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A pedestrian level of service method for evaluating and promoting walking facilities on campus streets

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ABSTRACT

Modern universities seek policies to sustain the streets on their campuses by making campus streets pedestrian-friendly. To maintain inclusive streets, campus designers and planners should consider all users. Currently, there are efforts to evaluate street conditions for pedestrians. However, a limited range of pedestrian facilities and abilities make the results of previous studies insufficient to evaluate and promote inclusive walking facilities. This study attempts to create a foundation for evaluating and improving campus streets for pedestrians. This research presents pedestrian design indicators based on different guidelines that consider various pedestrian needs. This paper also introduces the pedestrian level of service (PLOS) for campuses, which is a measure to evaluate campus street facilities and infrastructure for pedestrians. An analytical point system comparing existing pedestrian facilities to a standard is proposed to estimate this PLOS. Although this method can be utilized on campuses around the world, this research uses it to assess streets on the campus of Universiti Teknologi Malaysia (UTM). This method can identify existing street problems for pedestrians and can be used to propose improvements to existing campus streets. Since this study tries to serve all requirements of pedestrians, specifically vulnerable users whether old or disabled, designers have room to implement accessible routes for pedestrians in campus streets.

Introduction

Universities with large numbers of academic staff, students and administrative personnel and a variety of activities (e.g., working, studying, and business) are comparable to small cities (Mat et al., 2009; Norzalwi and Ismail, 2011). Therefore, campus planners must address the mobility and accessibility needs of these large populations. Planners and designers are concerned with walking conditions as a means to solve many problems (e.g., global warming, health problems, energy consumption, air pollution, etc.). Recently, universities have sought to propose strong pedestrian and bicycle plans to support the aims of sustainability. Walking is a green travel mode that is beneficial to the environment and the economy and can promote the health of campus users.

Norzalwi and Ismail (2011) estimated that approximately 18% of people use walking as their travel option at the Universiti Kebangsaan Malaysia (UKM). Walking is the third most frequent (20%) travel mode at Kasetsart University, after private cars and buses (Panitat, 2010). In addition, a survey at North Carolina State University showed that only 2% of employees used walking as a primary mode of transport (North Carolina State University, 2011). These statistics show that a lower proportion of people on these campuses use walking than other travel modes. Ample hidden costs are produced by car-based transportation (Balsas, 2001). Therefore, it is obvious that university policy makers should encourage people to walk to create sustainable campuses with fewer externalities (environmental, economic, and social problems) so; the pedestrian-oriented campus will be a primary focus of future studies (Grenis, 2009).

Universities should encourage people to shift their travel modes from cars to other types of travel, especially walking (Balsas, 2003). Improving walkable paths can encourage people to increase their walking trips (Park, 2008). Providing walking facilities in addition to other effective policies (e.g., restricting automobile traffic within a campus and limiting automobile parking spaces on campus) can encourage the large numbers of students who live on campus to walk to their destinations. Walking has many health benefits and no cost (Balsas, 2003), which is important for students with small budgets. Universities must save land, energy, and money for the future. Improving pedestrian facilities and encouraging less driving are primary strategies to achieve this aim (Toor and Havlick, 2004). To improve streets on campus, designers should have a good understanding of the needs of street users, including disabled users.

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In other words, planners should know which street factors affect walking conditions for various types of pedestrians.

Level of service is a tool for describing existing conditions and facilities and assessing the overall quality of service, infrastructure and street furnishings (Asadi-Shekari and Zaly Shah, 2011; Asadi-Shekari et al., 2013a,b; Moeinaddini et al., 2013). To provide a suitable and clear context for evaluating pedestrian infrastructure, it is necessary to review the current efforts that propose a pedestrian level of service (PLOS). The quality of street conditions for pedestrians is commonly assessed by a PLOS.

There are various approaches to PLOS models. Some previous PLOS methods emphasize the pedestrian flow and volume and the sidewalk capacity (e.g., Benz, 1986; Fruin, 1971 and Pushkarev and Zupan, 1971, 1975). Fruin (1971) proposed the first PLOS method based on sidewalk capacity and volume. HCM (2000) considered these indicators as well as speed to evaluate PLOS. This method has been criticized because pedestrians were treated like vehicles. Some important indicators, such as qualitative factors, facilities and furnishings, are not considered in these types of models.

Other approaches consider pedestrian facilities. Lautso and Murole (1974) considered the influence of environmental factors on walking. Sarkar (1993) suggested a qualitative model to assess streets. In this model system coherence, safety, comfort, convenience, continuity, security, and attractiveness were the primary factors. This model considered six pedestrian service levels ranging from A to F. PLOS A indicated pedestrian-friendly streets, whereas service level F indicated incomplete streets. Khisty (1994) developed a quantitative method based on Sarkar's model. Some studies have also considered convenience facilities, shady trees, benches, and pedestrian-scale lighting (e.g., Dixon, 1996; Jensen, 2007; Sarkar, 2002).

