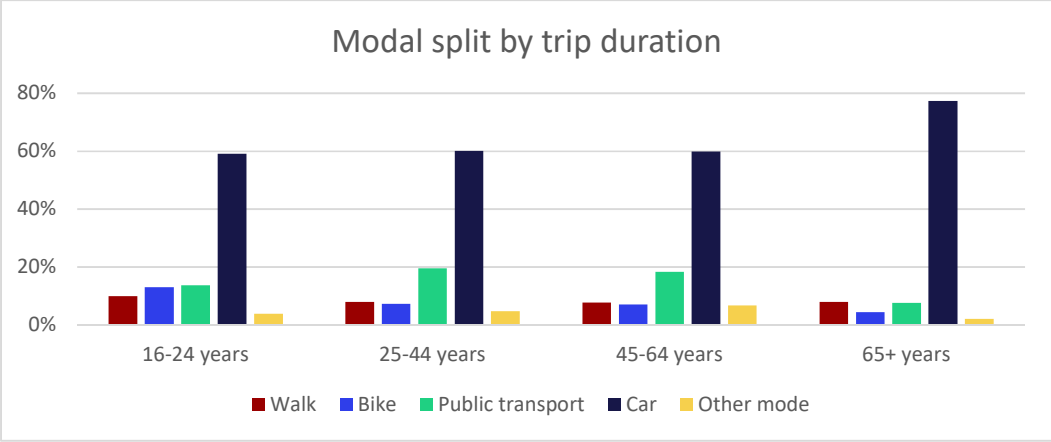

Figure 8: Modal split by trip duration, divided by age group

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Figure 9 shows the average distance per trip for each of the transport mode groups for the four age groups. The age group 25-44 shows that PT distance is more than double the distance for car.

Figure 10 presents the average travel time per trip per mode and age group. PT, Car and Other mode is dominating in the first three age group, whereas the 65+ group use almost the same time for walking and cycling as for Other mode.

