Evaluation of Sidewalk Autonomous Delivery Robot Interactions with Pedestrians and Bicyclists

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Project Objective

Information and communication technology advancements and an increased demand for contactless deliveries following the Covid-19 pandemic outbreak resulted in the growing adoption of automated delivery services. In this research project, we examine the impacts that sidewalk autonomous delivery robots (SADRs) have on the objective safety and perceived comfort of pedestrians and bicyclists who share pathways with this last-mile food delivery service that has been deployed on college campuses.

Problem Statement

The emergence of SADRs on college campuses has offered students, faculty, and staff a convenient, on-demand option for delivering meals to their residence or workplace. However, SADRs traverse campuses on active transportation networks designed for pedestrians and bicyclists, creating prospective conflicts amongst pathway users and potentially unsafe traffic conditions for pedestrians and bicyclists.

Research Methodology

Adopting a two-stage analytic approach, our research project investigates the prevalence and severity of observed SADR-involved interactions with human pathway users and self-reported comfort perceived by pedestrians and bicyclists sharing pathways with this low-speed automated delivery service. In the first analysis, one-week of field-recorded video from ten sites on Northern Arizona University's campus was collected, with identified interactions between SADRs and human pathway users evaluated by adapting the surrogate safety metric of post-encroachment time. An ordered logit model was then estimated to determine the conflict- and site-level characteristics associated with an increase in conflict severity. In the second analysis, a tablet-based survey instrument with stated choice experiments was developed and administered to a university population to detect their self-reported comfort in sharing pathways with SADRs as a pedestrian or bicyclist. Descriptive and inferential statistic methods were employed to characterize personal attributes associated with SADR adoption and relate these and other attributes to a survey respondent's perceived level of comfort in sharing pathways with SADRs as an active traveler.

Results

This research identifies traffic safety concerns of pedestrians and bicyclists sharing pathways with SADRs and offers needed evidence into the challenges of operating these new freight delivery technologies in a real-word setting. Descriptive findings from the first study suggest that moderate and dangerous SADR-involved conflicts cluster in locations with intersecting and narrow pathways without any delineation of what space human pathway users should occupy. Meanwhile, model results found that the severity of an SADR-involved interaction increased when the SADR was found to cross the intended trajectory of a pedestrian or bicyclist, who generally made an evasive action to avoid an SADR-involved collision. From our survey data, we found pedestrians were often more comfortable than bicyclists in sharing pathways with SADRs, but that individuals who reported past discomfort in sharing pathways with SADRs as a pedestrian or have had to alter their walking paths in the past because of SADRs were less comfortable needing to evade an oncoming SADR. Regarding the impact of consumption behavior, individuals who

have frequently adopted automated food delivery services in the past year are more comfortable in taking evasive actions as a pedestrian or bicyclist to avoid more-severe interactions with SADRs. Taken together, we believe these research project results can help to inform researchers, practitioners, and policymakers seeking the safe introduction or continued operation of SADRs in multimodal settings.

Figure 1. Distribution of observed SADR-involved interactions with human pathway users by PET severity levels

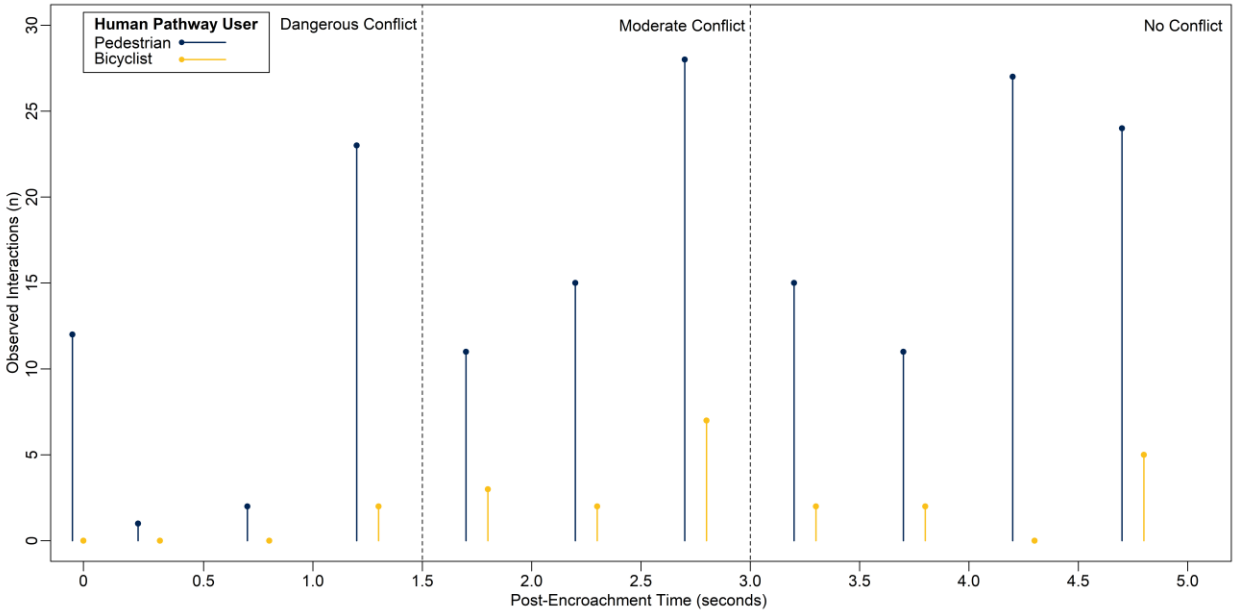

Figure 2. Distribution of reported pedestrian and bicyclist comfort levels in sharing pathways with SADRs