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Accessibility evaluations for nighttime walking and bicycling for low-income shift workers

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ABSTRACT

This paper addresses an important issue related to nighttime commuting of low-income shift workers who walk and/or bike to their workplace using public transit. A shift worker is anyone who follows a work schedule that is outside of the typical daytime working hours of a business day and commute after dark - by walking or bicycling to a transit stop. However, poor visibility conditions on sidewalks and bicycle lanes often thwart safety of their walking and bicycling activities. Therefore, this paper develops two simple scores - nighttime accessibility score for walking (NASW) and nighttime accessibility for bicycling (NASB) - for evaluating nighttime infrastructure for pedestrians and bicyclist. The scores consider the employment data, travel time and the physical distribution of streetlight poles along the sidewalks and bicycle lanes. Data from the city of El Paso in Texas is used to demonstrate the applicability of the two scores. Employment data from three prominent service industry sectors known to employ low-income shift workers – i) Retail Trade, ii) Accommodation and Food Services, and iii) Health Care and Social Assistance – are used for demonstration purposes. It is observed that amongst the three sectors analyzed, both NASW and NASB values are higher for regions in El Paso with low-income employment concentrations from the Health Care and Social Assistance sector. It is also observed that some prominent regions in north-east, south-east and west of El Paso need improvements in streetlight systems, sidewalks and bicycle network to facilitate walking and bicycling amongst low-income shift workers employed in Retail Trade, and Accommodation and Food Services industry sectors to access transit stops at night.

1. Introduction

Transportation policies and programs that aim to increase walking and bicycling to a transit stop should include improvements in infrastructure of bike lanes and sidewalks along with personal safety of pedestrians and bicyclists. Several studies show positive correlation between infrastructure improvements around transit stop and increase in walking and bicycling levels (Saelens and Handy, 2008; Pucher et al., 2010). Another study by Dill describes interconnectedness between public transport infrastructure and increase in bike ridership (Dill, 2009). Dill's study showed that to encourage bicycling, a well-connected network of streets and bicycling infrastructure are needed. However, most of these and similar studies highlight findings that are applicable for daytime commuters who are pedestrians and bicyclists and seldom the focus has been on commuters at night. This is due to usually low levels of transit ridership observed through walking and bicycling at night. Further, with reduced transit frequency at night, non-transit modes and mainly private car is usually the primary mode of transport for nighttime commuters, especially for women transit riders considered vulnerable at night (Beirão and Cabral, 2007). Female transit riders at night prefer pick-up and/or drop-off at a transit stop than having to walk or bike to access transit (Kim et al., 2007a, 2007b). Due to low perception of personal safety at night, late-night commuters, in general, are hesitant to wait at a transit stop (Ferris et al., 2010). The situation, however, is even more challenging for low-income nighttime commuters who work after dark, are often not private car owners or users and often are subject to longer waiting times at stops due to reduced frequency of transit operations at night. Buying or owning a car is not always the best option available to a low-income household due to financial constraints – thus, they rely primarily on transit to commute at night.

The importance of adequate lighting on pedestrian crossings is

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important for a driver to recognize pedestrian presence at the crossing during night. Tomczuk (2013) performed a study on this subject by comparing the illuminance with additional light frames for a driver of a vehicle approaching the crossing (Tomczuk, 2013). Similarly, for bicyclists using bike paths and streets at night, Ouyang et al. (2014) identified nighttime lighting as important safety factor on roads and used weights to quantify various lighting situations on bike paths and roads (Ouyang et al., 2014). While full lighting and day light riding, as the safest situation, was allocated a 100% (or 1) as weight, partial lighting with a weight of 0.4 and a weight of 0.1 for road segments on paths with no road lighting. Other factors which were considered as safety factors for bike path constituted road type, road width, and signs on the road. Hebert et al. (2013) proposed a lighting design solution for pedestrian and bike paths with illuminated pedestrian and bike paths for safety and security purposes (Hebert et al., 2013). The efforts needed or the ability to access a transit stop at night is dependent upon the availability of sidewalk and bicycle infrastructure around the stop supplemented by the streetlight systems that illuminate the paths along these sidewalks and bike lanes leading to the stop (Chandra and Radhakrishnan, 2015). The level of access to a transit stop is described as 'accessibility' in this paper and refers to the measured attractiveness of number of opportunities at destinations (employment centers) around a transit stop being treated as the origin (El-Geneidy and Levinson, 2006). Although studies on transport accessibility has been numerous, mode of choice components of walking and bicycling for nighttime commuters has seldom been studied under the topics of accessibility. This paper is an effort in this direction to evaluate walking and bicycling facilities around transit stops commuting at night. Of specific focus is the low-income shift workers that are very likely users of transit at night. This paper also aids city planners in understanding the needs of low-income population and assessment of existing first/last mile transport infrastructure in a particular area of transit operations at night.

