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

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Mopeds in Shanghai

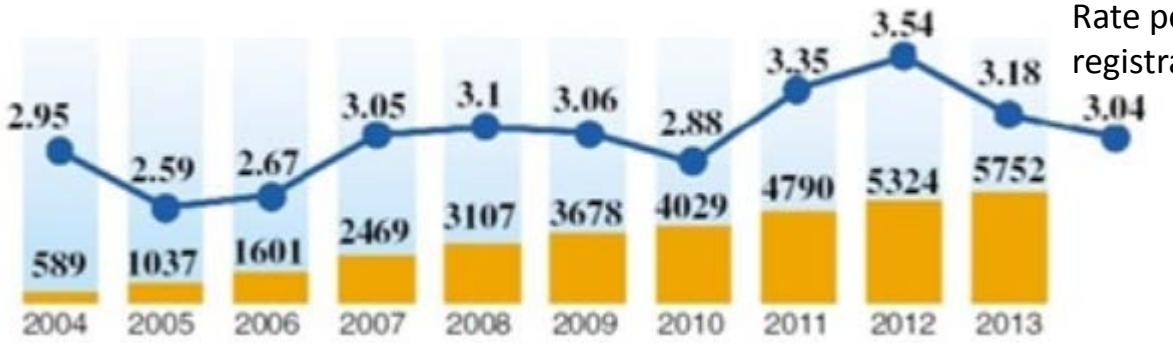
- Shanghai regulations

	Max Speed	Engine displacement	Driver's License	Vehicle registration	Designated driving lane	Limitations
Motorcycles	>50km/h	> 50 cc	Yes	Yes	Motor vehicle lane	
Scooters	>20km/h <50km/h	< 50 cc	Yes	Yes	Motor vehicle lane	Forbidden on speedways, major bridges, tunnels, etc.
Mopeds	<20km/h	-	No	Yes	Non-motor vehicle lane	

- 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)



