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Published paper
CAR TRAVEL TIME VARIABILITY
ON LINKS OF TWO URBAN ROUTES
IN BERLIN (WEST):
Methodology and Surveys

R Slapa
ABSTRACT

This report describes the surveys conducted, and the methods employed, for a study of travel times on two routes, each of five links, in Berlin. The surveys were conducted in order to study the level of variability of travel time, to identify possible causes of variability, and to test the reliability with which vehicles equipped with LISB route guidance equipment could estimate the mean and distribution of route and link travel times. Travel times were recorded by registration number matching, from LISB records of equipped vehicles passing, and from manual and LISB-based records from two LISB-equipped survey vehicles. Potential explanatory variables recorded included flow, composition, turning movements, parking, and two congestion indicators. The study formed part of a larger project on fundamental aspects of dynamic route guidance systems.
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1. **INTRODUCTION**

1.1 **General**

This working paper is one of two describing a study of travel time variability on two main urban routes in Berlin, and is concerned with the methodology and surveys of the study. The first survey round was carried out in the second half in September 1989. A second survey is intended in Summer 1990 during the main school holiday period when traffic flow will be reduced. The objectives of the complete study were:

- to estimate the amount of travel time variability within short time periods and between time periods and between days
- to attempt to explain the observed variability
- to assess the reliability and consistency of link travel time predictions produced by cars equipped as part of the Route Guidance System (LISB).

The study itself forms part of a wider programme of research into the fundamental aspects of dynamic route guidance systems.

The study with which this report is concerned had its origins in earlier work carried out by the Institute for Transport Studies (Montgomery and May (1987), May, Bonsall and Marler (1989)).

1.2 **Scope and Limitations of the Study**

The project was concerned with measuring car travel times over links on two urban routes, with simultaneous recording of data on traffic flow, composition, on saturation and on obstruction of traffic at and leaving the junctions. All these items were measured as they were considered to be most likely causes of variation of link travel times.

The main limitation of the study is that it is concerned only with the off peak and afternoon peak period, and was also restricted to the North-South direction and to weekdays (Monday to Friday). The period of data collection for the surveys was 1330 to 1800 on Route 1 and 1300 to 1730 on Route 2 with a break of half an hour on each route.
2. DATA COLLECTED

2.1 Selection of Study Routes

In order to measure the amount of travel time variability of cars, sections of major urban routes were sought which had the following characteristics:

i) traffic signal control of major junctions, this being the most usual form of junction control in urban networks;

ii) mixed frontage, to represent the different nature of urban routes through different types of area;

iii) variation of link type but uniform geometry within links;

iv) substantial flow of vehicles equipped with the Route Guidance System.

Five routes were investigated in detail by field visits, in the North, East and South of Berlin (West). They were initially selected to include links with high flow where a substantial number of equipped vehicles could be expected. Most parts of these routes in practice had little variation in link type and frontage activity.

Finally two routes were selected, containing five consecutive links each, which most closely conformed to the above criteria. Survey Route 1 is a main tangential route in the eastern area of Berlin (West) running close to the wall from Müllerstraße/Fennstraße to Entlastungsstraße/Paul Löbe Straße with a total length of 2.93 km. This route typically has two lanes in the survey direction where parking is not permitted.

Survey Route 2 is an outbound radial in the South, leading from Thorwaldsenstraße/Knausstraße to Röblingstraße/Attilastrasse with a total length of 2.82 km. This route varies by type of link, including both one and two way roads with either one or two lanes in the survey direction.

On Route 1, most traffic passes through the whole route, whilst on Route 2 traffic patterns are more mixed, with substantial traffic streams leaving and entering the route in the survey direction. The surveyed routes are shown in a map in Figure 1. On both routes significant congestion can be observed in the afternoon peak, especially on the most southerly link on route 2 as the exit junction surveyed was mostly oversaturated caused by relatively short green phases. The links surveyed on route 1 vary in length between 0.2 km and 1.1 km with traffic flows of 65,000 ADT. The links on route 2 vary between 0.1 km and 1.0 km in length, with somewhat lower flows. Further link characteristics are outlined in more detail in Section 2.5.

2.2 Timing of Surveys

In view of the different traffic conditions which occur at different times of the year, it is intended to split the surveys into two different time periods. Whilst the survey in stage one was carried out in September 1989, the second stage of the survey will be conducted in Summer 1990 during school holidays. Traffic flow profiles have shown that traffic in Berlin is significantly lower in the summer holiday period. The periods surveyed were from Monday to Friday between

13:30 and 15:30/16:00 and 18:00 (Route 1)
13:00 and 15:00/15:30 and 17:30 (Route 2)
FIGURE 1: SURVEYED ROUTES IN THE AREA OF BERLIN (WEST)
thus containing the afternoon peak and off peak period. Between the two two hour
blocks a break of half an hour was provided to avoid loss of surveyors' concentration
whilst working at highly polluted locations.

