Using SMS technology to determine the start and stop of trips in GPS data

Associate Professor Henrik Harder, Ph.D M.A. HDO
hhar@create.aau.dk

Assistant Professor Kristian Hegner Reinau, Ph.D. M.Sc.
reinau@plan.aau.dk

Research Assistant Michael Weber, M.Sc.
miwe@create.aau.dk

The ACTUM research project

- "The objective of the project is to provide an activity-based framework that is able to capture and describe individual and household activity patterns within a multi-modal transport environment that is characterized by a diversity of travel mode combinations."(ACTUM 2010, p.2)

- This GPS tracking project is funded by the ACTUM research project, and the overall objective is to deliver data for the estimation of the activity based models.

- Funded by The Danish Council for Strategic Research
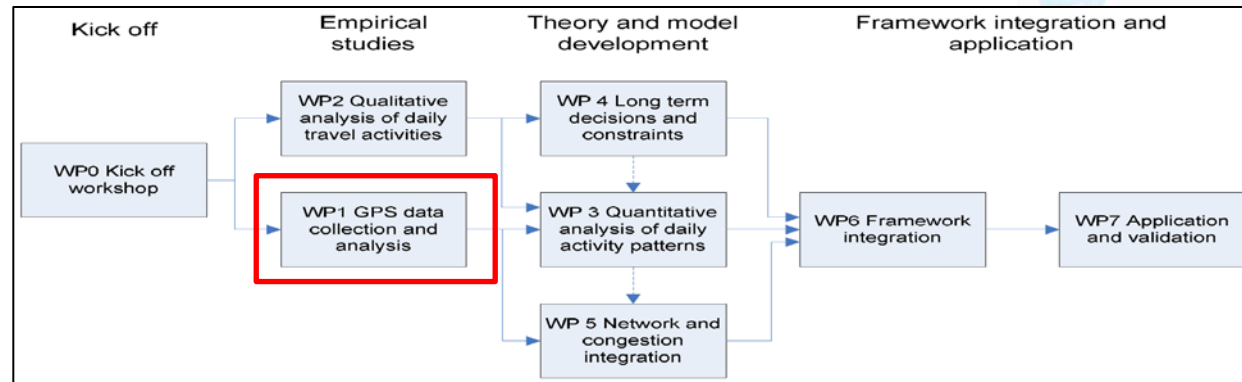
(ACTUM 2010, p.5)

Research question

- Can GPS technology and SMS technology be combined to form a method of accurately determining the start/stop of trips without placing too high burden on the respondents?

The survey setup in Copenhagen

- *50 Households (188 people)*
  - *7 days of GPS tracking*
  - *SMS data about experiences of trips*
  - *Web-survey*
  - *Late September and early October 2011*
  - *Sample: Mother, father and one or more children over the age of 6.*
    - *NB: Not representative for Copenhagen*
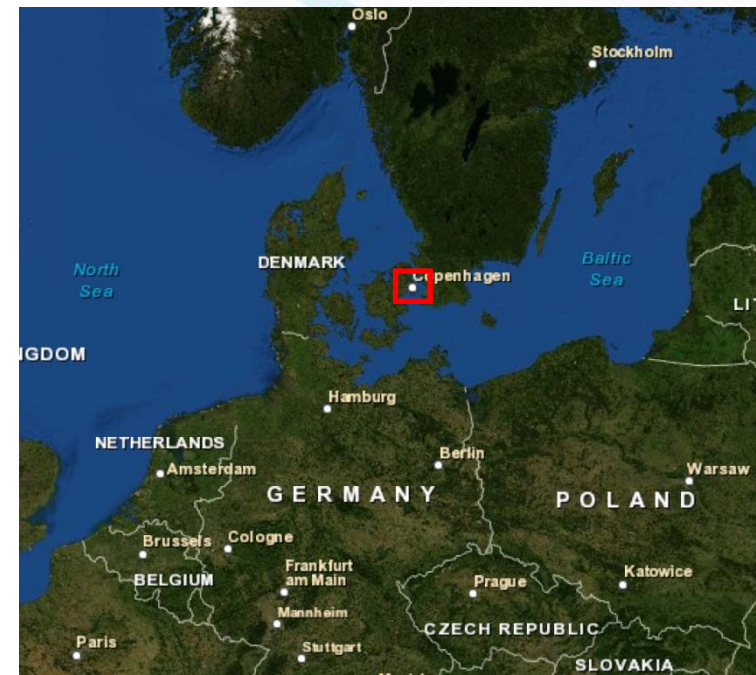
A contingency based beeper study

- **Setup A (38 households)**
    - When you start the journey, for example when you exit your front door in the morning, you should send an SMS with the information "Work start" or "School Start" to number 40471443.

