Responsible Design and Delivery of the Constructed Project
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PRIORITIZING SIDEWALK UPGRADE PROJECTS TO MAXIMIZE COMPLIANCE WITH ACCESSIBILITY REQUIREMENTS

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People with disabilities form 18.7% of the United States population, as reported by the U.S. Census Bureau in 2012. To avoid discrimination against this significant portion of the population, state and local governments are required by federal and state laws to provide and maintain accessibility for people with disabilities on their sidewalks and pedestrian facilities. To achieve compliance with these laws, state and local governments need to conduct self-evaluations to identify inaccessible pedestrian facilities and develop transition plans to schedule upgrade projects for these inaccessible pedestrian facilities. The federally-mandated transition plan requirements include the development of a schedule that displays, in detail, deadlines for all upgrade projects needed to achieve full compliance with accessibility requirements. To prepare this schedule, public entities are required to rank and prioritize pedestrian facilities upgrade projects. This paper presents the development of a novel methodology to quantify the impact of upgrading inaccessible pedestrian facilities on people with disabilities. The developed methodology considers several factors related to pedestrian facilities' conditions and location to estimate the number of expected pedestrians with disabilities impacted by upgrading each inaccessible pedestrian facility. This methodology is designed to assist decision makers in state and local governments in the process of ranking and prioritizing inaccessible pedestrian facilities upgrade projects.

Keywords: ADA, Self-evaluation, Transition plan, Pedestrian facilities, Ranking.

1 INTRODUCTION

People with disabilities form 18.7% of the United States population (U.S. Census Bureau 2012). This significant portion of the population requires special accommodations in order to be able to fully participate in society. These special accommodations help create accessible environments that enable people with disabilities to carry out their day-to-day activities independently. Several federal and state accessibility laws and regulations have been enacted to prevent discrimination against people with disabilities, including (1) the Architectural Barriers Act (ABA) (U.S. Congress 1968), (2) the Rehabilitation Act (U.S. Congress 1973), and (3) the Americans with Disabilities Act (ADA) (U.S. Congress 1990). Federal agencies such as the U.S. Department of Justice and the U.S. Department of Transportation are appointed by the aforementioned accessibility laws to develop and enforce federal regulations such as the 2010 ADA Title II regulations (U.S. Department of Justice 2010). Failure to comply with these accessibility laws and regulations often forces people with disabilities to travel in dangerous conditions, navigate difficult environments, or suffer painful injuries. In addition, state and local governments have incurred costly settlements due to non-compliance with accessibility laws and regulations. For example, the City of Los Angeles agreed in 2016 to pay $1.4 billion to upgrade its sidewalks and pedestrian facilities and achieve full compliance with accessibility requirements in order to avoid litigation (United States District Court 2016).

To avoid these costly settlements and guarantee a higher level of service for their citizens, state and local governments are required to conduct self-evaluations to identify non-compliant pedestrian facilities and develop transition plans to explain in detail the actions and steps required to achieve full compliance with accessibility laws and regulations (U.S. Department of Justice 2010). Public entities are also required to make these self-evaluations and transition plans available to the public and keep them in record for at least three years. This federally mandated transition plan requirement proved to be one of the most difficult tasks for municipalities and local governments because federal and state laws, regulations, standards, and guidelines did not offer any guidance on how to rank and prioritize pedestrian facilities upgrade projects, which leaves state and local governments with the challenging task of developing methodologies to perform this ranking process (CCRPC 2016).

Several studies have been conducted to assist state and local governments in ranking and prioritizing the upgrade projects of non-compliant pedestrian facilities. Most of these studies adopted a conceptual framework that utilizes two main factors: (1) *Pedestrian Potential Index* (PPI), that represents travel demand; and (2) *Pedestrian Deficiency Index* (PDI) that incorporates infrastructure and safety factors. Each of these two indices can include multiple indicators that are utilized to calculate a weighted index that can be used to rank pedestrian facilities (CCRPC 2016, City of Bellevue 2008, City of Clayton 2014, City of Fishers 2015, Loewenherz 2010). Higher PPI and PDI values means higher upgrade priority.