The surveys on Route 2 began half an hour earlier as the visibility tended to
decrease in the late afternoon caused by the one hour change from Summer to
Winter time. The weather conditions were clear, sunny and dry during the first
week on route 1 whilst in the second week surveyed on route 2 the weather became
colder and more cloudy including one rainy day on Tuesday 26 September.

2.3 Explanatory Variables

As the basis for the explanatory variables affecting car travel times and their
variability the following data were collected:

i) traffic flows and turning movements entering the link at the most relevant
intersections;

ii) traffic composition, as the presence of heavy vehicles might cause an increase
of travel times;

iii) whether or not any exit from a junction was obstructed at any time during
the cycle;

iv) whether a queue remained at a junction stop line at the end of the green
phase, as an indicator of the degree of saturation;

v) recording of lanes blocked by parking vehicles within a specified distance
from the stop line;

vi) recording of any other obstructions and incidents like accidents or road
works.

Manual data collection techniques were used for the collection of these data by
individual signal cycle. Further details are given in Section 3.4.

2.4 Travel Time Surveys

The objectives of the work required data to be collected on the distribution of travel
times on links within short time periods, and so it was necessary to collect travel-
time data by recording registration numbers and times of passing of a sample of
cars at the upstream end of each link, with travel times subsequently being
produced by matching the registration numbers at each location.

As an effective method for collecting this data and its analysis, Psion Organisers
(small hand-held computers) were used. Further details are given in Section 3.1.
In addition, two research vehicles were used in collaboration with the Institute of
Traffic and Road Research at the Technical University of Berlin for collecting travel
times simultaneously over the survey period. Both vehicles were equipped with the
LiSB Guidance System and were driven by the Institute's staff. The times of
passing the upstream and downstream end of each link were manually recorded by
a second in-vehicle observer using a synchronised stopwatch and a prepared list of
recording locations. One of these vehicles was also equipped to measure time and
space trajectories for each trip on both routes automatically. Further details are
given in Section 3.2.

The reasons for using these two research vehicles as an additional source of travel
time data were:

i) to test the reliability of link travel times derived by the LiSB central
computer from telegram data transmitted by each of those equipped vehicles;
ii) to test the consistency of link travel times derived by the Guidance System from the survey vehicles and from individual LISB-equipped vehicles;

iii) to obtain a substantial number of LISB-recorded travel times for the whole section on the two surveyed links, in order to assess the accuracy with which LISB could be used to estimate the mean and distribution of travel times.

2.5 Survey Locations

The first stage of the survey study was conducted in the second half of September 1989. Figure 2 shows a map of route 1 with the locations where the different surveyors were placed for collecting number plate records, traffic flow and congestion data. This route had eight signalised junctions (numbered 1-8 on Figure 2), but was defined by five consecutive links for which travel times were analysed. These were between Junctions 1 and 2, 2 and 3, 3 and 6, 6 and 7, 7 and 8.

Traffic flows were only collected at locations 2, 3 and 7 where main traffic streams were entering and joining the link in survey direction. The traffic lights at points 4 and 5 operate with semi-actuated signal control mostly showing green. Only if pedestrians or vehicles from the minor road are demanding to cross the main road do the signals change to red for the main directions. At both locations congestion observers were placed, recording the time when the signals went to red.

Route 2 also included eight junctions and was also defined by five consecutive routes between Junctions 7 and 6, 6 and 5, 5 and 4, 4 and 2 and 2 and 1. A map of this survey route is shown in Figure 3. Traffic flow data was collected at locations 7, 5', 4 and 2. Junction 5' is not signalised but substantial flow is entering the survey link from the north direction of Rubenstraße. Also, this junction is defined by nodes in the LISB network. Traffic lights at Junction 3 operate with semi-actuated signal control showing mostly green as described before for junctions 4 and 5 on route 1.

Link characteristics of each of the five links on both surveyed routes are shown in Tables 1 and 2. Further details about signal program data at the surveyed signalised intersections are specified in Table 3 and 4. Signal cycles change from 70s in the off peak to 90s in the afternoon peak on Route 1, and from 60s to 70s on Route 2. The times of change are indicated in the tables. Table 5 provides the codes used to describe the links in future analysis.
FIGURE 2: LOCATION OF TRAFFIC SURVEYORS ON ROUTE 1

1. Mill/Penn Str
2. Mull/Seller Str
3. Heidstr/Nord-Hafenbrücke
4. Heidstr/Container-Hafen (an der Fußgängerrampe)
5. Heidstr/Döberitzer Str (an der Fußgängerampe)
6. Heidstr/Invalidenstr
7. Alt Moabit/Moltesbrücke
8. Entlastungsstr/Paul Löbe Str
Figure 3: Location of Traffic Surveyors on Route 2

