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Parking Generation by "Pharmacy" Land Use Type in Johor Bahru, Malaysia

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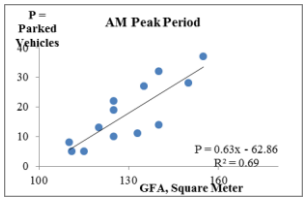
Graphical abstract



Abstract
Transportation planners need prior data on "Parking Generations" for new developments and to predict changes in the parking generation due to modifications in the existing land use types. Parking Generations depends on various factors including the socioeconomic characteristics. The Institute of Transportation Engineers (ITE) is an international body of transport professionals that publishes and updates the information on parking generation for various land use types in USA. In Malaysia, no parking generation guidebook exists. Transport planners in Malaysia have to depend on the parking generation data and models developed based on other countries which may be misleading and inaccurate. The ITE provides parking generation data for 106 different land use types including "Pharmacy". The objective of the paper is to study the parking generation rate for the land use type "Pharmacy" and develop regression models for predicting daily parking generation by pharmacies based on the Johor Bahru environment in Malaysia. Data were collected from the selected thirteen (13) pharmacy locations in Johor Bahru area. The data collection also included a survey of stakeholders including information on a) gross floor space area b) available parking spaces adjacent to the pharmacy c) presence of similar pharmacies in the vicinity (500 m radius). Linear regression models were developed to predict peak hour parking generations by the "Pharmacy" land use type. The developed models are recommended to be used by the professionals for the Malaysian local environment.

Keywords: Parking generation rates; parking demand; pharmacy parking rates

1.0 INTRODUCTION

In recent years, with the rapid development of urbanization in Malaysia, and the rapid increase in motor vehicles, in particular cars, cities are facing more and more parking problems. Transportation planners need prior data on "Parking Generations" for new developments. The Parking Generation data are necessary for transport professionals for conducting parking requirement analysis, site impact studies, on-site circulation studies and other land use related studies. The Institute of Transportation Engineers (ITE) is an international body of transport professionals based in Washington, DC, USA, that publishes and updates the information on the parking generation for various types of land uses in USA through Parking Generation (4th Edition), 2010 that includes data on 106 land use types. Generally parking studies were conducted to collect and analyze data relationship between parking and the site characteristics for a particular land use type based on the USA local conditions. ITE's Parking Generation and the Transportation Planning Handbook both offer transport professions methods for conducting a variety of parking studies [1, 2]. No comprehensive study has yet been carried out on parking generation on the "Pharmacy" land use type in local context of Malaysia. This paper provides results of the study conducted to develop parking generation data for "Pharmacy" land use type in the Johor Bahru, Malaysia local environment.

Literature review as discussed below shows that parking generation studies of various land use types have been conducted in western countries but very little have been done for the Asian condition. In many cases, parking requirements of proposed developments in Asian cities are determined using rates developed for western cities. This may not be appropriate because there are differences in level of vehicle ownership, public transport service, and traffic management as well as land-use planning**.** Such differences can result in poorly planned facilities**.** Parking facility is an important element in the road mode of transportation and an adequate number of parking spaces are to be provided to meet the parking demand. Parking facilities are needed especially at the residential areas, business areas and commercial areas. Congestion problem usually occurs at the area that has high density due to high demand and lack of parking spaces [3]. The Montana State University Institute of Transportation Engineers (MSU-ITE) gathered field observations in order to produce trip and parking demand data for small office complexes. Since the current trip and parking generation manual do contain a small office land use, MSU-ITE compared those data to available data for land use, a research and development center, due to the types of business on-site and the type of office space

[4]. The Portland State University (PSU) Institute of Transportation Engineers (ITE) student chapter also conducted a trip and parking generation study at the Portland IKEA for ITE. IKEA is an international and home products retailer. The 280,000 square feet store is located in a relatively new commercial shopping area. The research revealed difficulty due to internal shopping, and there was quite a bit of pedestrian flow between stores so it was difficult to distinguish between transit and those using another store's parking lot and walking to IKEA [5]. Another research was conducted to improve models for estimating parking generation rates of commercial developments in Singapore by using basic site characteristics such as available floor area and site location [6]. The research showed that use of the existing characteristics can be implied for parking prediction at those locations.

■2.0 METHODOLOGY

First, this study involved detailed review and information gathering about the fundamentals of parking generation and regression models. The basic assumption while developing a regression model that the considered data set for the studied parameters were distributed normally was taken in to account. Next, potential sites were initially identified through internet based location mapping. The initially identified locations were visited and further screening was done. The ITE Parking Generation manual [1] - considered five (05) data points for this land use type to develop a regression equation as shown in Figure 1. Upon referring the literature, on the number of studied samples for parking generation, thirteen (13) pharmacy locations were selected for detailed studies in this study.

