Evaluation of the safety effect of bike boxes

Lahrmann, Harry; Madsen, Tanja Kidholm Osmann; Tønning, Charlotte; Olesen, Anne Vingaard; Agerholm, Niels

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Harry Lahrmann, hsi@civil.aau.dk, Tanja Kildhom Osmann Madsen, tkom@civil.aau.dk Charlotte Tonning, cht@civil.aau.dk, Anna Vingaard Olesen, avo@civil.aau.dk, and Niels Agerholm, na@civil.aau.dk

Introduction

Accidents between straight-ahead running cyclists and right- or left-turning cars in signal-controlled intersections is one of the most common types of accidents between cyclists and cars. Over the years, Denmark has focused a great deal on these types of accidents without finding an effective measure. In an attempt to prevent these accidents, a report was published in 2014 (Rigspolitiet et al., 2014). The report proposes a number of initiatives that are expected to prevent these accidents, including bike boxes. Based on the report, the Danish Road Directorate has conducted a large-scale trial with bike boxes in 57 signalised intersections.

Aalborg University has evaluated the safety impact of the large-scale trial for the Danish Road Directorate. A number of studies have evaluated bicycle boxes. [34 et al., 2002; Hunter, 2005; Bygøe et al., 2005; Atkins Services, 2005; Rodgers, 2005]. The studies have applied behavioural observations based on a few hours of video observations, which are subsequently manually analysed and/or questionnaires where users’ perception of the bike lane's contribution to their safety has been asked. None of the studies have been evaluated by accident before and after and none of the behavioural observations have been carried out following one of the acknowledge conflict study methods [Hydén 1987, Krey 2013].

Methods

The Danish Road Directorate wanted a quick assessment of the safety impact of the bicycle boxes to that although the large scale trial included 57 intersections, it could not be expected that there in the 57 intersections would be a sufficient number of registered bicycle accidents that any possible change in accident rates could be determined with the necessary statistical significant. Therefore, it was decided to determine the safety beforeafter using conflicts as surrogate by accident. Due to the size of the budget and an estimate of the expected number of conflicts, it was decided to record videos from one leg of the 57 intersections, which in this project are the 7 intersections, that are spread throughout Denmark and traffic varied from low to high - see figure 1. We filmed for 16 hours on 19 weekdays before and after each intersection. This would allow for a safe result if the effect would be at least 30% and that there were observed 1.5 conflicts per weekday on average in the 7 legs in the before-period.

In the study we used the Swedish Conflict Technique and we used the following process for analysing the recorded video data: First, the recordings were analysed with the video analysis program RUVA (Madsen & Lahrmann, 2017). RUVA was used to find simultaneous arrivals, which in project are defined to occur when the cyclist arrives at the point of intersection until the next road user arrives at the same point. Only a small proportion of the simultaneous arrivals imply a high probability for a crash, but since each event is unique, and the progress of the event is important if there is a situation, all simultaneous arrivals are manually reviewed to decide if there is a potential conflict. Events are post-processed if:

- It is estimated to be a short distance from the first road user is leaving the two road users common point of intersection until the next road user arrives at the same point.
- There seems to be a lack of interaction between road users, causing one or both road users to slow down at the last minute, or to perform evasion maneuvers (accelerates, decelerates, changes direction) to avoid collision.
- The incident does not feel ok or feels dangerous.

For example, if it is considered that there is something that makes it interesting to investigate the interaction more closely. This includes, for example, incidents where it is estimated that a collision can easily occur if something unexpected occurs.

Subsequent processing of potential conflicts has been done in the T-Analyst program (Trafvid, 2014). This program manually creates trajectories for the two parties in the potential conflict, and the program can then calculate how close the parties were in collision, see Figure 3. In this project, the following limit values have been selected in T-Analyst TTCmin ≤ 2.0 sec, or T2, min ≤ 0.5 sec - cf. the Swedish Conflict Technique. Figure 4 shows a schematic representation of the procedure for data processing.

Results

Discussion

To determine the extent of the video recordings we when the project was planned based on past experience made the assumption that there would occur between one and three right-turning and left-turning conflicts per day (16 hours) in each intersections. This condition has been met in the study, as we in average found 2.9 conflicts per day in the before period and 2.8 in the after period.

Unfortunately, the effects in 7 intersections point in different directions, and when the effects are weighted with the log-odds method, the weighted effects have a high p-value - especially 0.63 and 0.37 - and it is not possible to conclude from these. Overall the study can't detect any safety effect of bike boxes in the 7 robust interactions. A contributing reason for this is probably that the boxes were largely not used by cyclists. A systematical mapping of the use was not part of the evaluation, but consistent feedback from the observers of the potential conflicts was that they rarely saw cyclists in the boxes.