1. Attilastr/Robling Str
2. Preller Weg/Robling Str
3. Preller Weg/Sembritzkist
4. Preller Weg/Grazerdamm
5. Preller Weg/Thorwaldsen St
6. Thorwaldsen/Rubensstr
7. Thorwaldsen/Knausstr
<table>
<thead>
<tr>
<th>Link No</th>
<th>Length (km)</th>
<th>From (upstream)</th>
<th>To (downstream)</th>
<th>No of Lanes</th>
<th>Permitted* Movement</th>
<th>Other Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.184</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>all</td>
<td>No parking permitted, bus stop, residential area with shopping, 3 lanes in each direction divided, 2 right turn lanes in main survey direction at downstream end.</td>
</tr>
<tr>
<td>2</td>
<td>0.658</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>straight, right</td>
<td>No parking permitted, but parking at right angle across kerb, two lanes in each direction undivided, small (minor) entries/exits on right hand side.</td>
</tr>
<tr>
<td>3a</td>
<td>0.264</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>straight, right</td>
<td>Parking permitted, railway crossing (50 m ahead of 3), two lanes (not marked) in each direction, undivided, semi-actuated signal control at downstream end.</td>
</tr>
<tr>
<td>3b</td>
<td>0.393</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>straight, right</td>
<td>Parking permitted, petrol station right side, small minor entries/exits on right and left hand side, in each direction undivided, semi-actuated signal control at downstream end.</td>
</tr>
<tr>
<td>3c</td>
<td>0.454</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>all</td>
<td>Parking permitted, petrol station right side, small (minor) entries/exits right hand side, two lanes (not marked) in each direction. Link 3 in total length: 1.110 km, industrial area.</td>
</tr>
<tr>
<td>4</td>
<td>0.576</td>
<td>6</td>
<td>7</td>
<td>2</td>
<td>left, right</td>
<td>Parking permitted, bus stop, main survey direction turns left at end, two lanes in each direction partly divided partly undivided.</td>
</tr>
<tr>
<td>5</td>
<td>0.397</td>
<td>7</td>
<td>8</td>
<td>2</td>
<td>straight,</td>
<td>Parking permitted, two lanes in each direction, partly divided and partly undivided, open space (Tiergarten).</td>
</tr>
</tbody>
</table>

* at downstream end
### Table 2: Link Characteristics of Route 2

<table>
<thead>
<tr>
<th>Link No</th>
<th>Length (km)</th>
<th>From (upstream)</th>
<th>To (downstream)</th>
<th>No of Lanes</th>
<th>Permitted* Movement</th>
<th>Other Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.127</td>
<td>7</td>
<td>6</td>
<td>2</td>
<td>all</td>
<td>Parking permitted on right and also on left side; two-way divided, residential area.</td>
</tr>
<tr>
<td>2a</td>
<td>0.467</td>
<td>6</td>
<td>5(^1)</td>
<td>1</td>
<td>all</td>
<td>Parking permitted on right kerbside, not signalised, two-way divided.</td>
</tr>
<tr>
<td>2b</td>
<td>0.325</td>
<td>5(^1)</td>
<td>5</td>
<td>1</td>
<td>straight, right</td>
<td>Parking permitted on right kerbside, two-way divided.</td>
</tr>
<tr>
<td>3</td>
<td>0.080</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>all</td>
<td>No parking permitted, traffic actuated control but with constant settings in (straight) survey direction. Two-way divided.</td>
</tr>
<tr>
<td>4a</td>
<td>0.400</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>straight, right</td>
<td>Bus lane, no parking permitted from 1500 to 1800, semi-actuated control, two-way divided.</td>
</tr>
<tr>
<td>4b</td>
<td>0.440</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>all</td>
<td>No parking permitted, main survey direction on right at downstream end, two-way undivided.</td>
</tr>
<tr>
<td>5</td>
<td>0.987</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>all</td>
<td>No parking permitted, bus stop at downstream end, two-way undivided.</td>
</tr>
</tbody>
</table>

* at downstream end
<table>
<thead>
<tr>
<th>Junction</th>
<th>Signal Cycle(s)</th>
<th>Green Time(s) +</th>
<th>Time of Day</th>
<th>Day of Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70</td>
<td>15(→)</td>
<td>1300-1500</td>
<td>MON-FRI</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>17(→)</td>
<td>1500-1530/1730-1830</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>25(←)</td>
<td>1530-1730</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>70</td>
<td>23(↓)</td>
<td>1300-1500</td>
<td>MON-WED</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>28(↓)</td>
<td>1500-1530/1730-1830</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>44(↓)</td>
<td>1530-1730</td>
<td>FRI</td>
</tr>
<tr>
<td>3</td>
<td>70</td>
<td>40 (a)</td>
<td>1300-1500</td>
<td>MON-WED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1300-1430</td>
<td>THU</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>58 (b)</td>
<td>1500-1800</td>
<td>MON-WED</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1430-1800</td>
<td>THU</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1330-1800</td>
<td>FRI</td>
</tr>
<tr>
<td>4</td>
<td>70</td>
<td>35(*)</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>59(*)</td>
<td>as b above</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>47(*)</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>67(*)</td>
<td>as b above</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>70</td>
<td>36</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>51</td>
<td>as b above</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>70</td>
<td>38</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>53</td>
<td>as b above</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>41</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>60</td>
<td>as b above</td>
<td></td>
</tr>
</tbody>
</table>

*) only if demand in minor direction

+) green time relates to main survey direction
Table 4: Details of Signal Programme Data - Route 2