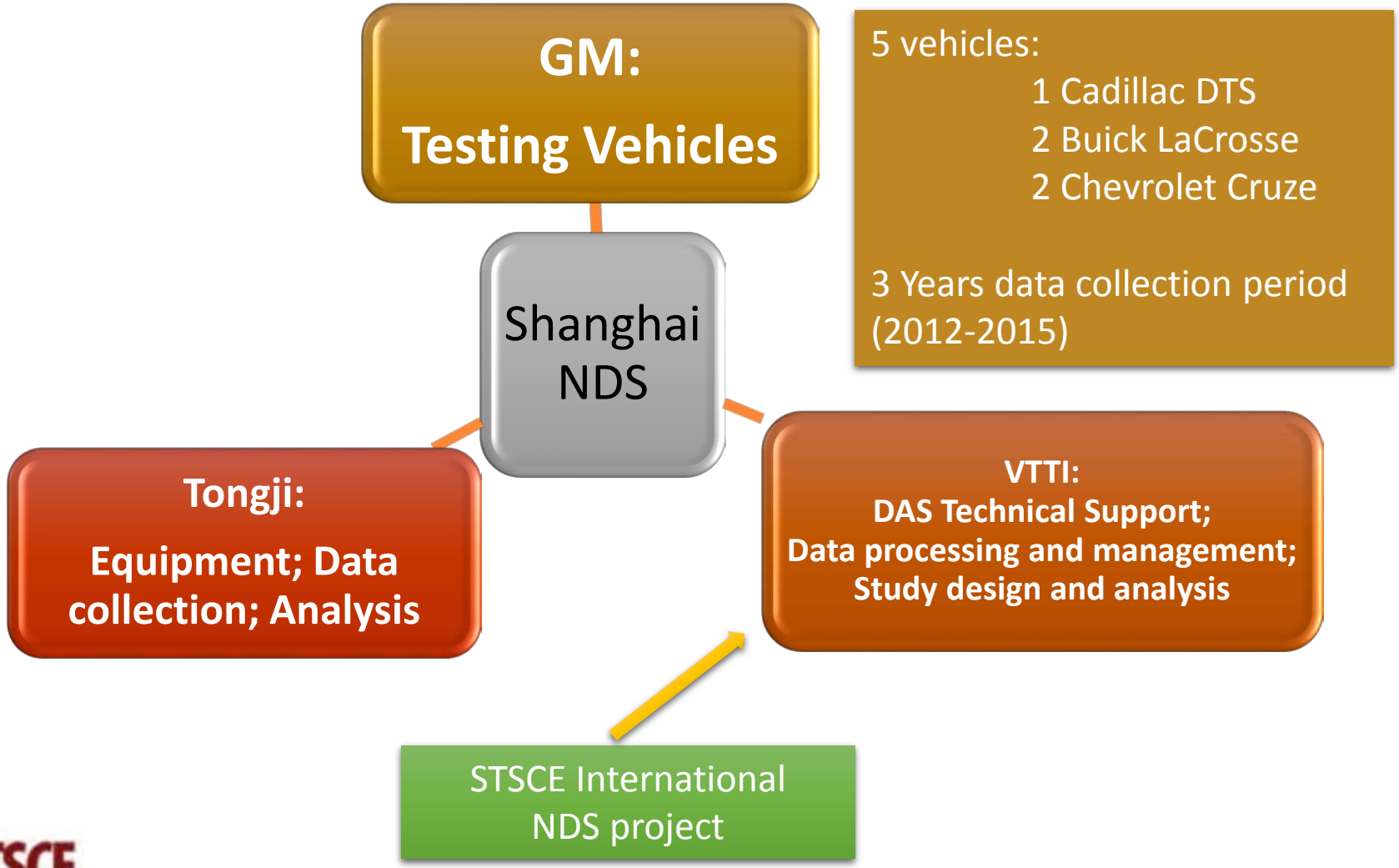
Rate per 10,000 registrations

In 2014, US fatality rate:
All vehicle: 1.2;

Study goals

- Exploring Chinese moped-vehicle conflict configurations;
- Examining car driver responses to moped-vehicle conflicts.