    - When you arrive at your work/school, you should send an SMS to number 40471443 with the information "Work End" or "School End", as well as what transportation form you used in the journey, for example "Walk Bus" if you walked some of the way and took the bus some of the way.

- In addition we would like if you answer the following question:

    What three words will you use to describe the experience of the journey you have just been on?

A contingency based beeper study

- **Setup B (12 households)**
  - We would like if you, when you start the journey, will send us one word describing the objective of the journey to number 40471443, for example "Work" if you are heading for work, "School" if you are heading for school, "visit" if you are heading for a family visit, "exercise" if you are heading for exercise, "shopping" if you are going shopping etc.

  - When you arrive at your destination, we would like that you send an SMS to number 40471443 with the answer to the following questions:

    What three words will you use to describe the experience of the journey you have just been on?

The GPS data

- 2.7 million waypoints

Data collected in inner Copenhagen

Unclassified waypoints

The SMS data

	Setup A	Setup B	Total
SMSes received	2855	642	3487
Identifiable trips	1152	152	1306
Trips containing valid GPS data	803	90	893
Subset of trips containing valid GPS data			
Contained purpose	803	90	893
Contained mode of transportation	661	4	665

SMS-GPS-Trips

- 108,243 valid waypoints in trips

Trips
Unclassified waypoints
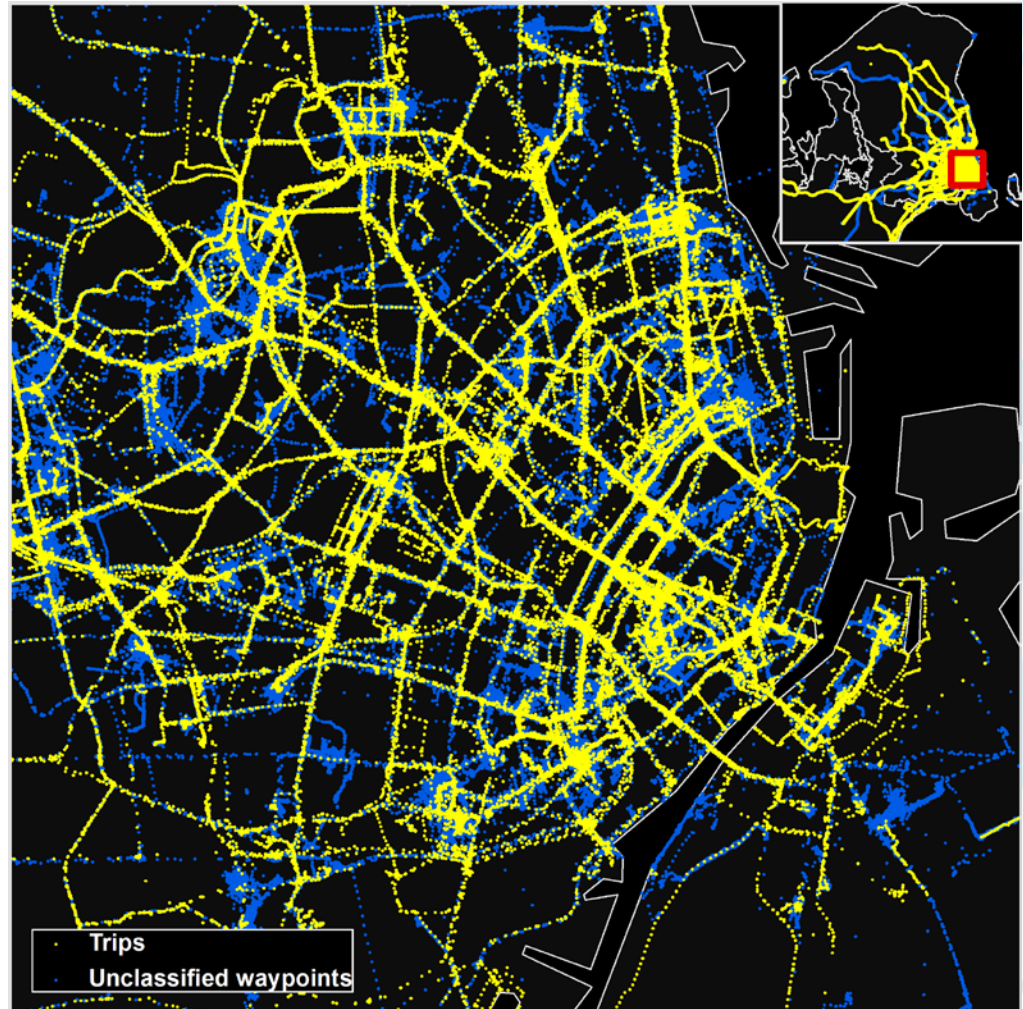
Data collected in inner Copenhagen