<table>
<thead>
<tr>
<th>Junction</th>
<th>Signal Cycle(s)</th>
<th>Green Time(s)</th>
<th>Time of Day</th>
<th>Day of Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>60</td>
<td>20</td>
<td>1300-1800</td>
<td>MON-FRI</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>28</td>
<td>1300-1800</td>
<td>MON-FRI</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>20</td>
<td>a(1300-1500)</td>
<td>MON-THU</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a(1300-1430)</td>
<td>FRI</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>25</td>
<td>b(1500-1800)</td>
<td>MON-THU</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b(1430-1800)</td>
<td>FRI</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>20</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>24</td>
<td>as b above</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>33(*)</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>40(*)</td>
<td>as b above</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>34</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>44</td>
<td>as b above</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>60</td>
<td>14</td>
<td>as a above</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>21</td>
<td>as b above</td>
<td></td>
</tr>
</tbody>
</table>

*) only if demand in minor direction  
+ green time relates to main survey direction

Table 5: Link Codes

Route 1

<table>
<thead>
<tr>
<th>Link No</th>
<th>Junctions</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-2</td>
<td>MS</td>
</tr>
<tr>
<td>2</td>
<td>2-3</td>
<td>HN</td>
</tr>
<tr>
<td>3</td>
<td>3-6</td>
<td>HI</td>
</tr>
<tr>
<td>4</td>
<td>6-7</td>
<td>AM</td>
</tr>
<tr>
<td>5</td>
<td>7-8</td>
<td>EP</td>
</tr>
</tbody>
</table>

Route 2

<table>
<thead>
<tr>
<th>Link No</th>
<th>Junctions</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7-6</td>
<td>TF</td>
</tr>
<tr>
<td>2</td>
<td>6-5</td>
<td>PT</td>
</tr>
<tr>
<td>3</td>
<td>5-4</td>
<td>PG</td>
</tr>
<tr>
<td>4</td>
<td>4-2</td>
<td>PR</td>
</tr>
<tr>
<td>5</td>
<td>2-1</td>
<td>AR</td>
</tr>
</tbody>
</table>
3. DATA COLLECTION METHODS

3.1 Travel Time Data Collection using Static Observers

Travel time data was mainly collected by using 'Psion Organisers' hand held computers. This method was found to be very useful as described and used in several surveys (eg. Bonsall et al (1988), May, Bonsall, Marler (1988)).

For the surveys Psion Organisers were used with 32k RAM. The Psions were loaded with software produced at the Institute for Transport Studies, designed for the capture and automatic timing (to the nearest second) of vehicle registration numbers.

Number plates of cars registered in Germany have normally up to 7 items including letters and numbers, as for example B-K7549, B-CD375 or B-OD25. Letters in front are specifying the area of Germany where the car is registered; B indicates the city of Berlin (West).

The number plates were recorded by using the last four alphanumeric characters only, which can have from 2 to 4 digits; 4-digits are the most common format for cars in Berlin (West).

The 4-item registration number was entered into the Psion via the keyboard and the time recorded as a specified key was pressed.

Three special character keys were programmed to enter the registration number into the machine according to whether the car had entered the link from the right, from straight ahead or from the left.

The data file thus created in the Psion consisted of a header line with the date and location typed in before the start of the survey, followed by the data lines each of which gave the time, registration number and direction symbol.

It was found that the Psion 32k RAM could hold in its memory between 2400 and 3000 registration numbers in the format described. This was always sufficient for a four hour period of daily data collection at the surveyed junctions.

On the observations only light vehicles were considered, excluding taxis. To maximise the sample size of matchings furthermore only specified car colours were considered with priority given to white cars. When no white cars were available red cars were recorded. A previous pilot in Berlin had shown that these two colours were the most frequent ones, with the number of white cars exceeding that of red cars by a ratio of 3 to 2.

Irrespective of the method used, the registration number surveyor was instructed to stand at a specified location 15-20 metres downstream of the junction, as this was found to be the best location to see the registration plates of vehicles coming straight or joining the route from the left or the right. It also normally avoided the problems which would have occurred of getting an accurate time for cars moving slowly in a queue upstream of the junction. Surveyors were instructed to enter the registration number as close as possible to the time the car actually passed the specified point.

In practice this was difficult to do in heavy and continuous traffic and numbers were often entered up to about 3 seconds late. However, this effect was similar for
all locations so the resulting errors are probably small. With this approach, travel
times on a link included junction delays at the downstream junction.

The instructions issued to the surveyors collecting registration numbers are given in
Appendix 1.

3.2 Travel Time Data Collection using Moving Observers

The method of travel time data collection by using two moving research vehicles has
been already outlined in Section 2.4.