PPI considers factors that affect the degree of use of pedestrian facilities and pedestrian traffic volume at each of those facilities such as (1) proximity to public facilities, (2) population density, (3) percentage of people with disabilities, and (4) land use near pedestrian facilities. Due to the lack of pedestrian traffic data, all the aforementioned studies utilized heuristics to represent the need to upgrade non-compliant pedestrian facilities (Guensler *et al.* 2015). Other studies focused on measuring and estimating the number of pedestrians using sidewalks and pedestrian facilities during a specific time period (Davis *et al.* 1988, Ryus *et al.* 2017, Sanders *et al.* 2017, Seyfried *et al.* 2006). These studies however focused on the analysis of a small area for the purpose of extracting design guidelines and best practices rather than accurately estimating the expected traffic at each pedestrian facility in a large urban area which is essential to provide a reliable ranking of upgrade projects for non-compliant pedestrian facilities. To overcome this limitation, this paper presents a novel methodology for ranking pedestrian facilities based on their level of use.

2 PEDESTRIAN LEVEL OF USE

To rank the upgrade projects of pedestrian facilities, the present model utilizes a novel metric that is named “Pedestrian Level of Use” (PLU) to represent the total number of pedestrian trips that utilize each pedestrian facility in a specific period of time. This metric reflects the varying levels of use for pedestrian facilities and can be used to rank these facilities based on how often they are used by pedestrians. The proposed methodology calculates the PLU for each pedestrian facility in four major steps that calculate (1) the average number of pedestrian trips for each pedestrian facility based on the available federal, state, and local statistics and surveys; (2) the preliminary Expected Pedestrian Trips (EPT) for each pedestrian facility that considers the level of service index LOSI that this facility can accommodate; (3) an adjusted EPT for each pedestrian facility that reflect the connectivity of sidewalk network; and (4) the final PLU that considers proximity to Pedestrian Trip Generators (PTG) in addition to all previous factors (see Figure 1). The following four sections provide concise description of each of these steps.

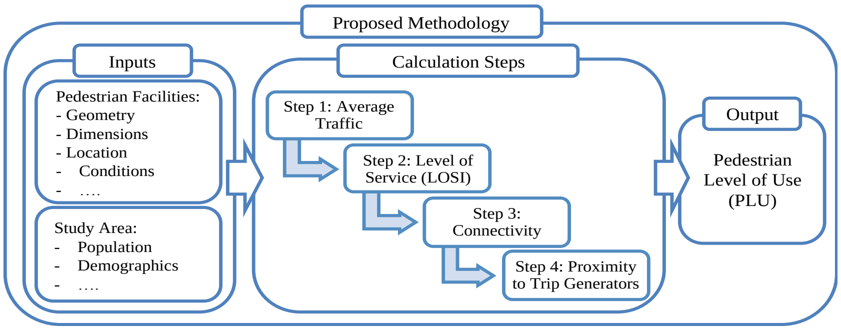

Figure 1. Proposed methodology.

2.1 Step 1: Average Pedestrian Traffic

The National Household Travel Survey (NHTS) reported in 2009 that the average number of walking trips per person in the United States is 362 (Santos *et al.* 2011). It also reported that the average walking trip length is 0.98 miles and the average trip time is 16.15 minutes in 2009 (NHTS 2009). In this step, the model utilizes these statistics to calculate the total number of pedestrian trips, miles travelled, and time spent walking for the entire study area by multiplying these national averages by the population of the study area.

2.2 Step 2: Level of Service Index

Level of Service Index (LOSI) for sidewalks quantifies the amount of pedestrian traffic that can be accommodated by that sidewalk, and is calculated in the present model based on the measurements and geometry of that sidewalk. For example, sidewalk width is one of the main factors that determines the level of service for sidewalks. Wider sidewalks can accommodate higher pedestrian traffic with acceptable LOSI, while narrower sidewalks provide much lower LOSI for the same number of pedestrians (Landis *et al.* 2001). In this step, the model utilizes LOSI calculations to find the maximum number of pedestrians that can be accommodated by each sidewalk to provide the highest possible levels of service, and then uses this value as relative importance weight to find the weighted average EPT for each pedestrian facility. For example, Sidewalk A in Figure 2 can accommodate twice the number of pedestrians that sidewalk B can accommodate at the same level of service because Sidewalk A is twice as wide as Sidewalk B (see Figure 2). Accordingly, Sidewalk A will have an EPT that is twice the value of Sidewalk B.