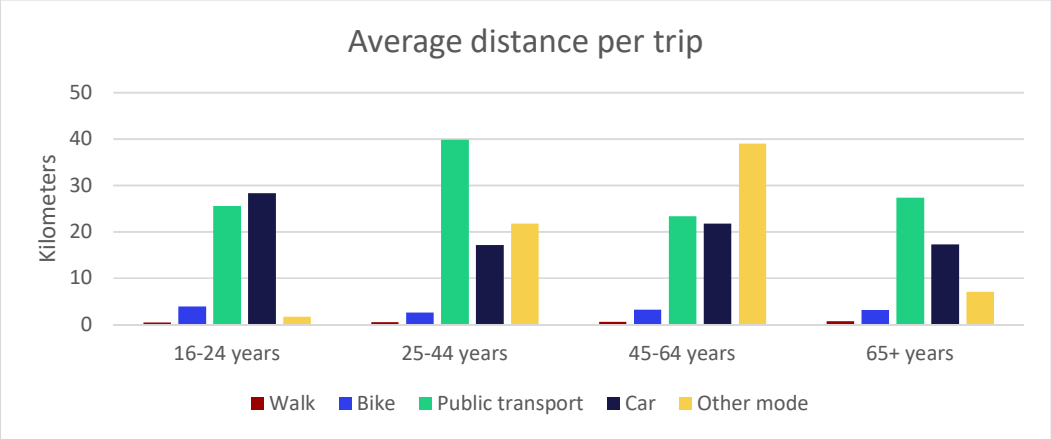

Figure 9: Average trip distance, divided by transport mode

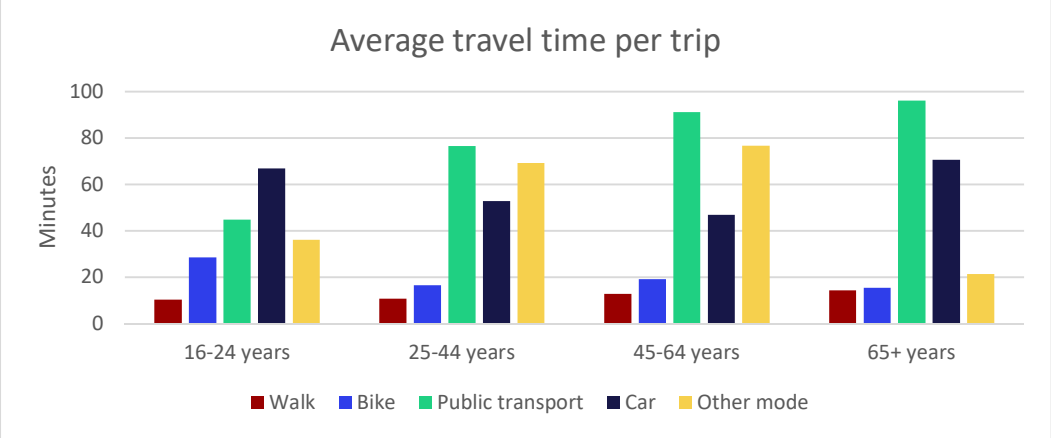

Figure 10: Average travel time, divided by transport mode

Table 5 shows the average speeds calculated based on the data from Figure 9 and Figure 10. The 18-24 years old have the highest speed when using Public transport (as also noted in Figure 7 and Figure 8). This could be because they use more simple PT trips without transfers and therefore obtain a high average speed. For the 25-44 years old, the PT speed is much higher than for the car trips, where the opposite is the case for the 45-64 years old. An

explanation could be that the public transport modes in the two age groups are different as long with the road and public transport network they use.

Table 5: Average speed per transport mode, divided by age group

(km/t)	Walk	Bike	Public transport	Car	Other mode
16-24 years	2.7	8.3	34.2	25.4	2.9
25-44 years	3.2	9.5	31.3	19.5	18.8
45-64 years	2.9	10.1	15.4	27.9	30.5
65+ years	3.1	12.2	17.1	14.7	19.9

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3.2.4 Analysis of region (home address)

Figure 11 presents the results divided on the five Danish regions. We see that the Region Hovedstaden has the highest number of answers. This is mainly due to the fact that most of the partner companies invited to join the survey are located in this region. The Region Hovedstaden also has the largest population. See statistics for the Danish regions in Table 6.