The vehicles were cruising around on a circuit on each route during the whole
survey period. The locations of the start and end of each journey are shown in
Figures 4 and 5 which represent the surveyed part of the LISB network. The start
and end points coincided with LISB beacons, to maximise the data collected. The
beacons passed at the beginning and end of each journey are numbered as follows:

| 1005 or 1033 | 7042         | Route 1 in survey direction |
| 7043         | 1005 or 1033 | Route 1 in opposite direction |
| 13106        | 16045 or 16066 | Route 2 in survey direction |
| 16045 or 16066 | 13106   | Route 2 in opposite direction |

Whilst number plate records were only collected at six of the eight specified
junctions within each link section on both routes, the moving vehicle observers were
recording the passing times at all of the eight junctions shown in Figures 2 and 3.
Additionally, some junctions were also considered beyond the end of Route 1 in the
survey direction, where the surveys were extended by TUB. This was undertaken in
order to obtain travel time data for both main links at beacon intersection 17026,
which has flow and occupancy detectors. The number of journeys was between 9
and 11 for each vehicle within a daily survey period of 4 hours which represents one
journey per 15 minutes at least.

3.3 Traffic Flow Data Collection

Traffic flow data was only collected at those downstream junctions where relevant
traffic streams are leaving or entering the surveyed link section.

Surveyors were issued with clipboard, survey forms to record classified turning
movements, pencil and synchronised digital watch, plus transparent polythene bag
for rainy conditions. The surveyor stood just downstream of the junction, close
to the location of the registration number surveyor, as this was the place where the
turning movements and vehicle classes could most easily be seen without visual
obstructions from large vehicles in a slow moving or stationary junction queue.

The surveyor recorded the number of vehicles in two classes: light or medium, and
heavy. Heavy vehicles were all those with a gross vehicle weight of more than 7.5T;
these were transport vehicles, lorries and buses. Light and medium vehicles were
all those under 7.5T. Motorcycles were not counted. Vehicles were recorded
separately as travelling straight, or turning left or right out of the downstream end
of the previous link. The unit of recording was one cycle. The surveyor recorded, to
the nearest second, the start of green from the upstream link, and then entered a
symbol in the 'left', 'right' or 'straight' box on the form according to whether the
vehicle was light/medium or heavy. At the start of the next green the process was
repeated on the next line of the form.

The instructions for the surveyors and the forms used are given in Appendix 2.
FIGURE 4: CIRCUIT OF RESEARCH VEHICLES ON ROUTE 1 WITH PART OF THE LISB NETWORK
FIGURE 5: CIRCUIT OF RESEARCH VEHICLES ON ROUTE 2 WITH PART OF THE LISB NETWORK
On Route 1 three junctions were identified where a relevant change of traffic flow could be expected whilst on Route 2 four junctions were selected to record flow data.

3.4 Congestion Data Collection

At the most important junctions information was collected on four items believed to be likely to influence travel times. These were whether or not any exit from the junction (left, straight or right) was obstructed at any time during the green period. Normally, this blocking was due to traffic backing up on the downstream link or on the roads to left or right or, in the case of right-turners, to obstruction from crossing pedestrians as their lights show green simultaneously. The second item recorded was whether or not a queue remained at the stop-line in the main survey direction during the first 3 seconds of red. The third item was the presence of parked vehicles, both upstream and downstream within 50m of the stop-line. The final item of data recorded was the occurrence and duration of any incident in or close to the junction, which could affect travel times, such as accidents or road works. All these items were recorded in appropriate boxes on the form. Each line on the form related to a single cycle of the lights. Also, the beginning and end of green time was recorded to the nearest second, using a synchronised stopwatch. The surveyor was located 20m upstream of the stop-line.

At locations 4 and 5 on Route 1 and at Junction 3 on Route 2, where the traffic lights operate with semi-actuated signal control, the duties of the surveyors were slightly modified. Traffic lights on the main road normally show green and only when pedestrians or vehicles from the minor road wish to cross (5 to 15 times per hour) is the green interrupted. At these locations the surveyors made their statements on the form every minute, as the lights showed green continuously. If green was interrupted the time of the signal change was recorded with an estimation of the number of vehicles stopped.

The instructions and standard forms used for this part of the survey are given in Appendix 3.

3.5 Day-to-Day Supervision and Organisation

A supervisor was allocated the task of day-to-day preparation of the survey materials, checking on survey personnel, standing-in in case of absence, collecting equipment and completed forms, etc, and keeping a record of general traffic conditions, weather and personnel deployment and problems. The supervisor had the duty of preparing all clipboards with the correct number of forms and ensuring all equipment (pencils, watches, etc) was present and operating correctly. It was his duty also to check the digital watches every evening and ensure they were synchronised (it was found that some watches could ‘drift’ by a few seconds per day). On Fridays, he had to ensure that each surveyor had a slip showing his or her duty in the coming week, with a map of the location and information on public transport access. He was also required to keep time records for the survey personnel.

Each survey day, the supervisor arrived at the section of route to be surveyed about an hour before the survey began. He always used a push bike for riding down the links, which was found to be very useful considering the relatively short length of both routes and their parking restrictions.

Surveyors were instructed to be in position between 15 and 30 minutes before the start of the survey (eg 1300-1315 on Route 1). At 1300, the supervisor would be at
the most northerly point to receive the prepared Psion Organisers. He would then ride south and hand out the appropriate equipment (Psion Organisers, stopwatches and forms) to the surveyors at all of the specified locations. The last one was normally reached 5 minutes before the survey began.