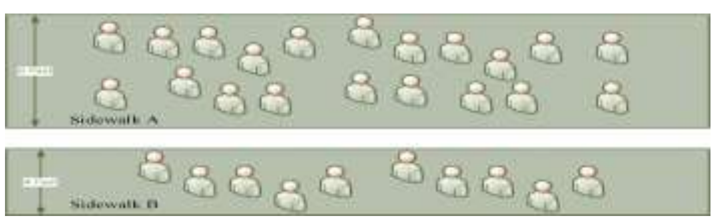

Figure 2. Level of service index.

2.3 Step 3: Connectivity

The main purpose of building sidewalks is to connect different points in the city in a way that allows pedestrians to use this interconnected network of sidewalks to travel from one point to the other with ease. In this step, the model utilizes a novel metric that is named *Connectivity Index (CI)* to consider the continuity of LOSI across the sidewalk network. This index identifies pedestrian facilities that disrupt the flow of pedestrians and provide a way to avoid that disruption in the calculations of PLU. For example, if we have a sidewalk that includes three connected segments A, B, and C with the widths of 6 feet, 4 feet, and 6 feet respectively (see Figure 3). In this example, the calculated LOSI for sidewalk segments A and C in the previous step is higher than that of sidewalk B due to their larger width. In reality, the LOSI in all three segments should be equal since they are all connected. To achieve this, the present model adjusts the LOSI of sidewalk B to match those of sidewalks A and C to maintain the same level of service throughout the entire sidewalk network.

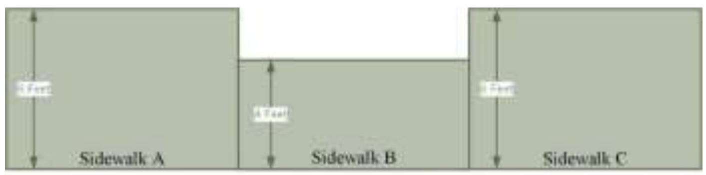

Figure 3. Connectivity.

2.4 Step 4: Proximity to Pedestrian Trip Generators (PTGs)

Pedestrian facilities near Pedestrian Trip Generators (PTGs) such as public facilities, transit stations, hospitals, schools, and shopping malls are exposed to higher volumes of pedestrian traffic due to the additional pedestrian trips to visit these PTGs (CCRPC 2016, City of Bellevue 2008, City of Clayton 2014, Frackelton and Guensler 2014). In this step, the model utilizes a novel index named *Block Index (BI)* to represent the proximity to PTGs. BI reflects the distance in urban street blocks between pedestrian facilities and trip generators. For example, sidewalks on the same block as the trip generator will have the highest BI values, while sidewalks in the adjacent blocks will have lower BI values, and the further a sidewalk is from the trip generator, the lower their BI value will be. This step calculates BI values for each block, and then uses them as relative importance weights to re-adjust the values of the previously calculated EPT and generate the final PLU values for each pedestrian facility in the case study. It should be mentioned that this step takes into account the potential latent travel demand (traffic that is currently latent due to inaccessible sidewalks) by adjusting the value of all sidewalks based on their proximity to PTGs regardless of their current accessibility conditions.

3 CASE STUDY

A case study of a small town with the population of 3830 was used to test the developed methodology. The case study includes 864 sidewalks that have the collective length of 22.52 miles, as shown in Figure 4. The case study requires calculating PLU for all sidewalks to rank and prioritize pedestrian facilities' upgrade projects. The required input data includes (1) existing dimensions, geometry, and conditions of all sidewalks in the case study, (2) locations of all sidewalks in the case study, (3) locations and types of all pedestrian trip generators in the case study area, and (4) demographic and statistical information about the case study area. The methodology utilizes this input data to calculate PLU for each pedestrian facility. An example sidewalk from the case study has received EPT of 1044 as an initial value in Step#1, 1153 due to its high capacity for pedestrian traffic in Step#2, 1215 to ensure the continuity of traffic with the two adjacent sidewalks, and 1258 due to its proximity to a hospital.