Other methods are sensitive to safety indicators, such as vehicle speed and volume and traffic buffers (e.g., Mozer, 1994; Landis et al., 2001). Landis et al. (2001) introduced a PLOS based on existing sidewalks, sidewalk width, motorized vehicle speed, motorized vehicle volume, lateral separation of pedestrians from motorized vehicles, and the total number of (through) lanes. This model is commonly used as a reference for other studies. FDOT (2009) used similar indicators to assess the PLOS. Although these models attempted to propose different effective factors, they did not consider some prominent furnishings and facilities that are essential for inclusive walking conditions (e.g., wheelchair accessible drinking fountains and tactile pavement).

Mozer (1994) proposed an LOS model for bicyclists and pedestrians. According to Mozer's model, facility design factors include the requirements of the Americans with Disabilities Act. However, it does not have specific or direct regulations or standards to measure. Therefore, these factors are insufficient to evaluate street conditions for disabled pedestrians. The scores are also based on the user's judgment. Sarkar (2002) developed a pedestrian level of service based on the needs of all pedestrians, but this model considers few standards and details for evaluating inclusive walking conditions. In addition, some important furnishings and facilities (e.g., tactile pavement for disabled users) are not mentioned in this method. This model also has financial and human resources limitations and some bias in the PLOS calculation.

Most LOS studies use questionnaires, direct observations, and video techniques to collect data. Usual analytical methods used in PLOS models are simulation (e.g., Miller et al., 2000), regression analysis (e.g., Landis et al., 2001 and Petritsch et al., 2006) and point systems (e.g., Jaskiewicz, 1999; Mozer, 1994; Dixon, 1996; Gallin, 2001). Dixon (1996) and Gallin (2001) developed a point system that is useful for rating street conditions. The point systems used by Dixon and Gallin are easy to follow, but the weights of the various indicators are arbitrarily chosen. This system can be enhanced by adding more indicators and avoiding bias.

What is most surprising about the previous studies on the evaluation of walking conditions is the lack of reliable and easy to follow measures to collect data and evaluate streets for all pedestrians with different abilities. Although PLOS models have been developed in different contexts, the results of these models are not sufficient for universal use (Singh and Jain, 2011). One of the reasons for this has been an approach to street evaluation that considers pedestrian indicators from a macro-level view instead of a micro-level view. Thus, researchers have not been successful in developing methods to assess micro-level walking conditions (Park, 2008). In addition, the majority of PLOS methods have assumed pedestrians without disabilities (NCHRP, 2008). As a result, the current PLOS models only cover a narrow range of street conditions and may not be applicable to all situations.

Consequently, this research proposes a PLOS model that covers various street conditions for pedestrians with different ranges of abilities. This method is useful for improving existing streets and is easily interpreted. Accordingly, the objectives of this paper are divided into different stages. The identification of effective facilities that affect walking conditions is the first stage. The second step is the proposal of complete guidelines for pedestrian facilities based on the combination of effective factors achieved in the first step. The introduction of a practical measure through a point system that covers the majority of pedestrian facilities and infrastructures is the third stage. The final stage is the assessment of campus streets by utilizing the proposed model to identify street problems and to present issues for improvements.

This research presents opportunities for universities to achieve sustainable design guidelines for pedestrians on campuses. This model attempts to evaluate intersection and roadway segment facilities on campus streets. For the purpose of this research, the main ring road on the Universiti Teknologi Malaysia (UTM) campus was chosen to examine this method.

Materials and method

Indicators and guidelines

This study attempts to consider the majority of pedestrian facilities based on current urban street guidelines. The process of reviewing guidelines was continued until all indicators and standards were repeated. Therefore, 27 indicators ((1) slower traffic speed, (2) buffer and barriers (curb and furnishing zone), (3) fewer traffic lanes, (4) mid-block crossing, (5) landscape and trees, (6) facilities (fire hydrants), (7) furniture (trash receptacles), (8) footpath pavement, (9) marking (crosswalk), (10) corner island, (11) sidewalk on both sides, (12) advance stop bar, (13) width of footpath, (14) driveway, (15) lighting, (16) signing, (17) bollard, (18) slope, (19) curb ramp, (20) wheelchair-accessible drinking fountain, (21) tactile pavement (guiding), (22) tactile pavement (warning), (23) ramp, (24) grade, (25) signal, (26) bench and seating area and (27) drinking fountain) were selected from 20 street guidelines in various countries. This selection from various cities is useful to cover different contexts. This study attempts to consider all facilities that influence the quality of walking on campus by referring to various urban street guidelines. These factors describe sidewalk and crossing facilities and the overall street condition to accommodate all pedestrian needs. These indicators are evaluated at the Universiti Teknologi Malaysia (UTM).

Method

This research proposes a PLOS based on a point system to rate streets. It attempts to evaluate pedestrian facilities on campus streets. These indicators do not have the same effects on the PLOS,