During the survey period he would then spend most of the time visiting each location to check on the surveyors' work, ensuring that items were being correctly recorded and that form headings were complete and correct.

Before the end of the survey period the supervisor rode to the most northerly point and collected the equipment from each location by riding down the route. Surveyors were instructed to wait where they were to have their data and equipment collected.

After all data was collected the supervisor went to the Institute of Traffic and Road Research at TUB to download the data recorded with the Psion Organisers. After this process the Psion Organisers were cleared and set up with the survey codes for the next survey day. Every second day the batteries of the Psions were changed, and also the internal clocks of all machines were synchronised again.

3.6 Personnel, Pilot Surveys and Training

The observer personnel were recruited from students with the help of the Students' Job Service (TUSMA) at Technical University of Berlin. There was no difficulty in finding and selecting the necessary number of 16 students. These students were invited to a meeting at the Institute where general information about the survey methods and background were given and discussed. The prepared instruction lists and general notes about the surveys were handed out to the surveyors explaining the different duties of the job on the survey tasks. After this, the students were selected for their different functions on the job as registration number plate surveyor, congestion and traffic flow enumerator.

Two pilot surveys were conducted each for one hour at the intersections of Route 1 to ensure surveyors' familiarisation with the equipment and the local traffic conditions, and also to test the survey methods.

The first pilot was conducted on 12 September with only the congestion and traffic flow enumerators whilst the second pilot was held on 15 September with only the crew of the registration number plate surveyors. The analyses of the data collected showed a sufficient rate of matched vehicles when only white and red cars were considered as a sample of traffic flow.
4. REFERENCES


DISK 39 (SLAPA) ERB
Allgemeine Hinweise für das Meßpersonal:

0. Beobachtungsstandorte:

\[ S = \text{Staubeobachter} \]
\[ V = \text{Verkehrsmengenzähler} \]
\[ K = \text{Kennzeichenerfasser} \]

1. Wetterfeste Kleidung mitbringen, da die Untersuchungen auch durchgeführt werden, falls es regnet.

2. Immer pünktlich am Beobachtungsort erscheinen (d.h., gewöhnlich 30 Minuten vor dem eigentlichen Meßbeginn), da die Ausgabe der PSION-Computer, Stoppuhren immer zwischen 7.00 - 7.20 erfolgt.

3. Immer darauf achten, daß ihr alle Meßinstrumente (PSION, Stoppuhren, Beobachtungs/Zählisten, Bleistift) ausgehändigt bekommt und ausreichend ausgerüstet seid.

4. Die allgemeinen Angaben im Header der jeweiligen Zähllisten immer vollständig ausfüllen (am besten vor Beginn der Messung).

5. Dauer der Messungen.............

6. Nach Ende der Messung jeden Tag abgeben:
   - ausgefüllte Zähllisten
   - Stoppuhren
   - PSION-Computer, da diese wieder synchronisiert, entladen werden müssen, Batteriewechsel

7. Am Ende der Woche erkundigen bzw. sicher sein, an welchen Standorten sich die Beobachter am nächsten Montag einzufinden haben.

8. Immer angeben, in welchen Zeitintervallen eventuell Fehler beim Messen aufgetreten sind... Probleme während der Beobachtung ?? ..mögliche Abhilfe ??


Reinhard Slapa, Tel. 314 24073, TU bzw. 314 22431, TU-Sekretariat
317534, Privat
Kennzeichenerfassung mit dem PSION-Computer:

1. Die Hinweise solltet ihr sorgfältig durchlesen und immer bei euch haben!

2. Immer pünktlich am jeweiligen Meßort erscheinen, d.h., 30 Min. vor dem offiziellen Meßbeginn (z.B. 7.00 Uhr). Der Einsatzleiter wird immer zwischen 7.00 - 7.25 Uhr an den Standorten erscheinen und die vorbereiteten Computer ausstellen. Bevor er wieder weiterfährt, checken, ob der PSION-ORGANISER aufnahmebereit ist....'On'-Taste drücken...es erscheint dann die Frage 'Do you want to start survey?'(Willst Du mit der Messung beginnen?)....'N'-Taste drücken = No, der Computer fällt dann in den Schlaf, bis er wieder gebraucht wird.

3. 5 Minuten vor Meßbeginn (z.B. um 7.25 Uhr, ggf. Kollegen mit der Stoppuhr fragen) den Computer aufwecken.......'On'-Taste drücken...es erscheint wieder die Frage 'Do you want to start survey?'......'Y'-Taste = Yes drücken. Danach erscheint die Frage 'Regno?' (= Kennzeichenerfassung ?). Zu diesem Zeitpunkt soll ihr einen Beobachtungscode eingeben (siehe Liste)...z.B. ..MS25SE....und danach die markierte 'K'-Taste (rechts unten) drücken.

