International Co-operation on Theories and Concepts in Traffic Safety

Traffic Conflicts between motor vehicles and micromobility riders at roundabout exits

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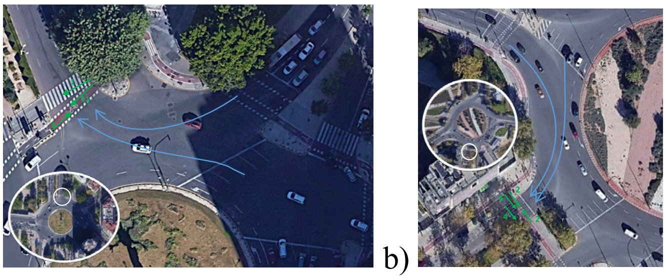
The increase in micromobility users, especially cyclists and electric stand-up scooters (e-scooters) riders, is changing the mobility paradigm in many cities across Europe and worldwide. However, this has also led to a rise in the number of crashes involving these users. The collisions between them and motorized vehicles are the most severe. In urban areas, these crashes tend to concentrate at crossings between traffic lanes and bike lanes, such as at roundabouts.

There are different configurations of roundabouts depending on the design or location of the bike lane. One of these, considered safer, is the type where the bike lane is separated from the traffic lanes. In these types of roundabouts, crashes and traffic conflicts typically occur at the entrances and exits. Generally, in signalized roundabouts, the signal cycle at entrances is typically green-yellow-red for motorized vehicles. However, at exits, to improve the roundabout's capacity and traffic operation, the signal cycle for motor vehicles is sometimes green-flashing yellow, allowing them to cross when the signal is green for pedestrians and micromobility users, but with caution and yielding to them. This combination of signal phases is sometimes considered the cause of crashes or traffic conflicts, as both types of users can cross, and the safety of the crossing relies mainly on their caution.

This study analyzes the traffic conflicts observed at two exits of two signalized roundabouts to gain further insight into the behavior of drivers and micromobility users at these points in the urban road network. These roundabouts are located in Valencia (Spain). They have similar traffic flows, motor vehicle speeds and micromobility demand. In both roundabouts, the bike lanes, along with the pedestrian paths, run parallel to and outside the carriageway. Distinct pavement types delineate pedestrian and cycle paths. Interaction between micromobility riders and motor vehicle traffic occurs only when riders must cross the carriageway at a roundabout approach or exit, engaging with drivers entering or leaving the roundabout. This study is only focused on exits.

In both roundabouts, the bike lane has one lane per direction, so vehicles exiting the roundabout must pay attention to users approaching from both the right and the left. Micromobility users only need to pay attention to one side, from which vehicles are approaching from the roundabout. However, there are two types of motorized traffic flows to consider at these exits: (i) vehicles coming from within the roundabout that must exit when their traffic light is green and that of pedestrians and micromobility is red; (ii) vehicles coming from the previous entrance and exiting the roundabout when the traffic light is green for pedestrians and micromobility users. In Roundabout 1, the traffic light for motor vehicles is flashing yellow, while in Roundabout 2, it turns red for a few seconds before changing to flashing yellow. The distribution in seconds of the traffic light cycles changes depending on whether it is peak hours (before 10 a.m.) of off-peak hours (after 10 a.m.), while maintaining the cycle configuration.

Figure 1 shows both roundabouts, with a closer zoom on the exits under study. Blue arrows represent the two types of traffic flow, while green arrows indicate traffic conflicts that occur depending on the direction and position of micromobility users. These traffic conflicts have been identified from videos recorded at both roundabouts for two hours during peak hours and two hours during off-peak hours.



a) b)

Figure 1.a) Roundabout 1; b) Roundabout 2

In both cases, more traffic conflicts have been identified when the micromobility user approaches from the right. This is logical since there is better visibility of users approaching from the median, and, furthermore, these users cross the exit after already having crossed the lanes of motorized vehicles entering the roundabout.

Three types of traffic conflicts have been characterized: (i) Type 1: there is no significant deceleration from either user. These conflicts have been measured using Post-Encroachment Time (PET). These conflicts are the most frequent. The lower value PETs have been recorded at Roundabout 1, especially with vehicles approaching from within the roundabout that cross the previous traffic light when it is already red or almost red. (ii) Type 2: one of the two users brakes suddenly, even coming to stop. These conflicts have been measured using Time-to-Collision (TTC). These conflicts have only been recorded with users coming from the sidewalk (right side of the driver). While in most conflicts recorded in Roundabout 1, it is the motorized vehicle driver who brakes suddenly, in Roundabout 2 there are conflicts where it is the micromobility user who brakes and conflicts where the motorized vehicle brakes. (iii) Type 3: the motorized vehicle stops at the line before the bike lane, and, when it starts to move, a micromobility user crosses, causing the vehicle to brake suddenly again. Only 1 conflict at Roundabout 1.

The analysis of interactions between micromobility users and motorized vehicles at such conflict points as those studied allows for establishing the foundations for designing roundabouts exits and programming traffic lights that enhance road safety for all road users and promote sustainable transportation.

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