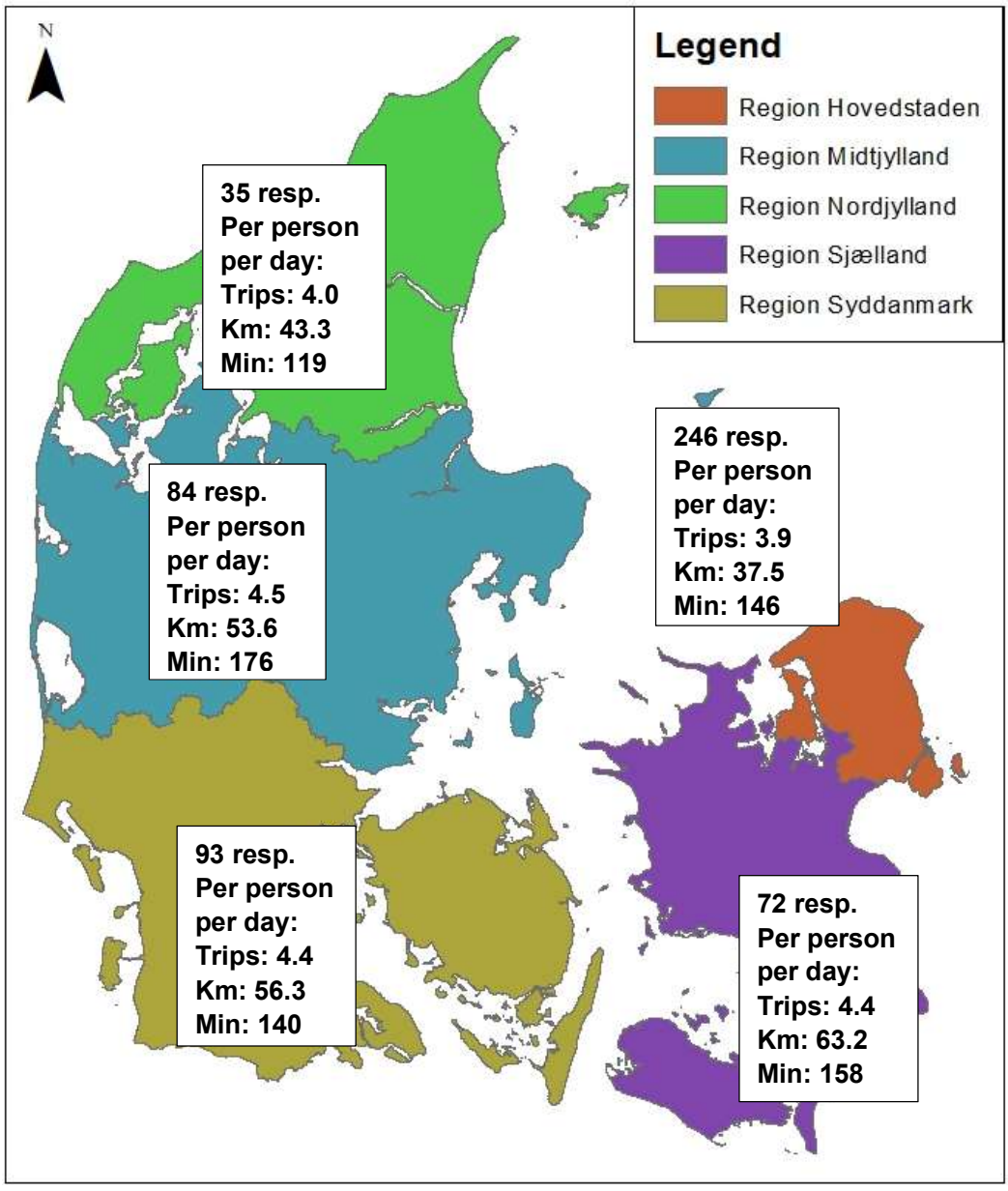

Figure 11: The Danish regions with survey data: number of respondents and average number of trips, driven kilometres and minutes per person per day

The driving pattern in the five regions are not exactly the same. We see that the regions with the fewest daily trips and the lowest sum of daily driven kilometres per person is the Region Hovedstaden and Region Nordjylland. Region Sjælland has the highest sum of distance and time for daily trips per person.

Table 6: Statistics of the Danish regions and share of respondents' home address region

Region	Area, km2	Population, persons	Density pers/km2	Population, %	Survey, %
Nordjylland	7 900	589 000	74.6	10.3%	7.0%
Midtjylland	13 100	1 321 000	100.8	23.2%	16.0%
Syddanmark	12 200	1 223 000	100.2	21.5%	18.0%
Sjælland	7 200	837 000	116.3	14.7%	14.0%
Hovedstaden	2 600	1 836 000	706.2	32.2%	46.0%

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3.2.5 Location data for trips

Figure 12 and Figure 13 present the location data from the TravelVU travel survey. Only trips with 20 or more coordinate points are visualised in these maps (26,379 trips). We see data in all parts of Denmark, with the majority of data is visualised in the Greater Copenhagen Area. We see that some data are detailed (many location points) so the trace follows the roads and public transport network, while there is also many trips with few points (straight lines) especially in the greater Copenhagen area.

