TRAFFIC ACCIDENTS IN SHANGHAI - GENERAL STATISTICS AND IN-DEPTH ANALYSIS

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ABSTRACT

In China, traffic accident data is published annually by the Traffic Management Research Institute of the Ministry of Public Security [1]. Accidents without casualties are usually not included. To gain a complete understanding and reliable insight of Shanghai traffic accidents, the project team collected the original accidents records on 192 Shanghai roads between 1-1-2009 and 12-31-2009. The overall traffic accident statistics, the temporal distributions, and the spatial distributions of crashes, crash modes, and crash severity were analysed for different road categories, including freeways, classified highways, urban expressways, and surface roads.
In-depth accident cases were obtained from Shanghai United Road Traffic Safety Scientific Research Center, a research consortium conducting accident investigation in Shanghai. Each case was reconstructed using PC-Crash. The impact speed was estimated and studied for different crash modes.

INTRODUCTION

Today, about half of the people in the world live in urban areas. In 20 more years, 60% of the world's population, and 80% of the wealth, will be concentrated in cities [2]. With such a trend, cities around the world are actively looking for smart and safe driving. In China, roads are classified as highways (freeway, Class I highway, Class II highway, Class III highway, and Class IV highway), and urban streets (urban expressways, arterial roads, minor arterial roads, and branch roads) [3]. This research studied the current traffic safety situation on different roads in Shanghai, China. The objective is to understand traffic accident characteristics on typical city roads in a megacity, like Shanghai, and to help develop safety priorities for vehicles driving in cities.

METHODOLOGY

The original accidents' records on 192 Shanghai roads (from the whole geographic area), between 1-1-2009 and 12-31-2009 were collected from traffic police stations. The general traffic accidents were analyzed on different roads.

Shanghai United Road Traffic Safety Scientific Research Center has been conducting in-depth accident investigation in Jiading, one of 19 districts in Shanghai, since 2005. This research consortium only investigates severe accidents involving passenger vehicles which meet one of following three criteria:

1. At least one of the involved persons sustained severe injury or fatal injury; or
2. At least one air bag deployed; or
3. The total damage is $3500 or above

"Severe injury" refers to non-life-threatening injuries, such as bone fracture.

A total of 404 cases collected between 2005 and 2011 were obtained and analyzed. Each case has a detailed report with many photos and measurements. There is information about accident time, location, weather, road surface condition, lighting condition, traffic condition, vehicles involved, and vulnerable road users, if any. The accident scene was generated to detail the crash event, the initial contact position, and final positions of involved accident participants (Figure 1). Vehicles were measured or scanned for exterior deformation and interior deformation (Figure 2). The restraint system performance was investigated (Figure 3). The injury descriptions were obtained from the traffic police and/or the hospital. Accident sketches were created using Auto-CAD, accurately scaled according to the accident scene investigation (Figure 4). The developed sketch was used for accident reconstruction in PC-Crash (Figure 5). Vehicle impact speeds were estimated by validating the vehicles' trajectory and final landing position.

Figure 1. An accident scene to detail the crash event

Figure 2. Vehicle deformation measurements

Figure 3. Restraint system performance investigation

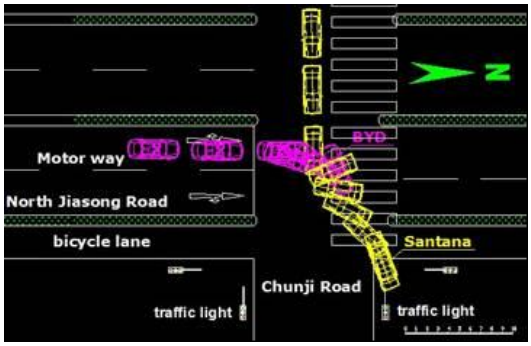

Figure 4. Accident sketch was created using Auto-CAD with accurate scale

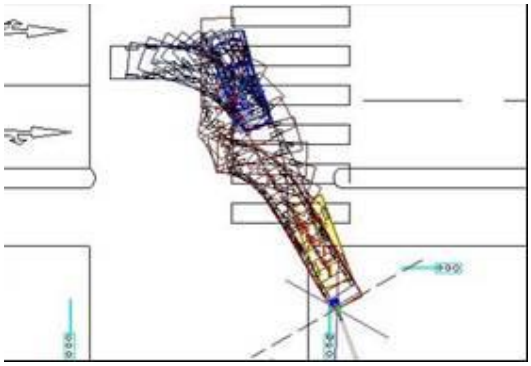

Figure 5. Vehicle impact speed estimation using accident reconstruction in PC-Crash