References

[9] Lahrmann, H. S. 2017). RUBA was used to find simultaneous arrivals, which in project are defined to occur when the cyclist arrives at the point of intersection until the next road user arrives at the same point – see Figure 2.

Figures

Figure 1 Geographical location of the seven intersections

Figure 2 Conflict type and p-value for respectively. Right turn conflicts and left turn conflicts divided into the seven intersections. Values with red indicates where CRR is significantly different from 1.

Table 2 Conflict rates, conflict rate ratio and p-value for respectively. Right turn conflicts and left turn conflicts divided into the seven intersections. Values with red indicates where CRR is significantly different from 1.

Table 1 Number of hours of recordings and number of conflicts recorded by the 7 intersections

Table 1

<table>
<thead>
<tr>
<th>Intersection No.</th>
<th>Number of conflicts</th>
<th>Recording (Hours)</th>
<th>Number of conflicts</th>
<th>Recording (Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intersection No. 1</td>
<td>304</td>
<td>53</td>
<td>8</td>
<td>320</td>
</tr>
<tr>
<td>Intersection No. 2</td>
<td>292</td>
<td>7</td>
<td>4</td>
<td>320</td>
</tr>
<tr>
<td>Intersection No. 3</td>
<td>276</td>
<td>7</td>
<td>4</td>
<td>368</td>
</tr>
<tr>
<td>Intersection No. 4</td>
<td>295</td>
<td>43</td>
<td>8</td>
<td>320</td>
</tr>
<tr>
<td>Intersection No. 5</td>
<td>305</td>
<td>26</td>
<td>17</td>
<td>320</td>
</tr>
<tr>
<td>Intersection No. 6</td>
<td>90</td>
<td>68</td>
<td>14</td>
<td>160</td>
</tr>
<tr>
<td>Intersection No. 7</td>
<td>157</td>
<td>45</td>
<td>10</td>
<td>160</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>1719</td>
<td>249</td>
<td>65</td>
<td>1907</td>
</tr>
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</table>

Table 2

<table>
<thead>
<tr>
<th>Conflict type</th>
<th>Conflict rates (conflicts/hour)</th>
<th>CRR</th>
<th>p-value</th>
<th>Conflict rates (conflicts/hour)</th>
<th>CRR</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>After</td>
<td></td>
<td></td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>Intersection No. 1</td>
<td>0.174</td>
<td>0.131</td>
<td>0.75</td>
<td>0.17</td>
<td>0.026</td>
<td>0.016</td>
</tr>
<tr>
<td>Intersection No. 2</td>
<td>0.024</td>
<td>0.028</td>
<td>1.17</td>
<td>0.75</td>
<td>0.014</td>
<td>0.006</td>
</tr>
<tr>
<td>Intersection No. 3</td>
<td>0.025</td>
<td>0.078</td>
<td>3.07</td>
<td>0.01</td>
<td>0.015</td>
<td>0.026</td>
</tr>
<tr>
<td>Intersection No. 4</td>
<td>0.146</td>
<td>0.109</td>
<td>0.75</td>
<td>0.21</td>
<td>0.027</td>
<td>0.056</td>
</tr>
<tr>
<td>Intersection No. 5</td>
<td>0.085</td>
<td>0.128</td>
<td>1.50</td>
<td>0.10</td>
<td>0.056</td>
<td>0.078</td>
</tr>
<tr>
<td>Intersection No. 6</td>
<td>0.757</td>
<td>0.381</td>
<td>0.50</td>
<td>0.00</td>
<td>0.158</td>
<td>0.188</td>
</tr>
<tr>
<td>Intersection No. 7</td>
<td>0.267</td>
<td>0.169</td>
<td>0.90</td>
<td>0.03</td>
<td>0.064</td>
<td>0.019</td>
</tr>
</tbody>
</table>

Conflicts were calculated by weighting the 7 conflicts rates (CRR) to one conflict rate ratio. The weighting of the effects of right turn conflicts is carried out with the so-called random effect log-odds-method, because the individual intersections varies a lot with respect to effect. For the left turn conflicts, we used the fixed-effect-log-odds-method as the 7 CRRs are more similar (Elsig et al., 2009) The weighted effect of right-turn conflicts in the seven bicycle boxes gives a CRR of 0.91, but since a value of 0.62, the decrease is not statistically significant. Also for left turn conflicts, the weighted effect of the bike boxes is not statistically significant. Here we got a weighted CRR of 1.17 and thus an increase but with a p-value of 0.37.

Figures

Figure 2 Screenshot from RUVA seeking potential right turn conflicts

Table 1 shows the length of the recordings and the number of conflicts divided between the two conflict types before and after and divided into the seven intersections.

Figure 3 Screenshot from T-analyst

Figure 4 Schematic representation of the procedure for data processing

Acknowledgements

This paper is based on an evaluation task that Aalborg University has conducted for the Danish Road Directorate.