Traffic Safety, Risk Analysis and Driver Behaviour in Motorcycle Dominated Traffic System

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Hanoi, 21.10.2013

Content

- Introduction
- Risk Analysis and Driver Behaviour in MDC
- Case study:
  - Behaviour of left-turning movement at intersections;
  - Behaviour of violating traffic regulation;
  - Traffic safety measurements (eg. education, engineering, enforcement, emergency) influence on traffic behaviour
- Conclusion and Recommendation
Problems and Issues

- Fast-growing economy and motorization
- Lack of people’s safety awareness and knowledge
- Insufficient infrastructure and road safety facilities
- Disregard of traffic rule and lack of safety driving manner
- Mixed and tangled traffic of car, M/C, B/C and pedestrians
- Frequent Traffic Accidents

Roadmap toward long-term and comprehensive traffic safety measures including policy, institution, human resource and fund source

Traffic Safety in Vietnam

- High rate of fatalities (per 100,000 inhabitants)
- Seems not trend to reduce
Traffic accidents in Vietnam

Main Causes of Traffic Accidents

- Over speeding: 33%
- Dangerous overtaking: 11%
- Misuse of lanes: 6%
- Turning: 10%
- Poor observation: 9%
- Pedestrian: 8%
- Other causes: 23%

89% Human behaviour


Traffic behaviour and conflicts

TRAHUSD project (2008)

Source: Dr. Ing. Le Thu Huyen
## Risk analysis approach

**Report on an accident:**
- Description: time, location, involved parties
- Damage: injury, serious injury, death
- Accident cause: eg. red-light running car
- Different reporters may have different conclusions

**Risk analysis approach:**
- Not enough information about the accident.
- External conditions come together.
- Causing elements should be a set of elements in the traffic environment and driver behaviour.

### Risk Analysis in Traffic Safety

Past | Present time | Future
---|-------------|---
Statistical data | | Forecasting

**Statistical analysis**
- types of damage
- causes leading to damage

**Traditional forecasting**
- damage levels
- simple relationships between causes and effects
  ⇒ Simple models

**Risk analysis**
- risk values
- interacting relationships (multi-dimensional) among causes
  ⇒ Complex models
Human Behaviour and Traffic safety

**Human behaviour in road traffic:**
- strategic level (mins): choice of destination, routes, transportation modes
- tactical level (seconds): lane changing, turning movements, etc.
- action level (% seconds): choice of speeds, acceleration/deceleration rates, etc.

**Research questions on human behaviour:**
- How do people behave in a specific case (different behaviours and probability distribution)?
- Why do people behave in that way?
- What are the effects of those behaviours?
Driver behaviours in MD intersections

- How do drivers behave at intersections?
  - Different behaviours

- Why do drivers have such behaviours in specific cases?
  - Influenced parameters

- How dangerous are those behaviours?
  - Risk levels (damages and their probability distribution)

Case study 1: left-turning movements

<table>
<thead>
<tr>
<th>Wrong movement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1-1</td>
<td>Wrong-Left Turn 1</td>
</tr>
<tr>
<td>W1-2</td>
<td>Wrong-Left Turn 2</td>
</tr>
<tr>
<td>W1-3</td>
<td>Wrong-Left Turn 3</td>
</tr>
<tr>
<td>W1-4</td>
<td>Wrong-Left Turn 4</td>
</tr>
<tr>
<td>W1-5</td>
<td>Wrong-Left Turn 5</td>
</tr>
<tr>
<td>W1-6</td>
<td>Wrong-Straight 1</td>
</tr>
<tr>
<td>W2</td>
<td>Wrong-Right Turn 1</td>
</tr>
<tr>
<td>W3</td>
<td>Wrong-Right Turn 2</td>
</tr>
<tr>
<td>W4</td>
<td>Wrong-U Turn</td>
</tr>
<tr>
<td>W5</td>
<td>Wrong-Crossing</td>
</tr>
<tr>
<td>W6</td>
<td>Wrong-Displaced</td>
</tr>
</tbody>
</table>
Accident progress