Several studies have shown that shift workers form a significant percentage of labor workforce in the industry sectors of healthcare, emergency services, manufacturing, retail, hospitality, entertainment/recreation and transportation communications (Neil-Sztramko et al., 2014; Golden, 2015). Therefore, the focus of this paper is on evaluating nighttime walking and bicycling accessibility of shift workers belonging to three related and similar service industry sectors in the United States – i) Retail trade, ii) Accommodation and food services and iii) Health care and social assistance. These industry sectors are identified in the North American Industry Classification System (NAICS) which is the standard used by Federal statistical agencies in classifying business establishments related to the U.S. business economy (North American Industry Classification System (NAICS), 2017).

Two categories of accessibility-based scores are proposed in this research - one each for walking and bicycling at night. The accessibility-based scores treat transit stops as nodal points of transfers for bicyclists and pedestrians. The scores proposed use publicly available employment data within an urban community and the transportation network information for sidewalks and bicycle lanes.

To the best of authors' knowledge, there is not a single literature in the domain of transportation research which can guide practitioners or planners in performing accessibility assessment of a transit stop at night for pedestrians and bicyclists. The authors exploit this missing gap in research and develop easy-to-use scores which can quickly identify areas around transit stops needing improvements in streetlighting, sidewalks and bicycling infrastructure to encourage walking and bicycling activities at night, thereby reducing dependency on automobiles. Enhancing nighttime infrastructure for walking and bicycling activities at night will also provide a sense of safety amongst pedestrians and bicyclists who are not necessarily accessing the transit. Specific focus of this paper is to bring out the needs for a reasonable street lighting system and highlighting missing sidewalks and bicycle lanes for low-income nighttime shift-workers from the three prominent service industry sectors identified above. As per the definition of National Sleep Foundation – "A shift worker is anyone who follows a work schedule that is outside of the typical '9 to 5' business day" (Shift Work and Sleep, National Sleep Foundation, 2016).

2. Literature review

A recent report published by the Working Poor Families Project (WPFP) (which is a national initiative focused on assessment of the economic conditions and state policies affecting working families) highlights shortcomings of irregular work schedules which impact the quality of life of low-wage workers in the United States (Choitz and Conway, 2015). Often managers craft schedules for workers employed in industry sectors of retail, restaurant and hospitality sectors with irregular shifts to cater to customer demands. As per the reports from WPFP and American Community Survey, there were estimated 10.6 million low-income working families in the United States in 2013. The State of Texas had the second highest number of working families below poverty line. As per the report published by the Joint Economic Committee of the United States Congress, workers from Hispanic and African American populations constitute a vast majority of low-income labor workforce catering to many such industries requiring shift jobs in the United States (Klobuchar, 2013). This group of labor workforce also have a lower median household income than the overall U.S. population (Benavides, 2015). Data from the Bureau of Labor Statistics (BLS) for 2015 further corroborates that industry sectors from retail, leisure and hospitality rely heavily on the services offered by these low-wage workers coming from the Hispanic and African American communities (Bureau of Labor Statistics, 2016).

The National Household Travel Survey for 2009 showed that low-income households spend a significantly high proportion of their income on travel (National Household Travel Survey, 2016). With respect to transportation mode choice available for commuting amongst Hispanic and African American workers, non-motorized transport (such as walking and bicycling) and transit are usually the most popular and common options (Hispanics and Transportation, 2009). Although the typical work schedule for an American employee during weekdays is during daytime until 5 p.m., a significant number of employees associated with service industries of retail, leisure and hospitality begin work on shift schedules from '2 pm to midnight' in an evening shift and from '9 pm to 8 am' in a night shift (McMenamin, 2007). Thus, this suggests that jobs associated with evening or night shift hours would require trips made from or to workplace after dark or during the night. Trips made for commuting during nighttime often make private vehicle, if available, as the default mode choice for comfort, convenience and safety reasons. This inadvertently encourages increased car usage amongst low-income workers at night and in turn reducing potential demand for transit (Beirão and Cabral, 2007).

Several studies on night-shift workers highlight the impact of irregular workhours on deteriorating health and issues related to cancer, obesity etc. (Ramin et al., 2015). In addition, there are studies which also point to underlining high risk of drowsiness-related motor vehicle crashes amongst night-shift workers (Lee et al., 2016). Research has shown that the presence of street lighting during nighttime can potentially reduce traffic crashes and the severity of the accidents (Yannis et al., 2013). Kim et al. (2007a, 2007b) explored the factors that contribute to the injury severity of bicyclists in bicycle-motor vehicle accidents. They concluded that darkness with no streetlights doubled the probability of an accident involving bicyclists. Similar research conducted by Klop and Khattak (1999) and Fernandez de Cieza et al. (1999) have corroborated that the ambient light conditions impact bicycle-traffic accidents. Perception of darkness and poor visibility after dark contributes to reduced willingness to bicycling (Bergström and Magnusson, 2003). Appropriate safety measures incorporated to reduce pedestrians and bicyclist fatalities are critical for nighttime commuters using transit. Amongst various types of drivers on roads, pedestrians