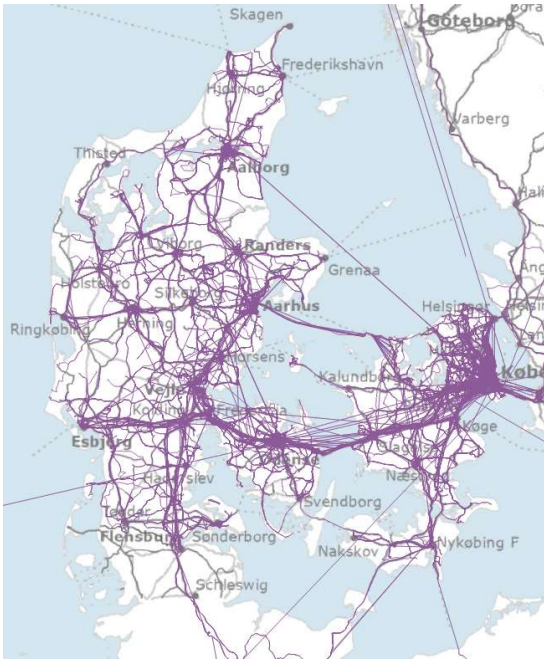

Figure 12: Location data, Denmark (trips with min 20 location points)

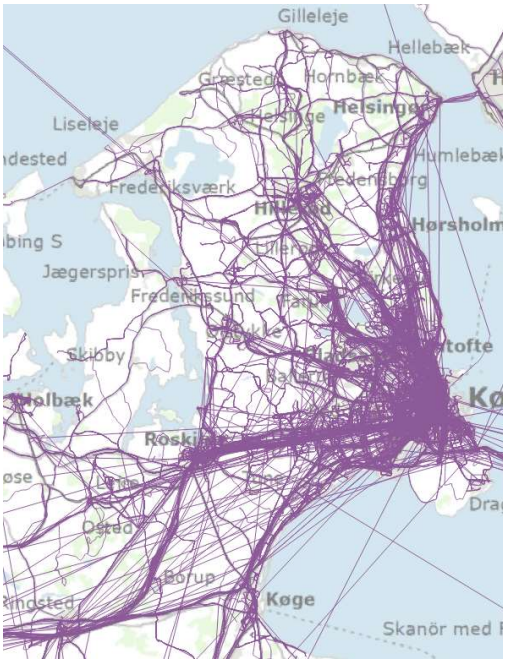

Figure 13: Location data, Greater Copenhagen Area (trips with min 20 location points)

In order to get a clearer picture, the data is filtered to show only trips with a location point for more than every 2 seconds. Figure 14 shows this data for Denmark and Figure 15 for the Greater Copenhagen area.

When using this filter most of the straight lines are filtered out. We see that the main road network is the most frequently used. We see more trips on the local network in the Greater Copenhagen Area. This can be because more respondents have a residence in the area, or an explanation could be the better GPS network in this area.