Shanghai Naturalistic Driving Study



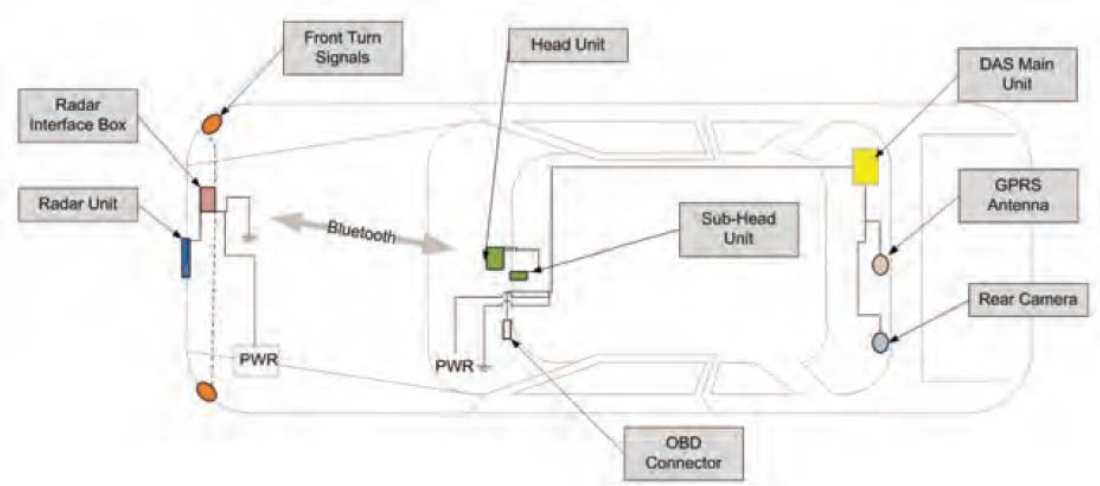
Shanghai Naturalistic Driving Study

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

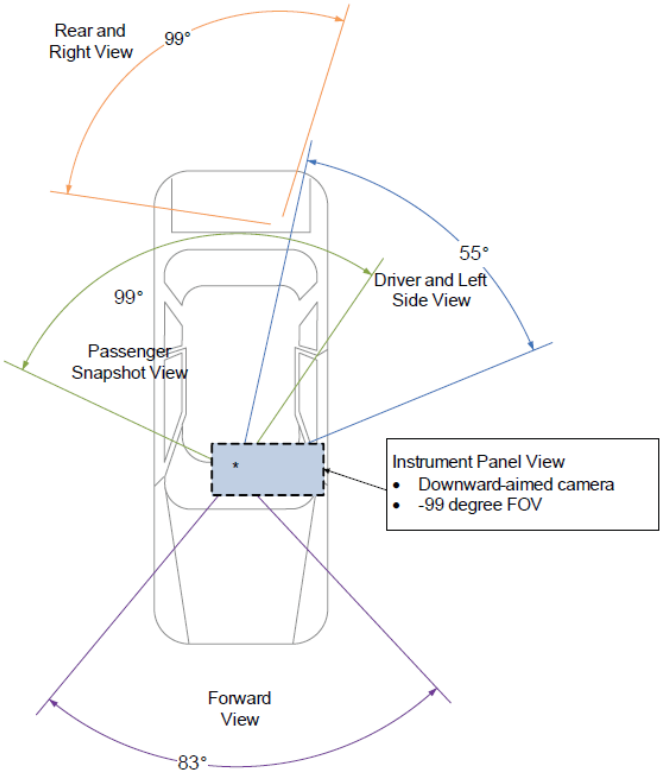
- Data used in this analysis
  - 36 drivers
  - 2,878 hours of driving, approximately 50,000 total vehicle miles

Shanghai Naturalistic Driving Study

- VTTI Data Acquisition System (DAS)



DAS schematic view

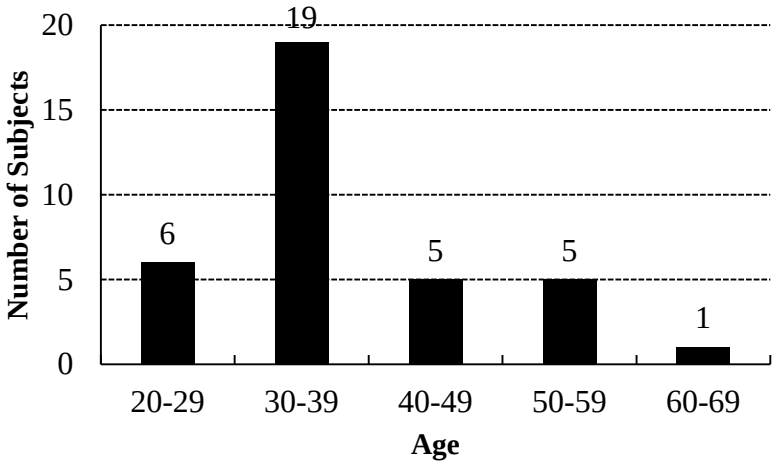


- high-resolution kinematic sensors,
- four video cameras,
- one forward radar,
- the vehicle network

Drivers' demographics

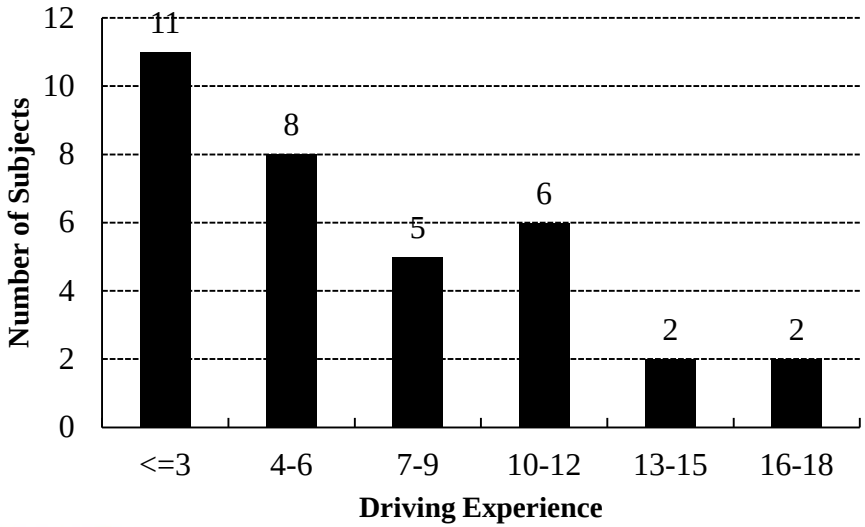
- 28 males vs. 8 females

(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)



(Registered drivers in China (2015): 11% have less than a year driving experience)

