

Characteristic Analysis of Vehicle-VRUs Crashes Based on Real Accident Data in China

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1. INTRODUCTION

This study analyzes real-world videos of crashes involving three VRU groups across pre-crash, in-crash, and post-crash stages. Typical pre-crash scenarios are identified using K-modes clustering to support vehicle safety systems and accident prevention.

2. Data Source and Research Methodology

2.1. Data Source

The study used 4,060 vehicle-VRU crashes from the VRU-TRAVi database (1), covering various urban road environments in China. All cases included video footage and parametric data, with 98.2% data completeness.

2.2. Methodology

VRUs were classified as pedestrians, cyclists, or powered two-wheeler (PTW) riders. Frame-by-frame video analysis was used to extract environmental, vehicle, collision, and VRU kinematic parameters. Descriptive and comparative analyses were performed, followed by K-modes clustering to identify typical pre-crash scenarios and risk factors.

3. Results

3.1. Pre-crash Characteristics

Visual obstructions, including stationary and moving vehicles and blind areas, occurred in 39.7% of pedestrian, 51.7% of cyclist, and 47.0% of PTW crashes (Figures 1–3).

3.2. In-crash Characteristics

Impact speeds were mainly 26–45 km/h for pedestrians (64.3%) and PTWs (61.1%), and 11–40 km/h for cyclists (67.5%) (Fig.1).

3.3. Post-crash Characteristics

Impact speeds were mainly 26–45 km/h for pedestrians (64.3%) and PTWs (61.1%), and 11–40 km/h for cyclists (67.5%) (Fig. 2).

3.4. Typical Pre-crash Scenarios

K-modes clustering identified eight pedestrian, seven cyclist, and nine PTW scenarios, including near-side and far-side crossing, longitudinal movement, and left-turn conflicts. Visual obstructions occurred in approximately half of these scenarios.

4. CONCLUSIONS

Analysis of 4,060 Chinese vehicle-VRU crashes showed that pedestrian crashes occurred mainly on straight roads, whereas cyclist and PTW crashes were concentrated at intersections. Visual obstructions were major pre-crash risks. Wrap trajectory dominated after impact, and head contact frequently occurred at the A-pillar and B5, particularly among pedestrians.

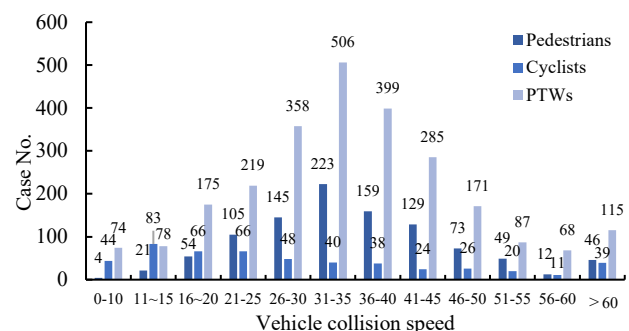


Fig. 1 Vehicle collision speed.

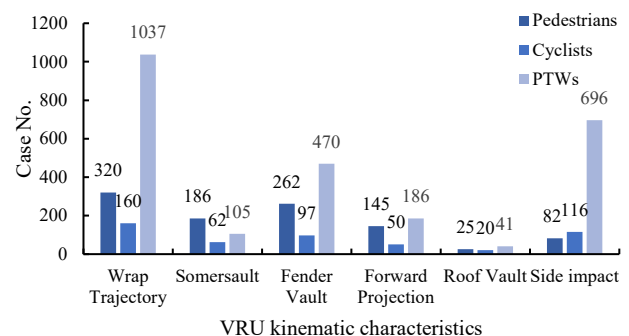


Fig.2 VRU kinematic characteristics.