Land Use Policy 33 (2013) 1–10

Contents lists available at SciVerse ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

A practical method for evaluating parking area level of service

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ARTICLE INFO

Article history:
Received 6 July 2012
Received in revised form
11 November 2012
Accepted 27 November 2012

Keywords:
Parking supply
Parking demand
Parking management
Parking area level of service

ABSTRACT

In recent years, some of the commonly used indicators in parking management have changed. Maximizing the supply and minimizing the price were the main objectives before, but today, optimizing the parking supply and price is the major objective. This research introduces a parking area level of service, which has not been previously addressed, to evaluate the new objectives of sustainable development with the existing parking areas. For the purpose of this research, Universiti Teknologi Malaysia (UTM) was selected as a case study to implement this method in an academic context. This method may also be utilized for other land uses, but some adjustments should be applied. In addition, based on the existing failures, some improvements are proposed to enhance parking efficiency.

Introduction

Currently, there is a need for parking management plans that reflect the aims of sustainability, including the development of efficient parking areas that encourage and enhance green travel modes. Since the 1990s, parking areas have been designed with predefined auto-oriented and functional classifications. These designs have not paid considerable attention to the environment or to the people who use the parking spaces. These shortcomings have resulted in an increased demand and a lack of supply, which have caused many communities to change their attitude toward this issue (Litman, 2012a). In addition, inflexible parking standards require suppliers to provide extra parking, which wastes space and money and harms the environment (USEPA, 2006). As a solution, the standards for parking areas should be significantly adjusted to optimize the supply (Topp, 2009). Moreover, to make desirable adjustments in parking standards, some factors, such as the geographic location, density, mixed land use, transit accessibility, car-sharing, walkability and duty hours, should be taken into consideration (Cuddy, 2007; Engel-Yan and Passmore, 2010). Viable parking strategies that are planned based on the optimal supply and demand may result in sustainable benefits, while plans based on the maximum supply do not maximize sustainability. In this case, efficiency is the key factor. Efficiency should be considered in relation to the economic, geographic, and demographic factors that may influence parking demand (Litman, 2012a).

Furthermore, many parking areas are currently free of charge and thus motivate people to use their motorized vehicles. The parking pricing strategy proposed by Shoup (2005) is a concept that indicates that parking users should pay directly to use the parking facilities. Such strategies may also encourage people to use other alternative travel modes, such as public transport, walking and cycling. Innovative sustainable development ideas include the concepts that prices should be paid by users and that this money should be spent on improving alternative travel modes.

Overall, during the current century, the issue of parking has undergone many changes. The main changes relate to the ways in which the problems and their solutions are described. Previously, the attitudes toward parking were based on car-dependent development. These maximum and free supply beliefs reinforced the notion that as many parking spaces as needed should be available at all destinations. Moreover, these parking areas should always have empty spaces, and the costs of parking should be either included in the buildings' costs or parking should be provided by the suppliers.

On the other hand, the availability of more parking spaces can cause more private motorized daily trips (Moeinaddini and Zaly-Shah, 2011). With more and cheaper parking, car ownership and usage has increased due to the rise of convenience and the lower cost (Litman, 2012a; Mildner et al., 1997; Morrall and Bolger, 1996; Shoup, 1997; Weinberger et al., 2008). Therefore, a new focused has been placed on the optimal supply instead of the maximum supply (Litman, 2012b). In this case, the supply and prices should be balanced with demand because too much supply and an extremely low price can be as harmful as a low supply and a high price.

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http://dx.doi.org/10.1016/j.landusepol.2012.11.014

The intention of this study is to encourage planners and engineers to design optimal parking areas, or parking spaces that consider sustainability and alternative travel modes instead of car-dependent planning. To achieve this objective, this research proposes a new evaluation method to assess the parking area level of service (*PALOS*) value that determines the percentage of efficiency for each parking area facility based on sustainable development issues.

Level of service (LOS) models are used to evaluate street conditions for different users. There are various LOS models, such as automobile, transit, bicycle and pedestrian (e.g., Asadi-Shekari et al., in press; Asadi-Shekari and Zaly-Shah, 2011; Dixon, 1996; Gallin, 2001; Landis et al., 2001; Lee and Lam, 2003; Miller et al., 2000; Mozer, 1994; NCHRP, 2008; Petritsch et al., 2006). The concept of level of service can be used to evaluate the efficiency of other facilities, such as parking areas.

This research implements the *PALOS* method on the campus of Universiti Teknologi Malaysia (UTM). Parking areas are critical spaces on the UTM campus due to the lack of alternative travel modes, such as walking and public transport. Evaluating the existing campus parking areas may help to identify the effective factors and requirements. It may also allow for enhanced parking efficiency. Therefore, this paper addresses a method to develop sustainable parking conditions.