RESULTS

General Statistics

The number of accidents per kilometer was used to compare the collision frequency among different roads (Figure 6). Using a freeway as a reference, the relative number of accidents on the urban expressways, classified highways, and surface roads are 2.8, 2.2, and 5.5, respectively. Surface roads have the highest number of accidents per unit length. Surface roads are designed for mixed road users, including motor vehicles, non-motorized vehicles, and pedestrians. Since they have the most frequent accidents, arterial roads and signalized intersections were separated out from surface roads when studying injuries and crash modes. Accidents occurred within 15 meters of a signalized intersection were excluded from surface roads and included for signalized intersection. Figure 7 shows the injury distribution. On all roads, the majority of accidents had no casualty (more than 74.6%). Accidents with minor injuries were the second most frequent accidents on all roads, followed by fatal accidents and accidents with severe injuries. The highest fatal accident probability is on freeway (0.7%).

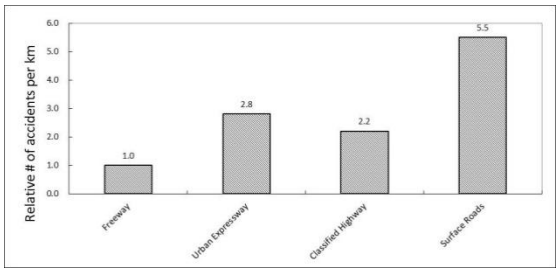

Figure 6. Relative number of accidents per kilometer on different roads

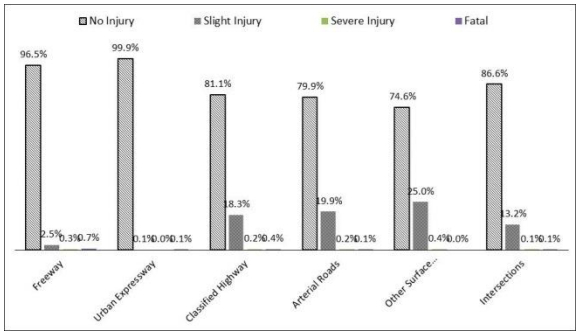

Figure 7. Accident injury severities

Figure 8 shows the crash modes distribution recorded in the accident reports. Freeway and surface roads (including intersections) had a large number of unknown crash type accidents (47.3% for freeway, 39.1% for arterial roads, 36.2 for other surface roads, and 43.6% for intersections). Such a large number of unknown crash types in the accident reports showed the need to improve the

data recording method. The unknown crash modes are only 8.1% and 12.6% for classified highways and urban expressways, respectively. Among all known crash modes, side collisions, followed by rear-end collisions, and "hit fixed objects" were the most frequent crashes on freeways, on classified highways, and on surface roads. Rear-end collisions followed by side collisions were the two dominant crash modes on urban expressway. It is interesting to note that less than 1.3% recorded accidents on all roads were "hit pedestrian". One explanation could be that all crash cases were collected from traffic police records. Many pedestrian collisions may not even be recorded by the traffic police, unless severe injuries occurred.