Achtung !: Bei der Eingabe von Buchstaben immer gleichzeitig 'SHIFT'-Taste (links unten) drücken.
Falls der Beobachtungscode falsch eingegeben wurde
1. 'K'-Taste drücken
2. Richtigen Code eingeben
3. Erneut 'K'-Taste drücken

Mit der Kennzeicheneingabe nicht früher als z.B. 7.25 und nicht später als 7.30 Uhr beginnen.

Achtung !: Der Computer fällt automatisch in den Schlaf (Anzeige erlischt auf dem display), wenn er ein paar Minuten nicht benutzt wurde. Falls dies gelegentlich auftreten sollte, kann man ihn mit der 'ON' -Taste wieder aufwecken bzw. betriebsbereit machen.

4. Der Beobachtungsstandort am jeweiligen Knotenpunkt liegt immer hinter der Kreuzung (ca.10-20m, z.B. Ende des Fußgängerüberwegs)

Nicht Kennzeichen eingeben, solange die Fahrzeuge an der LSA noch stehen, sondern erst dann, wenn sie anfahren und tatsächlich den Meßquerschnitt passieren werden. Dazu ist das Kennzeichen einzugeben und beim Durchfahren des Querschnitts (Fußgängerüberweg) eine der drei markierten (Zeit)-Tasten zu drücken.
5. Immer nur die letzten 4 Ziffern des Kfz-Kennzeichens eingeben,
   z.B. B - A 9698...... ⇒ 9698
   B - CD 375...... ⇒ 375
   E - OD 26...... ⇒ 26
   danach eine der entsprechenden Tasten drücken!

6. Welche Fahrzeuge sollen registriert werden?

   - Nur Pkw, aber keine Taxis und Fahrzeuge mit ausländischen Kennzeichen
   - Zwecks einheitlicherer Erfassung werden nur Pkws registriert, die eine bestimmte Farbe haben!

   ⇒) Unbedingt alle weißen Pkw, die den Querschnitt passieren.
   Weiβ bedeutet wirklich weiß und nicht beige, cremefarben, grau.
   Weiße Pkw mit farbigen Dächern, Streifen, Aufdrücken, zählen
   als weiß und werden registriert.
   Falls ihr nicht sicher seid, ob ein Pkw tatsächlich weiß ist,
   dann registriert diesen trotzdem, aber auch nur dann, wenn wirklich
   kein anderer-tatsächlich weißer-Pkw in Sicht ist.

   Tip: Schaut euch die Pkw (so weit möglich) an, die an der
   Signalanlage zum Halten kommen, um abzuschätzen,
   welche Pkw-Farben den Querschnitt passieren werden.

   ⇒) falls keine weißen Fahrzeuge in einem Signalumlauf auftreten
   sollten-und auch nur dann!-, sollen alle roten Pkw registriert
   werden.

7. Falls mehrere weiße Pkw hintereinander den Meßquerschnitt
   passieren, dann versucht, so viel wie möglich davon zu regist-
   rieren. Es ist jedoch besser, ein oder zwei Kfz auszulassen, um
   zu große Ungenauigkeiten beim Registrieren zu vermeiden.

8. Die Kennzeichen-Nummer wird durch die Bedienung der passenden
   Ziffern-Tasten eingegeben. Die drei (Zeit)-Tasten befinden
   sich oben rechts und sind markiert.

   →    →    →
   von Links von Rechts von Geradeaus

   Die Fahrzeuge aus der Geradeausrichtung treten in der Regel
   immer zu bestimmten Zeitpunkten innerhalb der Signalumlaufzeit
   auf während Einbürger von Links und Rechts hingegen relativ
   unregelmäßig auftreten. Das kann die Kennzeichenerfassung er-
   leichtern (insbesondere, wo Links – bzw. Rechtseinbiegen nicht
   erlaubt oder nicht möglich ist)

9. Sofort, wenn ihr eine der →    →    -Tasten gedrückt habt, ist
   der aktuelle Zeitpunkt, zu dem das Fahrzeug den Querschnitt
   (Fußgängerüberweg) passiert hat, automatisch gespeichert.
   Daher, drückt sofort die richtige Taste, nachdem ihr das Kenn-
   zeichen eingegeben habt.

_Achtung:_ Nur dann Korrekturen vornehmen, wenn der Fehler bei der zuletzt vorgenommenen Kfz-Eingabe gemacht wurde. Versucht nicht Fehler zu bereinigen, die ihr bei vorhergehenden früheren Kfz-Daten gemacht habt!

11. Ihr werdet bemerken, daß der Computer einen Piepton von sich gibt, nachdem ihr vier Ziffern eingegeben habt, zur Erinnerung/Kontrolle, daß 4 Ziffern maximal eingegeben werden sollen. (nicht immer zu hören, bei lauten Verkehrsgläsern)


Erneuter Beginn der Messung um ..........
Kurz davor den Computer wieder mit der 'ON'-Taste aufwecken und wie zuvor Kennzeichen + (Zeit)-Tasten bedienen.

Ende der Messungen um ...........
Der PSION-Computer schaltet sich automatisch aus

15. Warten bis der Einsatzleiter am Beobachtungsort eintritt
Aushändigung der Geräte sowie eventuelle Probleme bei der Datenaufnahme dem Einsatzleiter mitteilen.