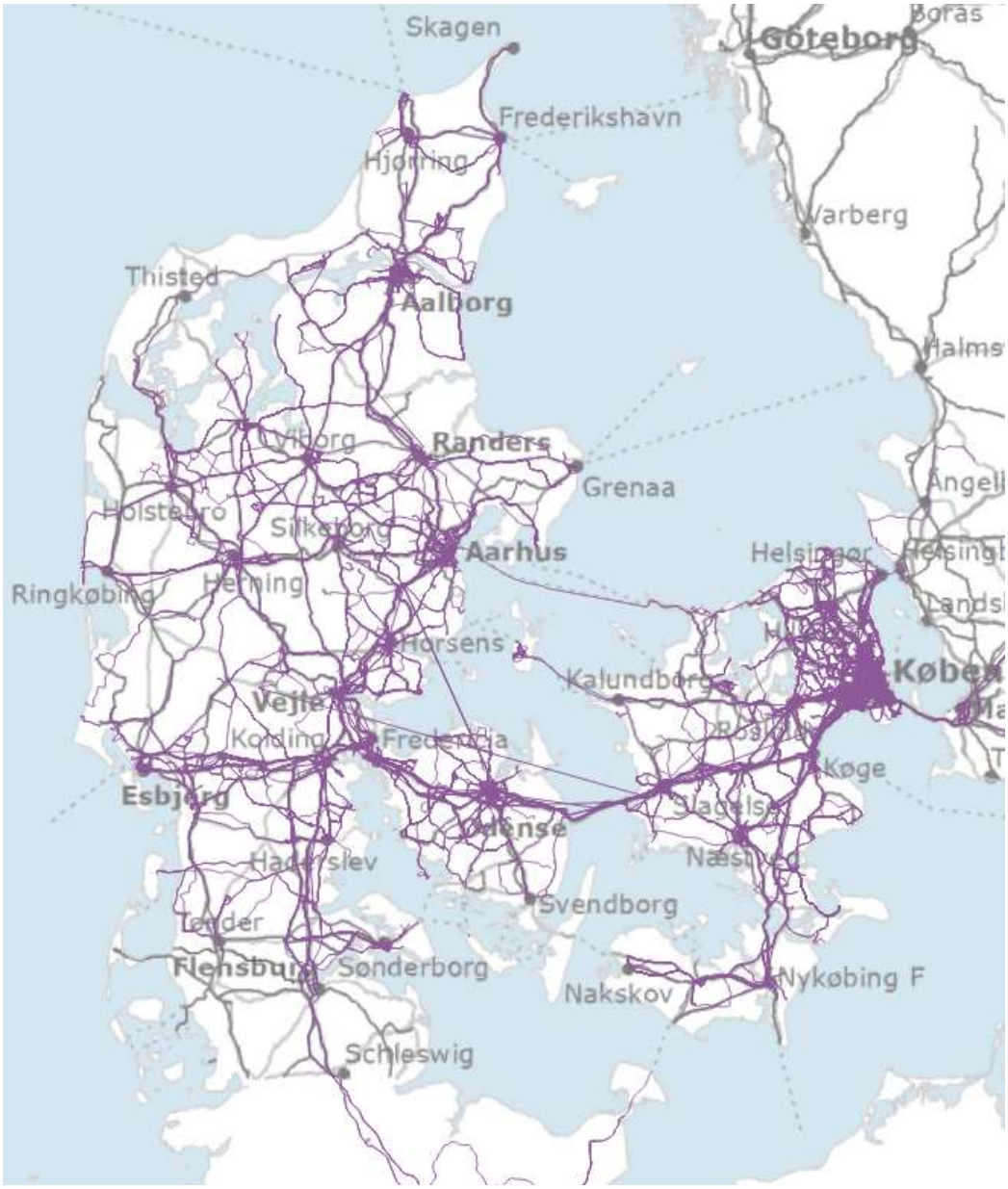

Figure 14: Use of main road network in the Danish TravelVU data (trips with min 1 location point per 2 seconds)

It is interesting to be able to see the large location variety in the collected data. The maps provide some insight in the origin and destinations of the trips on an aggregated level. Individual data is one of the strength in the data, but has to be anonymized for maps and publications.

The maps are very interesting and provide a good basis for explaining why the use of smartphone based data collection is important and helpful.