- Normal driving (Turning manoeuvre):
  - Perception: intersection, priority (if available), traffic signs and signals
  - Decision to proceed turning manoeuvre
  - Action: Decelerating/accelerating, choosing trajectory

- Avoiding critical situations:
  - Perception of critical situations
  - Calculating relative speeds
  - Deciding to act (braking urgent/normal, swerving, keep going)

Reference: Grundlagen für die Anwendung von Risikoanalysen im Straßenwesen, Bald (1991)

Accident progress at intersection

- Approaching
- Waiting
- Entering
- Leaving

Risk
Accident progress and Potential Conflicts

- Driver motivation
- Driver cognition
- Approaching speed
- Speed adjustment
- Perceiving the situation

Surrounding
Infrastructure
Traffic flow
Trajectory choice
Approaching conflict zone
Critical situation occurring
Potential conflict zones
Critical situation

Calculating Action Distance

Required Action Distance (RqSD)
Available Stopping Distance (AvSD)

RqSD > AvSD
(Potential) Conflicts

Stopping distance (required and available)

- Required action distance:
  - AASHTO formula
  - PRT
  - a (deceleration rate):
    - braking urgent: 2 m/s²
    - braking normal: 1.3 m/s²
    - swerving
    - no
  - v: average approaching speed (crowded & uncrowded traffic)

- Available stopping distance:
  - Potential conflict zone
  - Critical (hazard) situation: legal and illegal movement
Trajectory choice

- Groups:
  - Trajectory
  - Time scale (based on traffic signals)

- Influenced parameters:
  - Traffic flow (density)
  - Intersection dimension
  - Driver personality (age, gender, experience, motivation)
  - Enforcement
  - Priority rules (lane, signals)

Driver Behaviour Groups

- Uncrowded traffic:
  - low traffic volume,
  - high speed
  - (relatively) independent movement

- Crowded traffic:
  - high traffic volume,
  - low speed
  - movement in groups
Conflict Zone in Motorcycle-Dominated traffic

Conflict Points in Traditional Conflict Techniques
Motorcycle-dominated traffic flow

Critical situations and conflict zones

Conflict with on-coming traffic
Conflict with red-light running

### Conflict Time Segments

<table>
<thead>
<tr>
<th>Traffic signals (for left-turners)</th>
<th>Red</th>
<th>Green</th>
<th>Yellow</th>
<th>Red</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Opposite flow (NS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other flow (WE)</td>
<td></td>
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</tr>
</tbody>
</table>

- Group 1 waiting in the waiting line
- Group 2 conflicting with NS
- Opposite flow (NS) continuously moving, slowing, avoiding
- Other flow (WE) waiting in the waiting line

### Case study 2: Violating Traffic Regulation

![Diagram of Theory of Planned Behaviour](image)

**General attitude**

- **Attitude**
- **Subjective norm**
- **Perceived behavioural control**

**Specific-scenario acceptance**

**Intention** → **Behaviour**

*Source: modification after Icek Ajzen (1985) Theory of Planned Behaviour*
Driver behaviour of violating traffic regulations

→ Reasons for violating traffic rules:
  ✓ They intend to do so
  ✓ They are lack of knowledge on traffic and traffic safety
  ✓ They are forced to do so

→ Modifying into two groups of reasons:
  ✓ general attitudes towards traffic rules (long-term motivation)
  ✓ specific scenario acceptance of rules (short-term motivation)

General attitude towards traffic rules

External parameters
- Legislation (rules, enforcement, etc.)
- Traffic operation (traffic signs, signals, lanes of priority, etc.)
- Traffic flow conditions and other road users
- Other surrounding parameters

Driver personality
- Attitudes towards legislation
- Perception capacity
- Cognitive elements
- Motivation in specific cases

Beliefs and norms
- “Everybody breaks the regulations”
- “It is impossible to ride in such a crowded traffic without breaking the rules”

