Compact accident research

Switching off traffic signals overnight - Cost-cutting at the expense of safety?

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Preliminary remarks

Traffic signals are used at intersections of all kinds wherever this is necessary in order to control traffic flow or to ensure traffic safety.

The research carried out to date with respect to traffic safety when traffic signals are switched off at night is no longer up to date and is concerned with the systems installed in West Germany.

Following reunification, many traffic signals in cities of the former GDR were switched off at night, partly as a result of a lack of flexibility in the technical equipment and partly because of the low volumes of traffic.

A recent study carried out by the Institute for Traffic Planning and Road Traffic at the Dresden University of Technology [1] for the German Insurers Accident Research (UDV) demonstrated that switching off traffic signals at night, which is a widespread practice in German cities, cannot be justified on the grounds of safety.

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Preface

§ 37, Section 2 of the German „General Administrative Regulations on the Road Traffic Regulations“ (VwV-StVO) [2] has the following to say about the operation of traffic signals: „Generally, traffic signals should also be operated during the night. If the volume of traffic decreases at night, it is recommended that a special traffic signal program is selected for this period that reduces the waiting time for all road users to a minimum level. The option of switching off traffic signals at night can only be justified if extensive investigation has demonstrated that traffic safety can be maintained without traffic signals.“ This means that there is no blanket ban on switching off traffic signals during periods of low traffic volume, but that this option should remain a justified exception only.

The „Guidelines for Traffic Signals“ (RiLSA) published by the Road and Transportation Research Association [3] also recommends continuous operation of traffic signals due to the increased risk of accidents if the signals are switched off. According to this publication, „only such systems have to be considered for a switch-off for which a need for safeguarding no longer exists. [...] Each case has to be considered carefully.“ In cases where it is being considered that a traffic signal should be switched off periodically, it is furthermore recommended that specific investigations are carried out that evaluate accident data over a period of several years.

Even though legal and technical constraints provide clear guidelines, public demands for switching off traffic signals at night are regularly heard, and many cities and local authorities are bowing to such demands, sometimes on a large scale.

As a generalization, it can be said that the various local authorities switch off around 50 percent of traffic signals at night, although the extent varies from authority to authority. The stated motives for switching off signals regularly quote aspects such as a reduction in noise levels, reduction of fuel consumption and emissions and savings in power and operating costs.

1 Design of the study

Accident investigations

The investigation into the effect of switching off signals at night was carried out in the form of a „with/without“ comparison in the cities of Dresden and Leipzig and the Harburg administrative district. The study compared traffic safety at intersections where the signals were switched off at certain times with traffic safety at comparable intersections where the signals were in operation continuously, taking into account a control group (with the signals in operation).

The data set was made up of accidents with personal injuries over a period of 3 years from 2003 through 2005 and accidents with damage to property from 2005. The total data sample in the survey covered 272 traffic signals (Table 1), at which 1,855 accidents with personal injuries occurred over 3 years and 3,005 accidents with damage to property occurred in 2005. Of this sample, 182 traffic signals were switched off and 90 operated round the clock.

	Traffic signals operating continuosly	**Traffic signals which were switched off**
Dresden	32	132
Leipzig	50	30
Harburg administrative district	8	20
Total	**90**	**182**

Table 1:
Total sample of traffic signals investigated

Test runs and simulation

In Dresden, a vehicle fitted with a GPS receiver was used to carry out test runs. To do this, the vehicle at various times travelled along a predefined route on which intersections with traffic signals operating in different modes were located.

Possible control methods for ensuring the safety of intersections controlled by traffic signals at times with low volumes of traffic were investigated in a simulation study for a typical intersection that would be a potential candidate for switching off the signals or using a traffic-dependent control method. Four different control programs were investigated:

- Daytime program
  (fixed interval control)
- Low-volume program
  (fixed interval control)
- All lights red, immediately switching to green
  (traffic-dependent control)
- Primary direction permanently switched to green
  (traffic-dependent control)

The chosen intersection was modelled in the VISSIM simulation program [5], taking account of empirical counts, and then simulated using the four control programs that had been created, under otherwise identical traffic conditions.