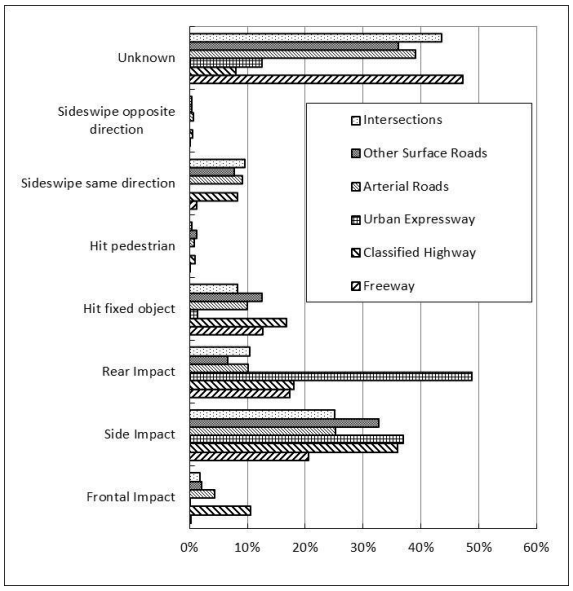

Figure 8. Crash modes as recorded in the accident reports

Figure 9 shows the causes of accidents that were recorded in the accident reports. More than 55% of accidents had unknown causes. Such a high percentage of unknown causes shows the urgent need to improve data quality. All the identified causes are related to driver behaviors. On freeway and urban expressway, where only motorized vehicles are allowed, and there is no traffic light, "illegal lane change" is the only dominant cause. On surface roads and classified highways, where mixed traffic participants are expected, including vehicles, two wheelers, and pedestrians, and there are traffic lights at intersections, "illegal lane change" and "fail to yield" are the two dominant causes of accidents.

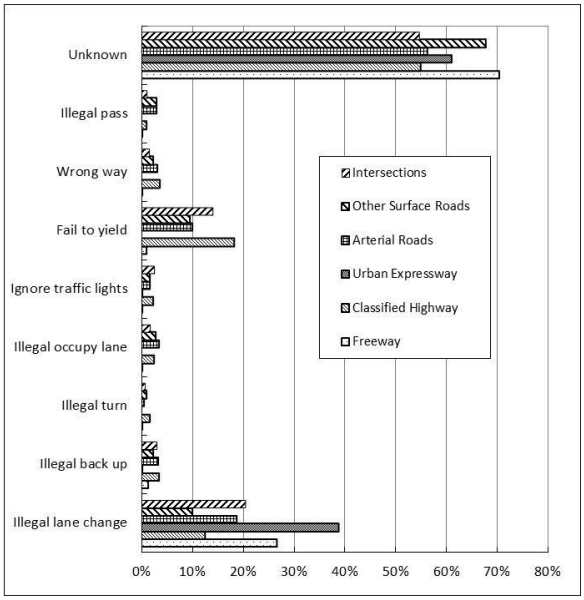

Figure 9. Cause of accident as recorded in the accident reports

In-Depth Analysis

The general statistics showed that side collisions and rear-end collisions were the top two most frequent crashes on Shanghai roads, a megacity with more than 19 million registered residents [3]. A total of 404 in-depth accident cases were obtained from Shanghai United Road Traffic Safety Scientific Research Center. Those cases were studied to understand how accidents happened and what the impact speeds were. Among those severe cases, only 231 cases were capable of being reconstructed using PC-Crash. The impact speeds were obtained from those 231 cases and studied for different crash modes.

Side Collision The impact direction of each passenger vehicle is identified according to the 12 o'clock scheme (Figure 10). The struck locations at 2, 3, 4, 8, 9, and 10 o'clock are grouped as side collisions. All side collision cases happened on surface roads. The struck vehicles were passenger cars. There were a total of reconstructed 67 side collisions. Those collisions involved 132 occupants. Figure 11 shows the estimated vehicle impact speed distribution.

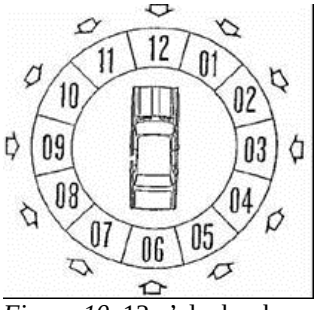

Figure 10. 12 o'clock scheme for impact direction

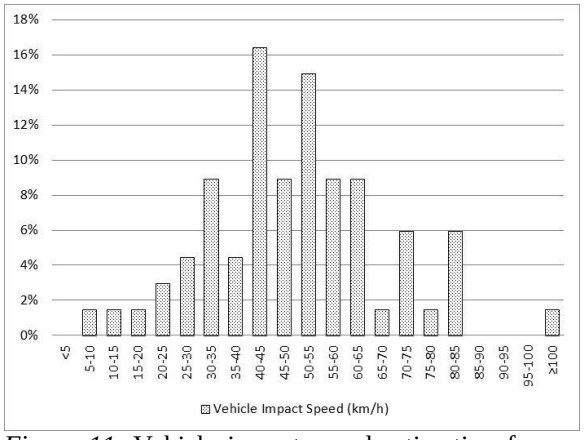

Figure 11. Vehicle impact speed estimation from reconstructed 67 severe side collisions

Rear-end Collision There were a total of 19 rear-end collisions reconstructed using PC-Crash. Six cases happened on freeway or classified highway. Thirteen cases happened on surface roads. Those collisions involved at least one passenger car and a total of 46 passenger car occupants. Figure 12 shows the estimated vehicle impact speed distribution.