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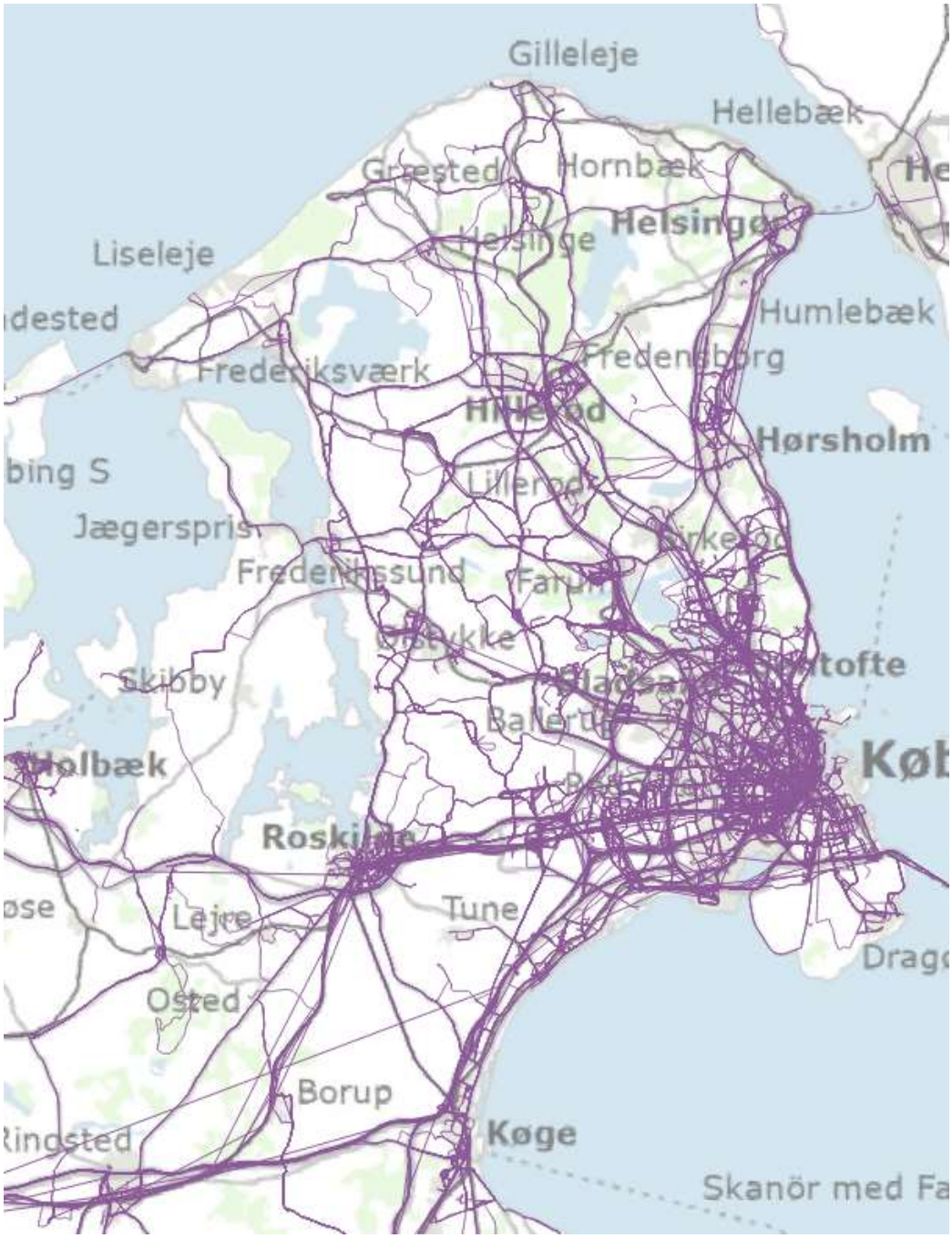

Figure 15: Use of road and public transport network in the Greater Copenhagen Area (trips with min 1 location point per 2 seconds)

4. Discussions and Conclusions

The following chapter will discuss and conclude on the travel data collected and analysed in this survey. Furthermore, some comments on the use of the TravelViewer tool is provided.

4.1 Regarding travel behaviour

We see that the data collected in the TravelVU survey is comparable to the data collected in the traditional Danish National Travel survey (TU). Some differences are pointed out, but the comparison is also tough since the traditional TU collects a much higher number of responses based on a higher economic cost.

Survey statistics
Data presented a higher share of people in the age groups 35-54 and 55-79 compared to the traditional Danish Travel Survey data and to the population (in the age from 18-79 years). In addition, data from a higher share of people with driver's license were collected.

The statistics show that the distribution of the survey data is not completely as intended, but when using the weighting option in TravelViewer this is accounted for.

