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An overview of pedestrian signal setting and implementation in the State of Qatar

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Abstract

Pedestrian signal control is a main influencing factor on the Level of Service of crossing facilities and on the safety performance considering conflicts with vehicles. In signal design, pedestrian clearance time is a key design parameter for ensuring safe pedestrian crossing at signalized crosswalks. The performance of pedestrian signal control and its impact on pedestrian behavior in the Gulf Cooperation Council (GCC) Countries is rarely addressed in the literature. The characteristics of population, cultural diversity, as well as the extreme hot weather conditions, may lead to significantly different pedestrian behavior in terms of crossing manoeuvres (path and speed), compliance with signal control and interaction with vehicular traffic. This study reviews the pedestrian signal design practices in various countries and investigates the current signal settings along with their adequacy in the State of Qatar using empirical observations. The empirical analysis showed that the 85th percentile crossing times were longer than the provided Pedestrian Flashing Green (PFG) intervals at the observed crosswalks. Study sites are characterized with unrealistically long Buffer Intervals (BIs) which, from one side, provide sufficient time for pedestrians who started crossing during PFG to complete the crossing. On the other side, they encourage pedestrians to continue crossing after the end of PFG. Additionally, the speed analysis indicated that the observed 15th percentile speed was 1.22 m/s which is similar to the assumed design speed by the Qatar Traffic Control Manual QTCM (2015). Further, the analysis showed that pedestrian crossing speed during PFG or BI was significantly higher than that during PG.

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Keywords: Clearance time, signalized crosswalks, pedestrian signal setting; crossing speed

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1. Background

The function of signalized crosswalks is to provide secure locations and time for pedestrians to perform safe crossing maneuvers. In most countries including the State of Qatar, pedestrian's signals have three signal indications, green (PG), flashing green (PFG) and red (R). However, in some countries like Germany and France, pedestrian signals have only two indications, green and red. In the US, pedestrian signals have three indications, green (or "WALK"), flashing red (or flashing "DONOT WALK") and steady red (or "DONOT WALK"). To ensure safe crossing of pedestrians, the provision of PG and PFG should be sufficient. In fact, in designing pedestrian signals, two parameters are essential; clearance time and red buffer interval (BI). Clearance time is generally defined as the time required by pedestrians who enter crosswalks at the end of the green indication to complete crossing before conflicting vehicular traffic movements are released. BI is the interval from the end of PFG to the onset of the green phase of the subsequent conflicting vehicle phase. In theory, PFG and BI should at least equal to clearance time while the remaining time of the parallel vehicle phase can be given as green time to pedestrians. Providing short PFG and BI intervals that are not sufficient for pedestrians to clear the crosswalk will lead to having pedestrians left on the crosswalk after the onset of the successive vehicle phase[1]. Provision of long BI and/or PFG intervals will be associated with short PG intervals. This will impose longer delays on pedestrians because of the shorter crossing intervals and as a result, it will push pedestrians to cross during BI or red interval increasing their risk of conflicts. Therefore, a clear effective approach for setting pedestrian signal control parameters that can maximize pedestrian compliance and minimize conflicts with vehicles is still missing. For this reason, we can easily find significantly different settings of pedestrian signals (in terms of indication and timing) in various countries.

In 2013, Xiao et al. proposed an adaptive pedestrian crossing signal control, which reduced the waiting time for pedestrians by capturing the number of pedestrians waiting at the crosswalk[2]. Ma et al. derived criteria for choosing suitable pedestrian phase patterns considering safety and efficiency for both pedestrians as well as vehicles using simulation approach[3]. A quadratic programming approach was used to optimize the signal timing for pedestrian and vehicle signals for one or two stage crosswalks[4]. In an observational study, the pedestrian compliance at concurrent and exclusive phasing was studied using data from 42 signalized intersections in the Connecticut, United States[5].

Pedestrian crossing behavior and the impact of signal timing was addressed by several studies. Alhajyaseen investigated the influencing factors on pedestrian crossing speed including signal timing in Japan[6]. Iryo-Asano et al. and Iryo-Asano and Alhajyaseen extended the analysis to consider the impacts of crosswalk geometry on pedestrian crossing decision and speed at signalized crosswalks[7,1]. All these studies had a common conclusion that pedestrian maneuvers are widely varying and they are significantly affected by control type (signal timing and indication), crosswalk geometry, the presence of conflicting vehicles, and others. Pedestrian signal indication and time setting can even cause behavioral changes while crossing. Depending on the available timing to complete crossing combined with other factors (such as crosswalk geometry and presence of vehicles), pedestrian may suddenly accelerate or decelerate without paying attention to the surrounding conditions which may increase safety risks[8].

Studies that address pedestrian crossing behavior and investigate the rationality of pedestrian signal setting in the Gulf Cooperation Council Countries (GCC) are missing. Therefore, the objective of this paper is to assess the adequacy of pedestrian signal timings in the State of Qatar while focusing on clearance timing, for safe pedestrian crossings. The analysis is performed using empirical observations at several signalized intersections in Doha city.

2. Methodology

Empirical observations were collected at four crosswalks from three different signalized intersections located near popular shopping centers in the State of Qatar. All these crosswalks are characterized with standard signal indications comprising of PG, PFG, and R. Each study site was videotaped for 1.5 hours in order to collect signal information and pedestrian maneuvers. The video recording was undertaken during December 2016, the temperature during recording varied from 15°C to 21°C. The pedestrian movements during active pedestrian signal phases were observed. Only the pedestrians who waited for pedestrian signal and crossed at the crosswalk were considered in the observations. The pedestrians who jaywalked from irregular locations, away from the crosswalk, were not considered. Some pedestrians were observed crossing during the red interval in two stages to avoid conflicts with vehicles, those pedestrians were also omitted from the analysis. The crosswalk lengths and widths were measured in the field using a measuring wheel.