Mean = 7 years

Identify moped-vehicle conflicts

Kinematic trigger	Threshold
Longitudinal deceleration	0.65g (SHRP 2), 0.5g, 0.4g
Lateral acceleration	(SHRP 2)
Longitudinal jerk	(SHRP 2)
Steering evasive maneuver	(SHRP 2)
Swerve evasive maneuver	(SHRP 2)
Yaw rate	(SHRP 2)

Due to a 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)

kinematic trigger
- Kinematic triggers automatically identify SCEs
- Video, overlap, and speed filters reduce duplicates

video reduction
- Manually inspect video data
- Identify event characteristics and moped conflicts

g-force offset check
- Extract kinematic profile time series data
- Check for errors in g-force offset

Final Data
- 119 moped-related conflict events
- 74 high g-force conflicts and 45 low g-force conflicts

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

Longitudinal

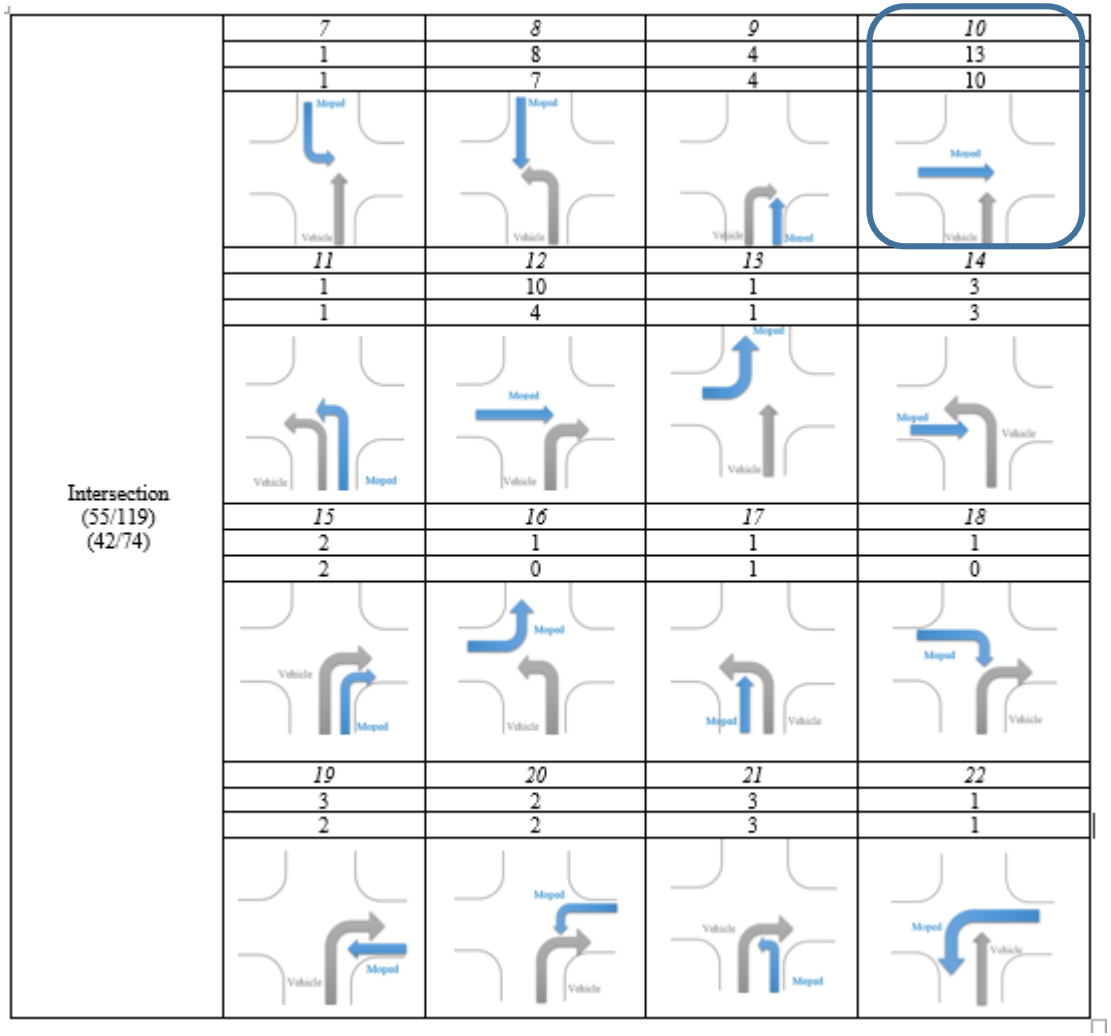
Lateral

Trigger		Moped–vehicle conflict	G-force offset check	
Trigger type	Threshold		Low g-force conflicts	High g-force conflicts
Longitudinal deceleration	0.65g	6	1 (1 trip)	5 (5 trips)
	0.5g	37	26 (8 trips)	11 (11 trips)
		9	0	9 (9 trips)
	0.4g	65	18 (7 trips)	47 (45 trips)
Longitudinal jerk	SHRP 2	0	0	0
Lateral acceleration	SHRP 2	0	0	0
Steering evasive maneuver	SHRP 2	2	0	2 (2 trips)
Swerve evasive maneuver	SHRP 2	0	0	0
Yaw rate	SHRP 2	0	0	0