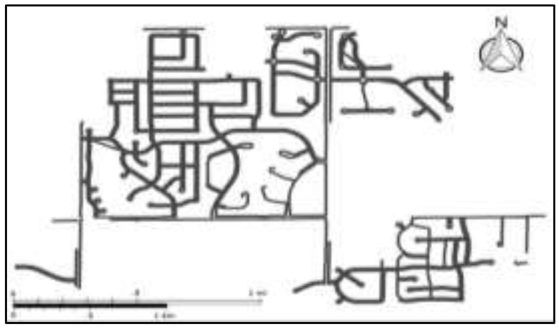

Figure 4. Map of the study area.

The capability of the developed methodology to efficiently calculate PLU for each pedestrian facility in the case study can be illustrated by its ability to calculate (1) the average pedestrian trips per pedestrian facility per year, (2) LOSI for each pedestrian facility, (3) EPT for each pedestrian facility that considers the continuity of the sidewalk network, and (4) final PLU value for each pedestrian facility that considers proximity to PTGs. In the case study the average number of pedestrian trips for each pedestrian facility calculated in Step 1 was 1044. After Step 2, the minimum number of pedestrian trips was 2 while the maximum was 2188. After Step 3, the maximum and minimum numbers have remained the same, while the median increased from 1044 to 1072. Finally, after Step 4 the total number of expected pedestrian trips was distributed over all pedestrian facilities considering proximity to trip generators, as shown in Figure 5.

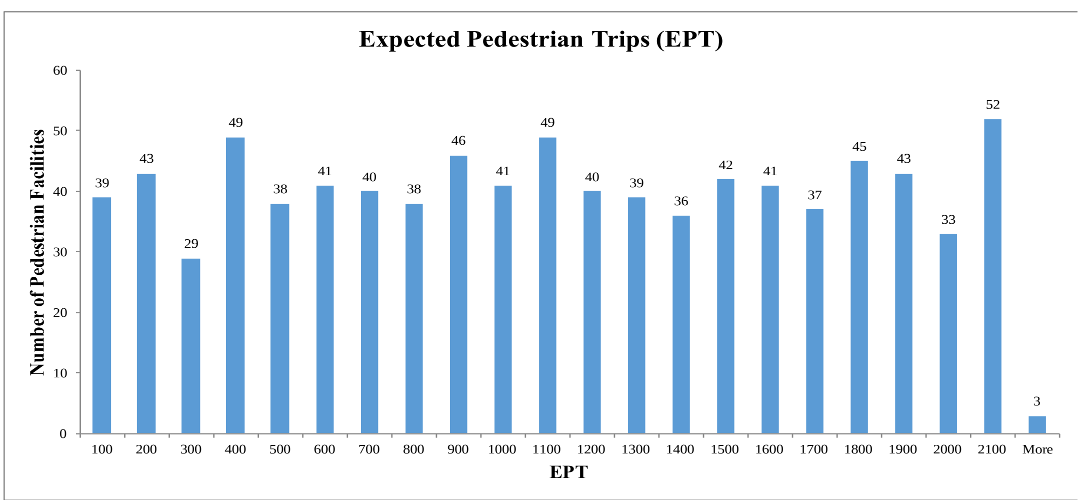

Figure 5. EPT distribution for all sidewalks in the case study.

4 CONCLUSION

A methodology was developed to calculate Pedestrian Level of Use (PLU). The PLU values were calculated based on available dimensional, geometric, demographic, and geospatial data.

The resulting PLU considered (1) total number of pedestrian trips in the study area, (2) level of service of pedestrian facilities, (3) connectivity and continuity of the sidewalk network, and (4) proximity to pedestrian trip generators. This methodology enables decision makers to rank and prioritize pedestrian facilities upgrade projects to maximize the impact of these upgrades and achieve full compliance with accessibility requirements.

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