Quality of SMS-GPS-Trips

Gaps

- Start and Stop gaps

  - Occurs if the trip is started while there is no or poor GPS reception

- Gaps in the middle of a trip

  - Passing through areas with bad reception

    - Inside a building or between tall buildings

   - During trips using Metro etc.

Quality of SMS-GPS-Trips

Gaps-thresholds

- A low gap threshold accounts for a good quality but significantly lowers the amount of usable trips

- The most commonly used threshold is 120 seconds, but in some studies up to 900 seconds are allowed (Axhausen, 2008)

- The many reasons for gaps, require further analysis for us to determine if a trip is usable or not
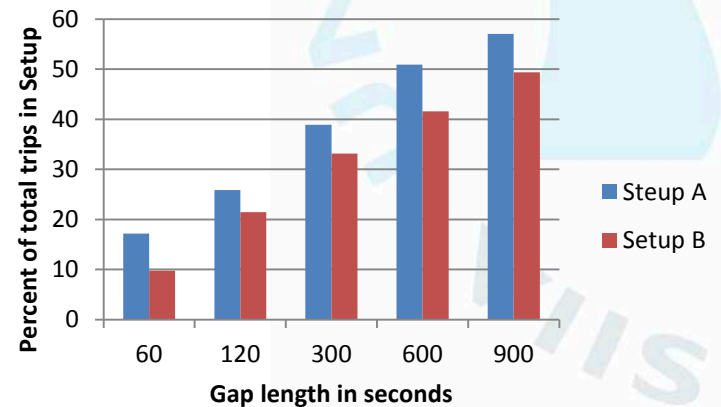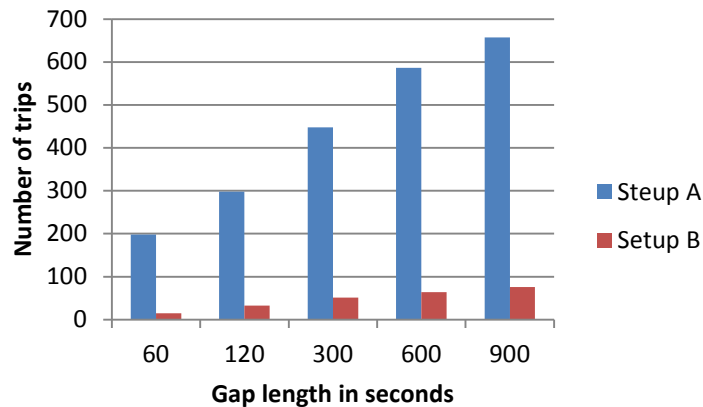
Quality of SMS-GPS-Trips
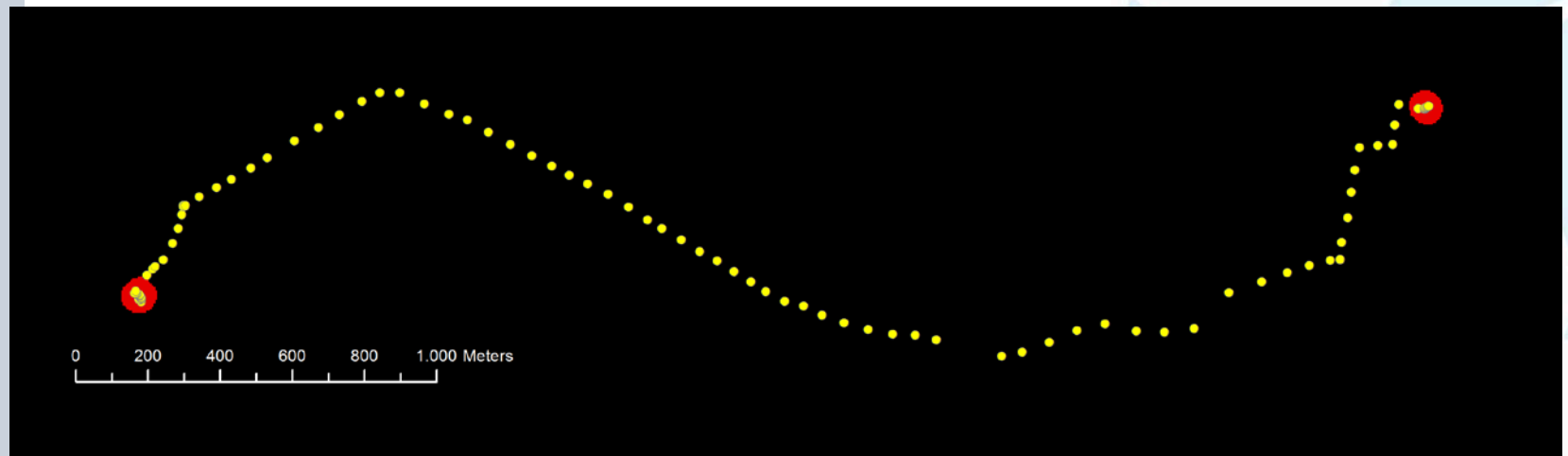
Analyzing the start and stop of trips for inaccuracies
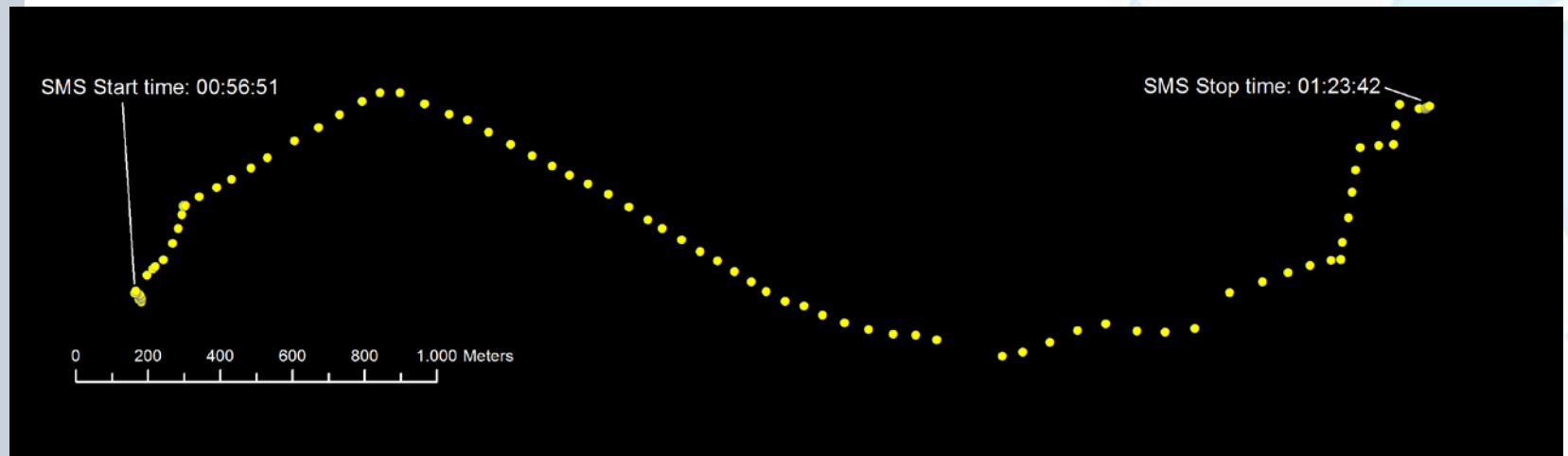
A trip defined by a start and stop SMS