(Total)		119	45 (8 trips, 1 driver, 1 vehicle)	74 (71 trips, 28 drivers, 5 vehicles)

Chinese moped-vehicle conflict configurations

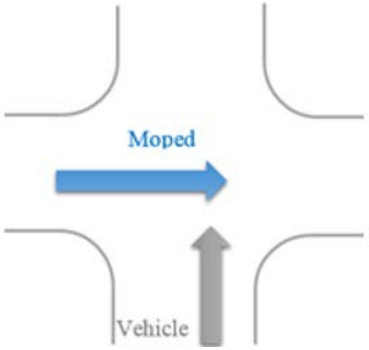
- 22 configurations were found

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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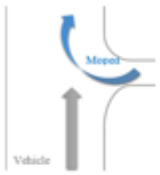
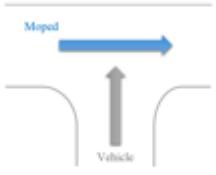
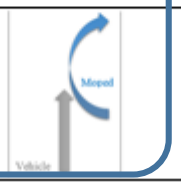
Chinese moped-vehicle conflict configurations

Access and T-junction (9/119) (8/74)	1	2		
	3	6		
	3	5		
				
Straight Road (55/119, 46.2%) (24/74, 32.4%)	3	4	5	6
	9	39	1	6
	7	12	1	4
				

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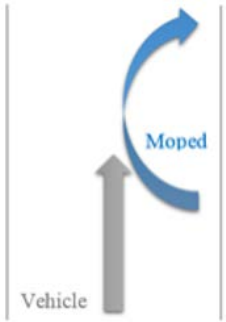
Chinese moped-vehicle conflict configurations



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

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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.

Intersection (55/119) (42/74)	*7* 1 1	*8* 8 7	*9* 4 4	*10* 13 10
	11 1 1	*12* 10 4	*13* 1 1	*14* 3 3
	15 2 2	*16* 1 0	*17* 1 1	*18* 1 0
	19 3 2	*20* 2 2	*21* 3 3	*22* 1 1

Another video

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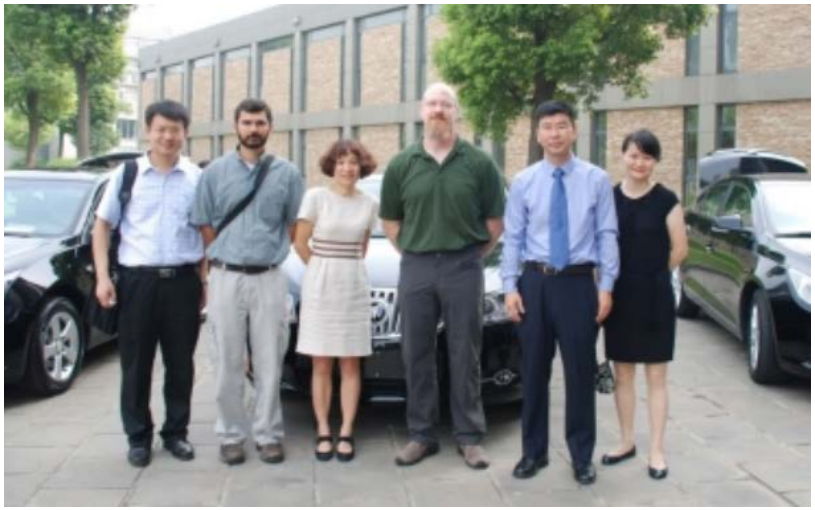
Discussion

- 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.

Acknowledgements



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Thank you for your attention