Materials and methods

This research is composed of three main areas: a users' opinion survey, a parking inventory and an analysis of the parking demand (utilization). The following sections introduce these stages and describe how the combination of these steps can help to achieve the *PALOS* and support improvements in parking planning.

Parking users

Studying the users of a parking area is a useful way to evaluate parking facilities. It is also a good way to identify user-related problems. A parking users' survey is performed using a questionnaire that is designed based on primary observations and user interviews. By utilizing this method of study, the need for facilities in critical parking areas as well as the main problems based on users' opinions can be identified. The questionnaire that is used in this section is shown in Appendix A.

The results of this study show that using public transportation after parking is not typical at the UTM campus. The majority of the parking areas are used daily, and except for parking 01, 03 and 22, there is usually not a space problem in the critical areas (refer to Appendixes B and C). Users' destinations after parking in these areas are different, and some of them are far away. The majority of the parking areas in UTM campus have shelter and shade problems; they also do not have suitable walking facilities available for use after parking. The results of this study may be useful to propose efficiency parking area rates in these critical areas.

Suitable shade and walking facilities make parking areas more convenient and attractive for users and decrease the problems they face. Figs. 1 and 2 illustrate parking spaces with adequate shade and walking facilities. To facilitate safe waking after parking, an accessible separate path for pedestrians is needed (refer Fig. 2).

Parking inventory

The second stage of this research sought to determine the parking supply. This parking inventory was also utilized to identify specific parking facility features that are critical for parking users, such as the number of accessible blocks (within 400 m), the number of parking spaces with suitable shade, the number of parking spaces

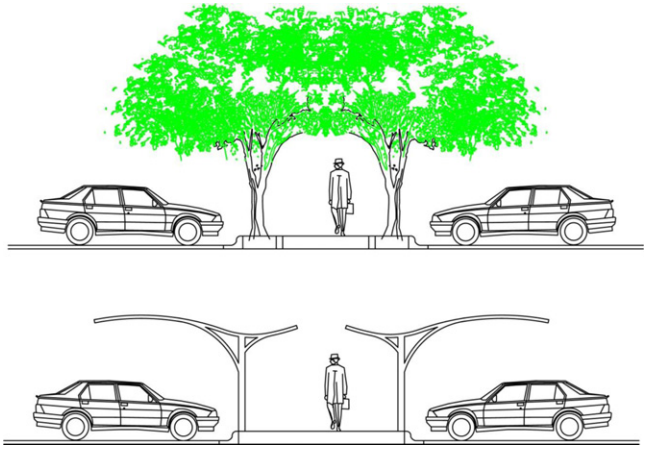

Fig. 1. Example of suitable shade for parking space.

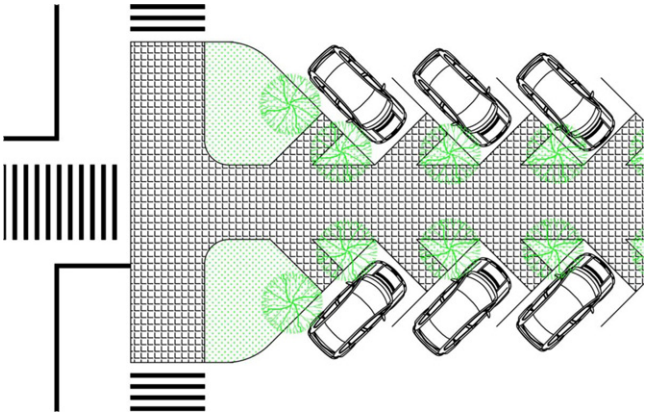

Fig. 2. Example of suitable walking path in parking area.

that have suitable walking routes providing to access various destinations (or walking accessibility), the number of accessible public transport stations and the presence of information signs. These factors related to the parking inventory have not been addressed in previous studies.

This study used a parking inventory level of service (*PILOS*) based on a point system to rate parking areas for their accessibility, which led to the creation of the following *PILOS* model (refer Eq. (1)):

$$PILOS = \frac{PI_1 + PI_2 + PI_3 + PI_4 + PI_5}{5} \quad (1)$$

where *PILOS* is the parking inventory level of service

PI_1 = Number of parking spaces that are within 400 m of the destination/total parking spaces

PI_2 = Number of parking spaces with suitable shade/total parking spaces

PI_3 = Number of parking spaces with accessible walking routes/total parking spaces

PI_4 = ($T \times$ Number of parking spaces with an accessible transit station (within 400 m))/total parking spaces