Operating costs

Existing studies were evaluated in order to assess the operating costs.

2 Results of the study

Accidents investigations

Analysis by accident type

In the presentation of the accident characteristics, the relevant share of each of the seven accident types harmonized for the whole of Germany is shown. This means that interpretation is strongly influenced by whether the share of individual accident types is subject to marked changes.

Looking at the accident types across all accidents (Figure 1), we see an increase in the proportion of driving accidents for both modes of operation during the period for which signals are turned off. Possible reasons for this could be the higher speeds at which vehicles are driven at night and reduced awareness of the traffic situation in the hours of darkness.

The proportions of turning-off accidents hardly vary between the two periods under consideration. In contrast, the proportion of accidents caused when turning into a road or crossing a road rises considerably when the traffic signals are switched off. It thus follows that switching off the traffic signals results in an increase in the frequency with which rights of way are not observed.

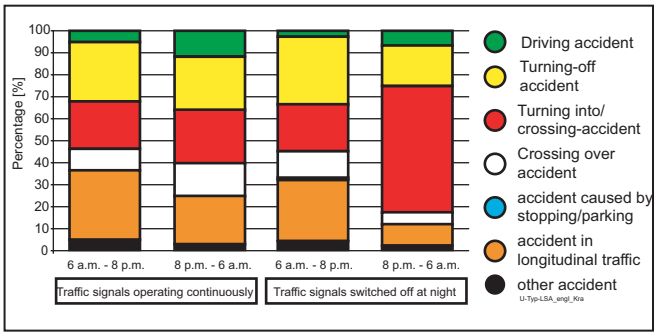

Figure 1:
Changes in the accident structure

One reason for the significant rise in the share of accidents where rights of way were not observed

(accidents turning into/crossing a road) as a result of switching off signals at night may lie in the design of the signal-controlled intersections. As a rule, this differs from the design and features of intersections governed by right of way.

In the case of intersections governed by right of way, the focus is on clear identification of the intersection, clear understanding of the right of way and visibility, whereas with signal-controlled intersections, the focus is on smooth operation. The accident structure therefore corresponds to that of intersections where the right of way is indicated by signs and where poor safety measures have been implemented.

In terms of both quantity and severity, the risk of having an accident when traffic signals are switched off at night is approximately double that when the traffic signals are in operation.

Safety level expressed as accident cost rate

During the course of the study, the accident cost rates are adjusted indirectly on the basis of the casualty structure. This adjustment is done for accidents with personal injuries at the signal-controlled intersections both where the signals are switched off at night and where they remain in operation and for the operating hours (6 a.m. - 8 p.m.) and for the time during which signals are switched off (8 p.m. - 6 a.m.). Adjusting the accident cost rates takes account of discrepancies in the casualty structure of the sample investigated.

The accident cost rates that were determined indicate that the accident severity for traffic signals which are switched off is clearly higher in general than that observed at traffic signals that are in operation continuously, with the accident cost rate being 17% higher in the case of accidents with serious personal injuries. The severity of the accidents is further increased in the time during which the signals are switched off (8 p.m. through 6 a.m.). This observation is also in line with the results of earlier research.

The increase in the severity of accidents at the signals which are switched off periodically must also be taken into account alongside the accident structure. This is done using the accident cost rate (ACR) for accidents with personal injuries. Because the accident cost rate relates to the number of crossings at the intersections, it permits comparative conclusions to be drawn with respect to the individual accident risk, taking into account the severity of the accident (safety risk).

The accident cost rates are calculated according to the following formula:

$$ACR = \frac{\sum_{i=1}^{n} 10^6 \cdot AC_i}{\sum_{i=1}^{n} 365 \cdot ADT_{I,i} \cdot t}$$

n	Number of intersections in the sample
ADT_I	Average Daily Traffic across the Intersection [vehicles / 24 h]
t	Observation period in years [a]
ACR	Accident cost rate [€ / 1000 vehicles]
AC	Accident costs [€] in t years

Looking at the accident cost rate for traffic signals in continuous operation and traffic signals that are switched off periodically as shown in Figure 2 clearly shows the deterioration in safety during the night-time hours in which the signals are switched off.