Quality of SMS-GPS-Trips

Analyzing the start and stop of trips for inaccuracies

- Using point density analysis, based on the time gap between waypoints allows us to distinguish when movement occurs
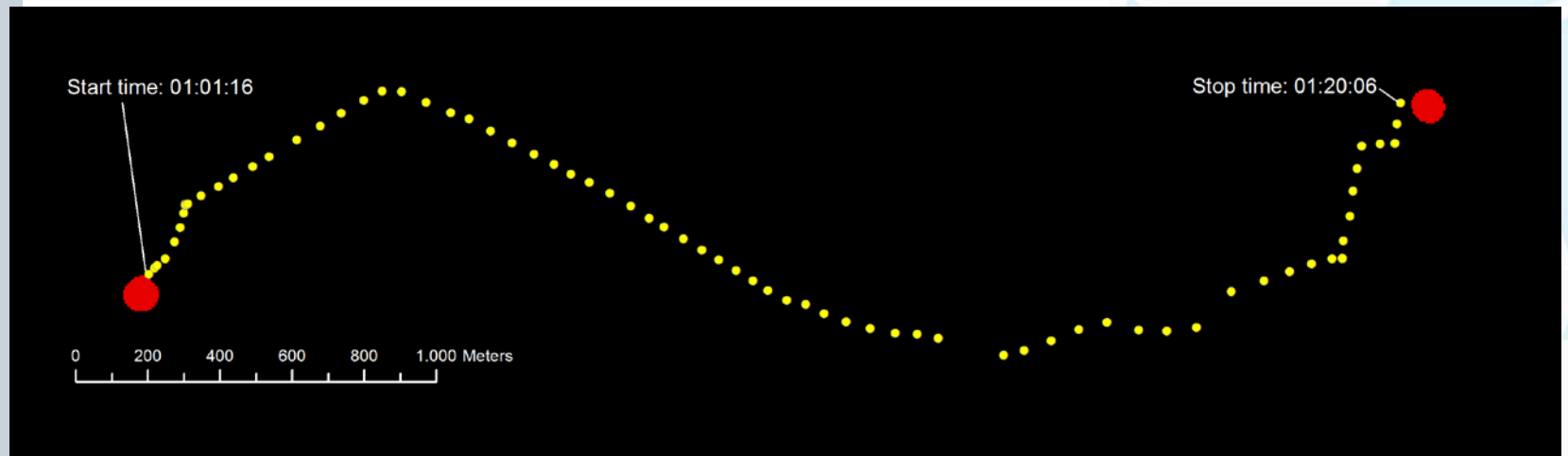

The trip and point density analysis within a 50 meter radius of each point

Quality of SMS-GPS-Trips

Analyzing the start and stop of trips for inaccuracies

- A new start and stop time can now be constructed

Trip with new, corrected start and stop times

Quality of SMS-GPS-Trips

Is the submitted trip actually more than one trip?

- Analyzing the time spent in an area allows us to identify if the trip contains extended stays, that suggest the trip actually contains multiple trips.
- This allows us to check how well the respondents have been able to perform the task of sending SMSes correctly
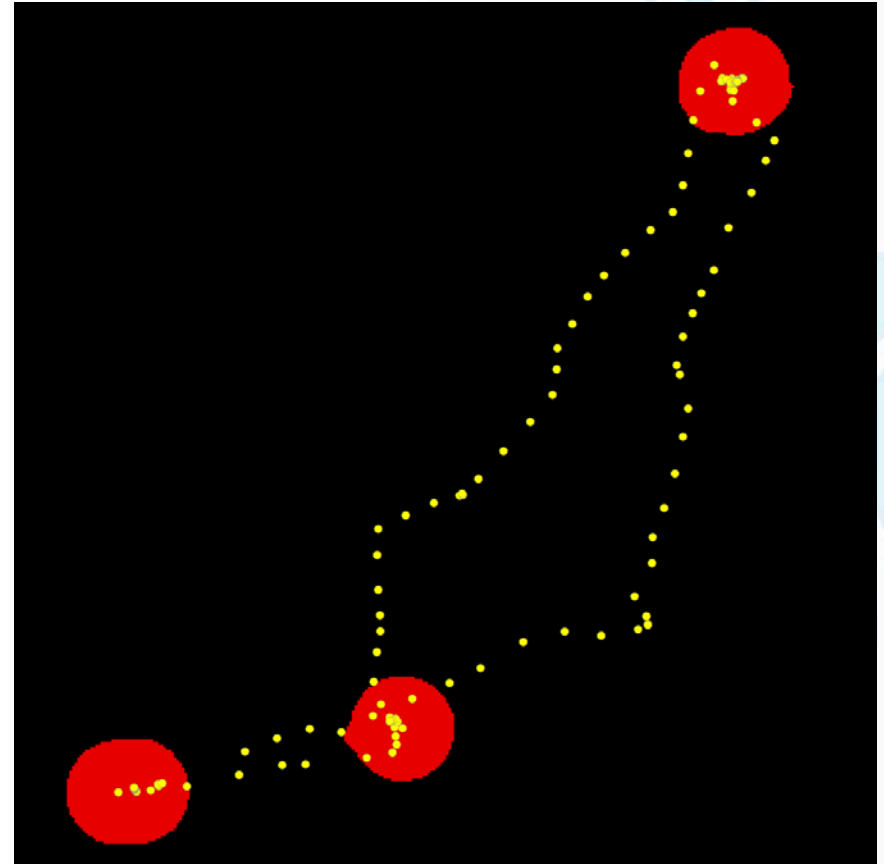
A trip with