Ausrüstung: -PSION - Computer
-Regenhülle
-Liste mit Hinweisen zur Messung und Beobachtungs codes der Knotenpunkte
-Armbanduhr (vom Beobachter mitzubringen und eventuell mit den Stau/Verkehrsmengenzählern be- züglich der Uhrzeit überprüfen)
APPENDIX 2: INSTRUCTIONS AND SURVEY FORM FOR CLASSIFIED TURNING MOVEMENT SURVEYORS

Verkehrsmengenzählung für jeden Signalumlauf

<table>
<thead>
<tr>
<th>Ort</th>
<th>Datum</th>
<th>Beobachter</th>
<th>Wetter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mühlst./Selbst</td>
<td>25.9.</td>
<td></td>
<td>trocken</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Linkseinbieger</th>
<th>Rechteinbieger</th>
<th>von Geradeaus</th>
<th>Grünbeginn bez. auf Ger</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKW</td>
<td>PKW</td>
<td>PKW</td>
<td>PKW</td>
</tr>
<tr>
<td>LKW</td>
<td>LKW</td>
<td>LKW</td>
<td>LKW</td>
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</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>PKW</th>
<th>LKW</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>LII</td>
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<td></td>
<td>LII</td>
<td></td>
<td>LII</td>
<td></td>
</tr>
</tbody>
</table>

- Standort des Beobachters: ca. 10-20m hinter der Kreuzung in gleicher Höhe, wo die Kennzeichen erfasst werden.

- Unterscheidung bezüglich der Einbiegerichtung:

  - von Links
  - von Rechts
  - von Geradeaus

- Unterscheidung bezüglich der Fahrzeugart:

  - Pkw (Lieferwagen, Kleintransporter, Pkw+Anhänger)
  - Lkw (Transporter >7.5t, Busse, Sattelschlepper)

  - Motorräder, Mofas werden nicht registriert

- Notieren des Zeitpunkts wann Grünbeginn, bezogen auf Fahrzeuge, die aus der Geradeausrichtung kommen. Da das Signal vom Beobachter jedoch nicht unmittelbar eingesehen werden kann, entweder den Zeitpunkt notieren, wann die Fahrzeuge an der Haltestelle anfahren oder den Grünbeginn für die Gegenrichtung eintragen.
**APPENDIX 3: INSTRUCTIONS AND SURVEY FORM FOR CONGESTION DATA SURVEYORS**

**Staubeobachtung für jeden Signalumlauf**

<table>
<thead>
<tr>
<th>Ort</th>
<th>Beginn/Hemm. / Selberhin.</th>
<th>Datum</th>
<th>Beobachter</th>
<th>Wetter</th>
<th>Trocken</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Grünbeginn</td>
<td>25.9</td>
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<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Std</th>
<th>Min</th>
<th>Sek</th>
<th>Std</th>
<th>Min</th>
<th>Sek</th>
<th>Stau während der Grünzeit</th>
<th>Parken in 2. Spur</th>
<th>Haltende Fahrzeuge bei Grünende</th>
<th>Andere Stör-Einflüsse im Verkehrsablauf</th>
</tr>
</thead>
<tbody>
<tr>
<td>07</td>
<td>45</td>
<td>18</td>
<td>07</td>
<td>45</td>
<td>50</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>28</td>
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<td></td>
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<tr>
<td>05</td>
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</tbody>
</table>

- **Standort des Beobachters**: ca. 25m vor der Haltlinie

- **Grünbeginn eintragen**

- **Grünende eintragen** (insbesondere, wenn die Dauer der Grünzeit nicht regelmäßig ist)

- **Stau während der Grünzeit**: Fortlaufend beobachten, ob eine oder mehrere Fahrspuren blockiert sind. z.B., wenn Stau...Stop&Go-Verkehr auftritt, so daß Fahrzeuge zum Halten kommen und/oder sehr langsam fahren (zähflüssiger Verkehr), dann ist dies einzutragen (x). Kein Stau, wenn Fahrzeuge kontinuierlich ohne Behinderung den Knotenpunkt passieren.

- **Parken in 2. Spur**: Wenn Fahrzeuge in der Fahrspur anhalten und kurzfristig parken (sogenanntes Parken in 2. Reihe) jeweils 50m vor und hinter der Kreuzung, dann entsprechend eintragen (x)

- **Haltende Fahrzeuge bei Grünende**: Wenn das Signal auf Rot schaltet, beobachten, ob Fahrzeuge zum Halten kommen und entsprechend eintragen (x)

- **Andere Störungen im Verkehrsablauf**: Alle Behinderungen, die zusätzlich den Verkehrsablauf beeinflussen (z.B. Straßenreinigungsfahrzeuge.. Rettungsfahrzeuge, mit Blaulicht Ausfall der Signalanlage Wartungsarbeiten.. etc.)

- Vorbereitung zur Erfassung des Grünzeitbeginns für den nächsten Signalumlauf