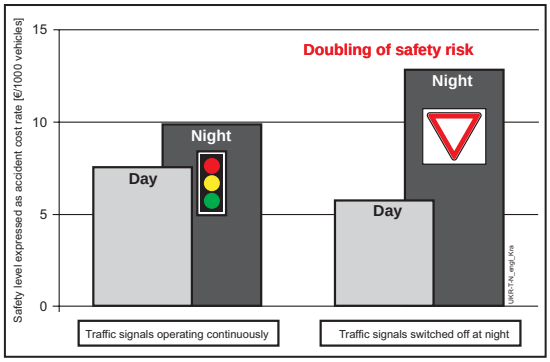

Figure 2:
Safety level expressed as accident cost rate

What intersections allow signals to be switched off?

Analysis of the intersections studied in terms of geometrical or traffic-related characteristics does not reveal any potential criteria according to which there would be any justification for switching off the signals for reasons of safety. It is clear that even at simple intersections, the traffic signals must not be switched off for reasons of safety. Every characteristic relating to complex intersections (the number of lanes, geometrical aspects and complex control issues) has an additional negative impact on the results.

Example of switching signals off at night

The fatal consequences of switching signals off at night are illustrated using the example of the following intersection (Figure 3).

Figure 3:
Kretschmerstr./Berggartenstr. intersection (City of Dresden)

The traffic signals are switched off at night at the intersection in the city of Dresden illustrated here.

Figure 4 shows the accident type map for the intersection in the three-year map for accidents with personal injuries. The classification of this location as an accident black-spot is based on both the 1-year map (5 accidents of type 3) and the 3-year map for accidents with personal injury (17 accidents of type 3). The accident black spot should be assigned to the category 3.1 – a normal black spot of the category „mixed" – as per the Guidelines for Evaluating Road Traffic Accidents as published by the Road and Transportation Research Association (FGSV) [4].

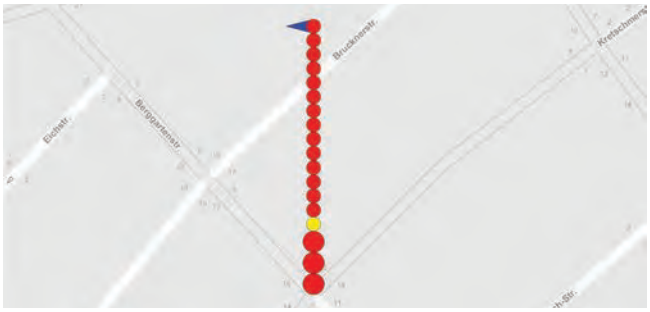

Figure 4:
Accident type map 3-YM showing severe accidents (2000-2002)

The accident chart „3-year map showing severe accidents" (Figure 5) shows unmistakably that this high number of accidents is due entirely to the traffic signals being switched off at night. Only two of 18 accidents (nos. 10 and 14) occurred while the traffic signals were switched on. Most of the accidents could probably have been avoided if the regulations laid down in RiLSA and the VwV-StVO had been observed.

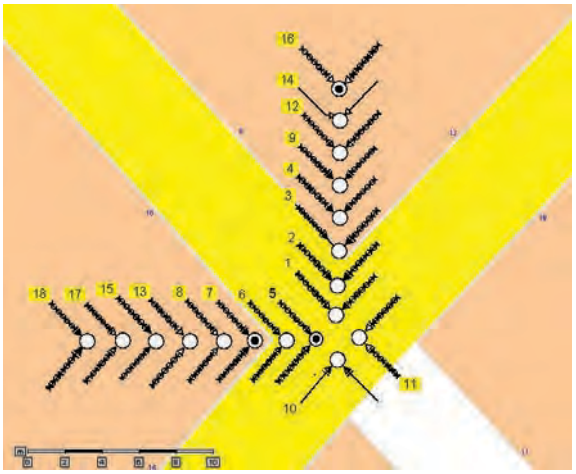

Figure 5:
Accident diagram 3-YM showing severe accidents (2000-2002)