Attitudes
- Correct driving = damage
- Incorrect driving = benefit

Behaviours
- Legal movement
- Illegal movement

Source: Interview in HN and HCM city in 2008
General Attitude towards Traffic Rules

**External parameters**
- Infrastructure
- Traffic flow conditions
- Other road users
- Traffic operation & management
- Other surrounding parameters

**Driver personality**
- Attitudes towards legislation
- Perception capacity
- Cognitive elements
- Motivation in specific cases

**General attitude**
- Subjective norm
- Intention

**Behaviour**
- obeying rules
- freely riding

Specific-scenario acceptance

Violating traffic rules: negotiating among risks

**Flow chart of balancing among risks**

- Obeying rules
- Freely riding
- Getting stuck
- Being punished
- Total risks
- Decision point
- Risks

5/15/2014
Chain of Violation Behaviour

Legend:
- independent parameter
- dependent parameter
- development

(A) Education level

(B) Experience of enforcement

(C) Experience of getting stuck

(D) Traffic volume

(E) Trip motivation

(F) Congestion status

(G) Perception skill

(H) Fear for congestion

(I) Enforcement level

(J) Age of drivers

(K) Enforcement level

(L) General attitude towards rules

(M) Specific scenario acceptance of rules

(N) Violation behaviour
Model Explanation

Field Survey: Policy 1

- Wearing helmet when driving
- 1 Month of enforcement campaign
- Locations:
  - NH1: National Highway N°1
  - NH2: National Highway N°5
  - BTL-NB: National Highway Bac Thang Long – Noi Bai
Field Survey: Policy 2

- Lane separation
- 1 Month of enforcement campaign
- Type of violation behaviours:
  - LV1: non-left-turning vehicles stop on left-turn lane.
  - LV2: left-turning vehicles stop on non-left-turn lane.
  - LV3: weaving over the separation line
  - SV: Traffic signal violation.

![Trend of enforcement effect](chart)

Using Risk Analysis Approach

- Monitoring + punishment
- Enforcement level
- [LV]
- [IV]
- General attitude towards rules
- Specific-scenario acceptance of rules
- Violation behaviour
Using Risk Analysis Approach

<table>
<thead>
<tr>
<th>Measure 1</th>
<th>( P_{bf}(\text{GATR} = \text{&quot;high&quot;}) )</th>
<th>( P_{bf} &gt; P_{df} )</th>
<th>( P_{af} &gt; P_{dr} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
<td>( P(\text{VB} = \text{&quot;yes&quot;}) ) decreases ( \rightarrow ) GATR has higher influence on VB rate</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Measure 2</th>
<th>( P_{bf}(\text{SSAR} = \text{&quot;high&quot;}) )</th>
<th>( P_{bf} &gt; P_{df} )</th>
<th>( P_{af} &lt; P_{dr} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect</td>
<td>( P(\text{VB} = \text{&quot;yes&quot;}) ) decreases then comes up again ( \rightarrow ) GATR are not effected with the measure</td>
<td></td>
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<tr>
<td></td>
<td>( P(\text{VB} = \text{&quot;yes&quot;}) ) of different behaviours are different ( \rightarrow ) GATR to different regulations are different</td>
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Conclusion and Recommendation

- **Conclusion:**
  - The methodology is practical and applicable.
  - The methodology is efficient in motorcycle-dominated traffic flow.
  - The methodology advantage is:
    - Its ability to work well even in case of data shortage.
    - Its ability to be improved and expanded whenever the knowledge and data are enlarged.
  - The case study can be applied to evaluate traffic measurements, strategy, policy, etc. before and after implementation

- **Recommendation:**
  - More detailed results require more efficient tools as well as more data.
  - Quantifying parameters in the model, with their probability distributions.
  - Evaluating and verifying relationships among parameters.
  - Integrating knowledge and experience from inter-discipline studies and researches
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Thank you very much for your attention!