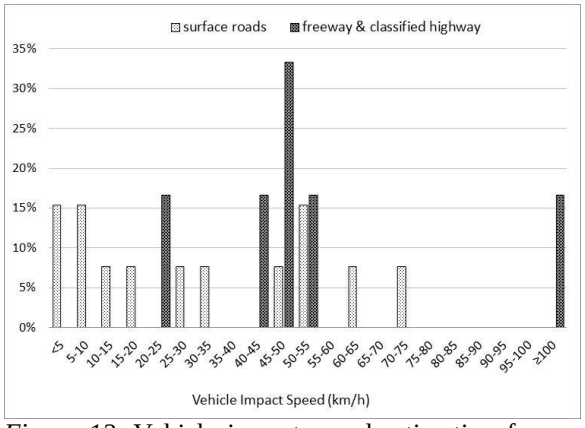

Figure 12. Vehicle impact speed estimation from reconstructed 19 severe rear-end collisions

Car to Two Wheelers Collision It is interesting to note that, among those severe in-depth cases in Jiading (a remote district of Shanghai), 47% cases were passenger car to two wheeler collisions. The two wheelers include motor bikes, electric bikes, and bicycles. Those collisions all happened on surface roads. All severe injuries were sustained by the vulnerable road users. There was no injury to the car occupants. A total of 110 car to two wheeler collisions were reconstructed. Those collisions involved at least one passenger car and a total of 139 vulnerable road users. Figure 13 shows the estimated vehicle impact speed distribution.

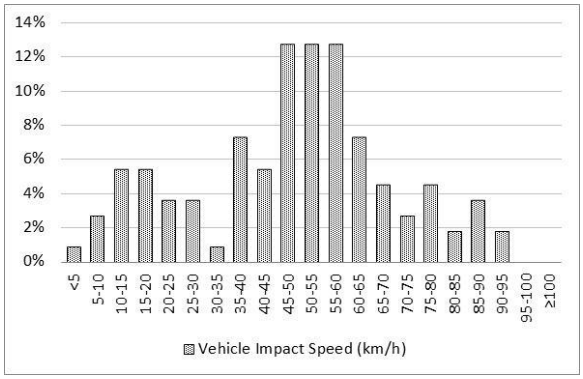

Figure 13. Vehicle impact speed distribution from reconstructed 110 severe passenger car to two wheeler collisions.

CONCLUSIONS

In a megacity like Shanghai, the majority of accidents recorded by traffic police, had no casualties. Surface roads have the highest number of accidents per unit length. As surface roads are designed for mixed road users, including motor vehicles, non-motorized vehicles, and pedestrians, improving megacity traffic safety would need to consider all road users.

Side collisions and rear-end collisions are the top two most frequent crashes on Shanghai roads. Technologies mitigating those types of crashes may be desirable.

All identified accident causes in the traffic police reports are related to driver behaviors. “Illegal lane change” is the only dominant cause on freeway and urban expressway. “Illegal lane change” and “fail to yield” are the two dominant causes of accidents on surface roads and classified highways. Traffic safety education and traffic law enforcement could improve road user behavior.

The high percentage of unknown crash types and unknown accidents causes also shows the need of using scientific method to accurately record traffic accidents.

Vehicle impact speeds were estimated by reconstructing in-depth accident cases. A wide range of impact speeds were observed. Detailed injury descriptions are needed for further study.

REFERENCES

[1] Blue books by Traffic Management Research Institute of the Ministry of Public Security (2000 to 2010)

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[3] Shanghai Urban Planning Institute, “The Fourth Shanghai Traffic Survey”, 2009.