Full sample
In the weighted TravelVU sample, the data shows:

- 4.3 trips / 50 km / 145 min of travel per person per day.

The Danish National Travel Survey (TU) shows:

- 3.1 trips / 42 km / 124 minutes per person per day

Share of walking and biking are high in terms of number of trips but low in terms of distance. Share of public transport is larger in terms of trip distance and trip duration and lower for number of trips.

We see several points of resemblance with the data from the Danish National Travel Survey. However, differences are seen for the public transport mode shares. The reason for this can be the respondents in the sample, since more respondents live in the Greater Copenhagen area where PT modes are more often used than in Denmark in general.

In the TravelVU survey the distribution of trips to activities shows that Work trips are lower in numbers but longer in distance and time whereas shopping is shorter in distance and time. For the traditional survey, the share of work trips is low in terms of travel time and number of trips compared to the TravelVU survey. The share in terms of trip distance is quite similar. We conclude that the data from the two surveys are comparable but affected by the different geographical representation.

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For both datasets, the trips to shopping have a lower share in terms of distance and travel time, compared to number. This is due to the fact that shopping activities take place closer to the trip origin.

Gender
There is a slight difference in the travel behaviour in terms of mode choice of men and women in the TravelVu survey. In general, men travel longer distances and with a higher time use. Men travel more often by car and women travel more often by public transport and bicycle.

Age group
The analysis of the travel behaviour of the age groups suffers from the unequal distribution of the respondents. The defined groups have 50, 216, 241 and 47 respondents.

The modal splits show very similar distributions for the four age groups in terms of number of trips with each transport mode. In the analysis, we recognise the high number of commuters in the 25-44 and 45-64 years age groups – they use car and public transport for long durations and distances.

The average speed of each transport mode is different for the different age groups. Especially for the public transport and the car modes. This is explained by the different use of the transport network, such as; local or regional roads, transfer in public transport.

Region
The highest number of respondents are found in the Region Hovedstaden. These travellers have the fewest daily trips and the lowest sum of daily driven kilometres per person, while Region Nordjylland has the second lowest. Region Sjælland has the highest sum of distance and duration for daily trips per person.

These data show that the transport network provided in the five regions are very different as long with the travel habits of the population. In some regions, the travellers have longer commute trips and more people own and use a car.

4.2 Regarding TravelVU and TravelViewer

The data collected in the TravelVU survey is very useful. The data has a clear structure and it is possible to obtain a deep insight into the travel behaviour of the respondents.

One drawback is the difficulty of recruiting a representative sample of the whole population, since smartphone ownership and use is a prerequisite to be able to contribute to the survey.

In terms of the respondents, the great difference between TravelVu and traditional travel surveys are the ease of use for collecting the data, with a low response burden. This is also a benefit for the data analysists since the data is validated and there is a possibility of collecting more data for example several days, when the response burden is lower.

For the users of the data, the detailed data is a clear benefit. The route choice data is easily obtainable, where it is very difficult to collect in a traditional survey.

It is a huge problem that we do not know anything about the unvalidated days. In the data, we see a large number of days not validated by the users. We see both users, who does not validate even one day, and users who does not validate all days. There is a possibility that the unvalidated days have some common features, for example a large complexity making it difficult for the user to correct and validate the day. If this is the case, it can be problematic for the data trustworthiness.

The TravelViewer analysis tool is a great help to get a quick overview of the data. This is especially helpful for organisations with limited resources for analysing the data, but also for more competent users who want to obtain overview of the data and for easy comparison between datasets.

The weighting tool is very useful to control for skewness in the collected data.

The TravelViewer tool has some limitations as to the flexibility. For example, it would be helpful to be able to influence and change the aggregation groups of transport mode and activities. A possibility of dividing data in age groups, genders, geographical location, trip distances etc. would be useful. Furthermore, it would be helpful to have a tool using the location data collected in the survey, for instance the possibility to show heat maps of the data.