Quality of SMS-GPS-Trips

Not all hotspots indicate a multipart trip

- Since the point density analysis is conducted using the time gap between GPS waypoints hot spots may appear in areas where the GPS signal has been lost.

- It is therefore also necessary to examine the distance between waypoints, to rule out these occurrences
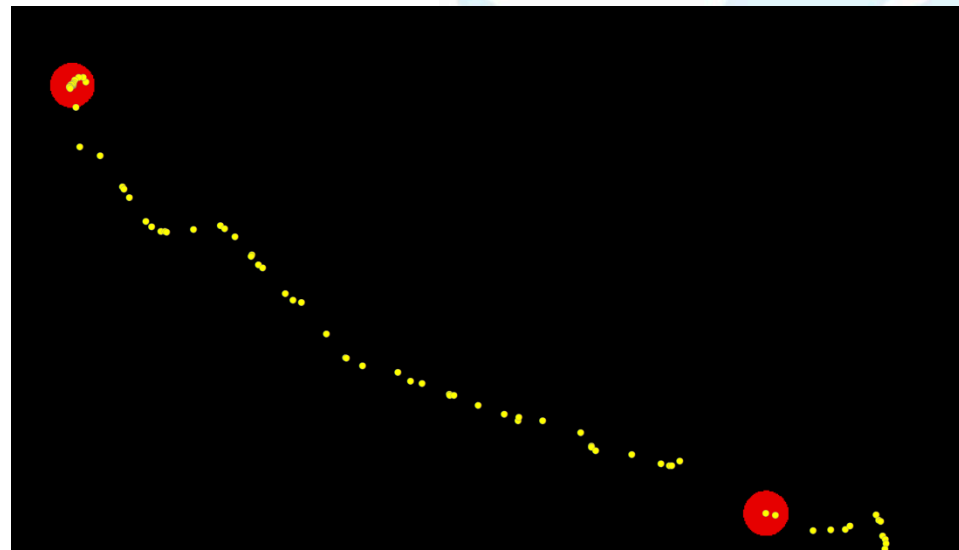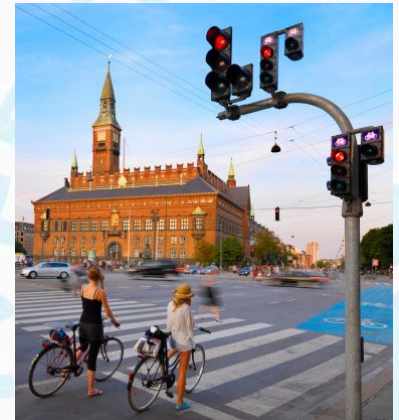
Conclusions

- The SMSes allows us to construct start/stop times
- The event contingency method provides for a better data collection
    - No memory bias
    - No post rationalization

- SMS technology is very accessible and can be used by the majority of people

- The low burden placed on respondents ensures a high level of participation.

Future work

- Improving models for quality assessment and correction of trips

  - Construction of start/stop times

  - Identification of multiple trips submitted as one

  - Including the distance factor in the analysis

- Completing quality assessment of all 893 trips

Acknowledgements

Thank you for your attention!