Test runs and simulation

Inspection of the test runs shows that the average travel time along the route increases over the four measurement periods (Diagram 1). Since the speeds on routes with traffic signals operated in both modes increase to virtually the same extent, the reasons are not necessarily related to the fact that the traffic signals are switched off. Lower volumes of traffic during the evening and night also cause an increase in the speed of travel. The time required for each kilometre of the route falls correspondingly. The difference between the values achieved when the signals are operated continuously and when they are switched off is the measure for the gain in time and is 2 through 4 seconds for each kilometre travelled. The 2 seconds per kilometre in the period after midnight amounted to a total saving in travel time of less than 3 %.

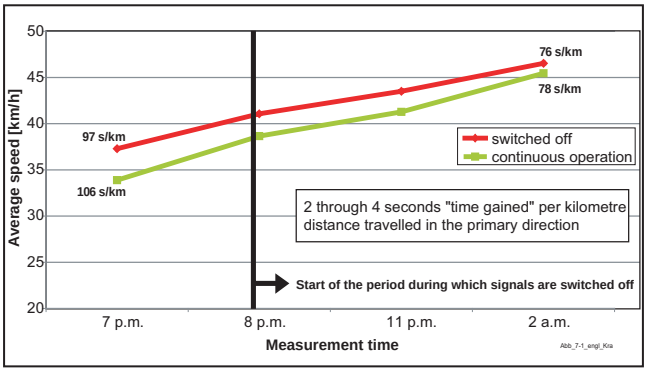

Diagram 1:
Average speed on inner-city test routes

Any savings in travel time are of a magnitude where driving style, weather conditions or the choice of route have a far greater influence. Test runs and simulations of traffic flow show that traffic-dependent control of traffic signals rather than fixed time sequences would achieve gains in time comparable to switching off the signals. Switching off traffic signals which are already controlled on a traffic-dependent basis brings little further benefit.

Operating costs

Operating costs can be subdivided into the elements maintenance, repair and power consumption. In this context, the maintenance and repair costs are essentially independent of the mode in which the traffic signals are operated (continuous or switched off periodically). It is only the power consumption resulting from the number of operating hours of the traffic signals that varies.

Even using optimistic assumptions, the maximum cost savings that could be expected would be in the region of 500 euros per intersection per year.

Such savings can easily be exceeded by the increased use of modern technology (LED technology).

3 UDV recommendations

All the conclusions confirm the effects already established by earlier research.

Switching off traffic signals at night

- has a negative impact on road safety
- leads to comparatively small energy savings
- only reduces travel times by a small amount and hence
- only marginally reduces fuel consumption, noise and emissions.

Even though the facts have been known for many years, the option of switching off traffic signals is not merely under discussion: In many cities, the relevant authorities are confronted by demands to switch off a certain percentage

of traffic signals at night. As this document has again reliably proved, demands of this sort relating to traffic policy cannot in any way be justified for economic reasons and completely ignore the protection of people and property in our cities. For this reason, UDV recommends:

- Systematic implementation of the stipulations laid down in the General Administrative Regulations on the Road Traffic Regulations (VwV-StVO)

- The decision to switch off traffic signals should remain an exception and should be justified and the situation with respect to accidents should be constantly monitored

- Improved technology should be used (low-voltage technology, LEDs)

- Intelligent, traffic-dependent signal control methods should be used.

The results of the study [1] were presented to the public during the GDV media forum in Dresden on 28/29 April 2008.

References

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[4] „Merkblatt für die Auswertung von Straßenverkehrsunfällen – Teil 1: Führen und Auswerten von Unfalltypensteckkarten.“ (Code of Practice for Evaluating Road Traffic Accidents – Part 1: Maintaining and Evaluating Accident Type Maps) (2003) Road and Transportation Research Association, Steering Committee Traffic Control and Traffic Safety. Cologne: FGSV

[5] VISSIM, Highly realistic traffic flow modeling, PTV AG

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