Investigate Moped-Vehicle Conflicts in China Using a Naturalistic Driving Study Approach

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Mopeds in Shanghai

• Shanghai regulations

<table>
<thead>
<tr>
<th></th>
<th>Max Speed</th>
<th>Engine displacement</th>
<th>Driver’s License</th>
<th>Vehicle registration</th>
<th>Designated driving lane</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorcycles</td>
<td>&gt;50km/h</td>
<td>&gt; 50 cc</td>
<td>Yes</td>
<td>Yes</td>
<td>Motor vehicle lane</td>
<td></td>
</tr>
<tr>
<td>Scooters</td>
<td>&gt;20km/h</td>
<td>&lt; 50 cc</td>
<td>Yes</td>
<td>Yes</td>
<td>Motor vehicle lane</td>
<td>Forbidden on speedways, major bridges, tunnels, etc.</td>
</tr>
<tr>
<td>Mopeds</td>
<td>&lt;20km/h</td>
<td>-</td>
<td>No</td>
<td>Yes</td>
<td>Non-motor vehicle lane</td>
<td></td>
</tr>
</tbody>
</table>

• On roads without non-motor vehicle lanes, E-bikes should use the right side of the lane (1.5 meter to the right lane marking)
• Gas-powered mopeds are banned in Shanghai since 2016
• Most mopeds (>80%) have max speed over 20km/h
Mopeds in Shanghai

• Moped is a very popular transportation mode in China
  • More than 3 million “mopeds” in Shanghai vs. 2.7 million motor vehicles (2011).
  • In 2013, 185 million e-bikes in China vs. 137 million vehicles (Chinese Cycling Association).

• Crash data
  • 37% of all crashes and 27% of all crash fatalities in Shanghai in 2010-2011 were associated with moped.
  • E-bike fatalities in China (China surface transportation crash statistics annual report)

In 2014, US fatality rate:
All vehicle: 1.2;
Rate per 10,000 registrations
Study goals

- Exploring Chinese moped-vehicle conflict configurations;
- Examining car driver responses to moped-vehicle conflicts.
Shanghai Naturalistic Driving Study

GM: Testing Vehicles

5 vehicles:
1 Cadillac DTS
2 Buick LaCrosse
2 Chevrolet Cruze

3 Years data collection period (2012-2015)

Tongji: Equipment; Data collection; Analysis

VTTI: DAS Technical Support; Data processing and management; Study design and analysis

STSCE International NDS project
Shanghai Naturalistic Driving Study

• The study collected data from 60 drivers (100,000 vehicle miles). Each driver drove one vehicle for 2 months.

• Data used in this analysis
  • 36 drivers
  • 2,878 hours of driving, approximately 50,000 total vehicle miles
Shanghai Naturalistic Driving Study

• VTTI Data Acquisition System (DAS)

DAS schematic view

• high-resolution kinematic sensors,
• four video cameras,
• one forward radar,
• the vehicle network
Drivers’ demographics

- 28 males vs. 8 females
  (Registered drivers in China (2015): male 74%; SHRP2: Female 51.9% vs. male 48.1%)

**Mean** = 38 years old

(In comparison: SHRP2: 37% older than 50 years old)

**Mean** = 7 years

(Registered drivers in China (2015): 11% have less than a year driving experience)
Identify moped-vehicle conflicts

<table>
<thead>
<tr>
<th>Kinematic trigger</th>
<th>Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal deceleration</td>
<td>0.65g (SHRP 2), 0.5g, 0.4g</td>
</tr>
<tr>
<td>Lateral acceleration</td>
<td>(SHRP 2)</td>
</tr>
<tr>
<td>Longitudinal jerk</td>
<td>(SHRP 2)</td>
</tr>
<tr>
<td>Steering evasive maneuver</td>
<td>(SHRP 2)</td>
</tr>
<tr>
<td>Sway evasive maneuver</td>
<td>(SHRP 2)</td>
</tr>
<tr>
<td>Yaw rate</td>
<td>(SHRP 2)</td>
</tr>
</tbody>
</table>

Due to an improper DAS setup in one vehicle, 45 SCEs associated with this vehicle had a lower actual deceleration (i.e., <0.4g) than the recorded deceleration. These events are referred to as “low g-force conflicts”. The other events are “high g-force conflicts” (i.e., >0.4g)
Identify moped-vehicle conflicts

Final data: 119 moped-vehicle conflicts

- A total of 74 high g-force conflicts.

- Conflict rate (g force > 0.65 or evasive steering) is 0.14 per a thousand miles.

- Only 2 conflicts were identified due to driver’s evasive lateral response.
  - Congested traffic allows no available steering space
22 configurations were found

1st row: Conflict type category code;
2nd row: Number of conflicts among all 119 moped–vehicle conflicts;
3rd row: Number of conflicts among 74 high g-force conflicts.
Chinese moped-vehicle conflict configurations

- Road users often do NOT follow traffic rules

The most common moped-vehicle conflict configuration.
(Germany: Hummel et al., 2001; Australia: Blackman & Haworth, 2013; California, Salatka et al., 1990)
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**Chinese moped-vehicle conflict configurations**

<table>
<thead>
<tr>
<th>Access and T-junction (9/119) (8/74)</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Straight Road (55/119, 46.2%) (24/74, 32.4%)</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9</td>
<td>39</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>12</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

1\(^{st}\) row: Conflict type category code;
2\(^{nd}\) row: Number of conflicts among all 119 moped–vehicle conflicts;
3\(^{rd}\) row: Number of conflicts among 74 high g-force conflicts.
Chinese moped-vehicle conflict configurations

- In Shanghai, mopeds should use non-motor vehicle lanes, but moped drivers take motor vehicle lanes frequently to avoid objects in their own lanes.

Video Redacted

This is a unique configuration that has not been reported as a common configuration in western countries.
Chinese moped-vehicle conflict configurations

Many configurations can be attributed to moped or vehicle traffic violations.
Another video

Video Redacted
Discussion

• The first analysis using naturalistic driving data to examine vehicle-moped conflicts.
• This study is based on a very small sample.
• Data were collected in Shanghai urban area only.
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Thank you for your attention