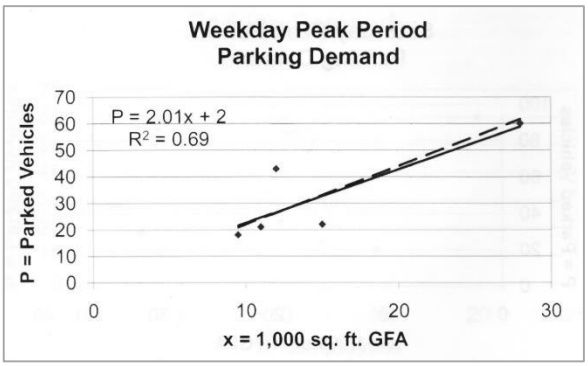


Figure 1 Plot of parking demand versus gross floor area [1]

2.1 Inventory of Existing Condition

In this study there were two types of details needed which are location survey and details of the pharmacy. The details for location survey consisted of the identity, type of location whether it is urban, sub-urban and so forth, number of parking spaces near the pharmacy, and presence of number of similar pharmacies in the vicinity (within 500 m radius). The details of the pharmacy comprised of floor area of the pharmacy, availability of parking spaces.

2.2 Data Collection on Parking

Thirteen Pharmacies around Johor Bahru area were studied based on the availability of information and availability of the stakeholders for data collection. Data were collected for each sites from (10.00 a.m. – 12:00 p.m.) and (3:00 p.m.- 6:00 p.m.).
The number of occupied parking spaces was counted for every 15 minutes interval. The sum of every four (4) consecutive interval total parking was then counted for selected peak hour total parking rate. Summation of every four (4) interval data was calculated for hourly parking generation rate. The highest hourly data was considered as the peak hour parking generation rate for each site. The data collection of parking data was done by recording the vehicle registration number that parked on parking space. The time of the vehicles arrived at the pharmacy and departed from the pharmacy were recorded and customers were interviewed before entering the pharmacy premise about their mode of transport and location of parking.

■3.0 RESULTS AND DISCUSSION

The relationships of the hourly vehicle Peak Hour (AM and PM Peak period) demand for thirteen (13) sites based on three (3) selected parameters which are i) gross floor area (Figure 2), number of available parking spaces (Figure 3) and presence of pharmacies within 500 metre radius (Figure 4) were plotted. From the simple regression analysis there are no clear relationships between parked vehicles to number of available parking spaces and presence of other pharmacies within 500 metre radius range. The regression values in between range of 0.2 to 0.6 can be considered as weak relationship. Moreover, the relationship between both peak periods (AM and PM) shows positive correlation relationships with gross floor area of the premises. Thus, the gross floor area (GFA) paramater was used to develop prediction models on parking generation for peak periods. Statistical analysis on number of peak periods parked vehicles based on gross floor area of pharmacy showing significant relationship compared to others.

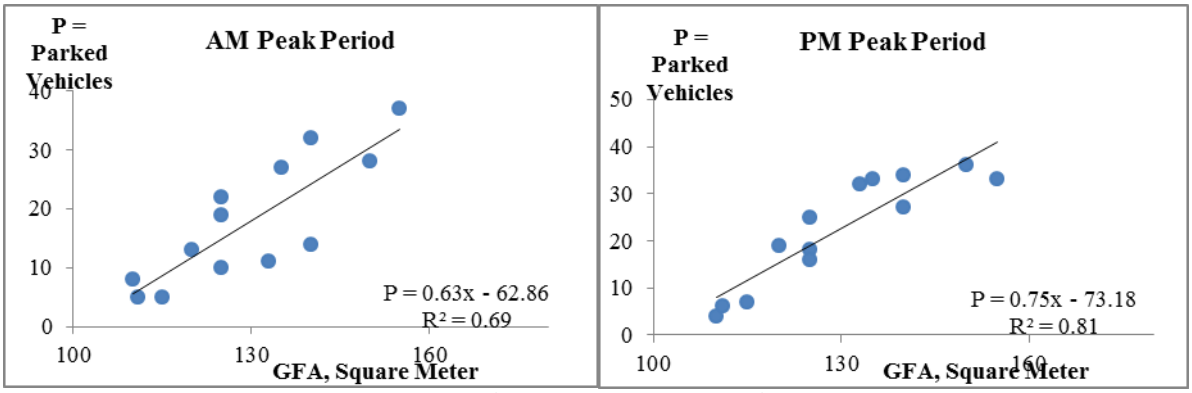


Figure 2 Plot of parking demand versus gross floor area

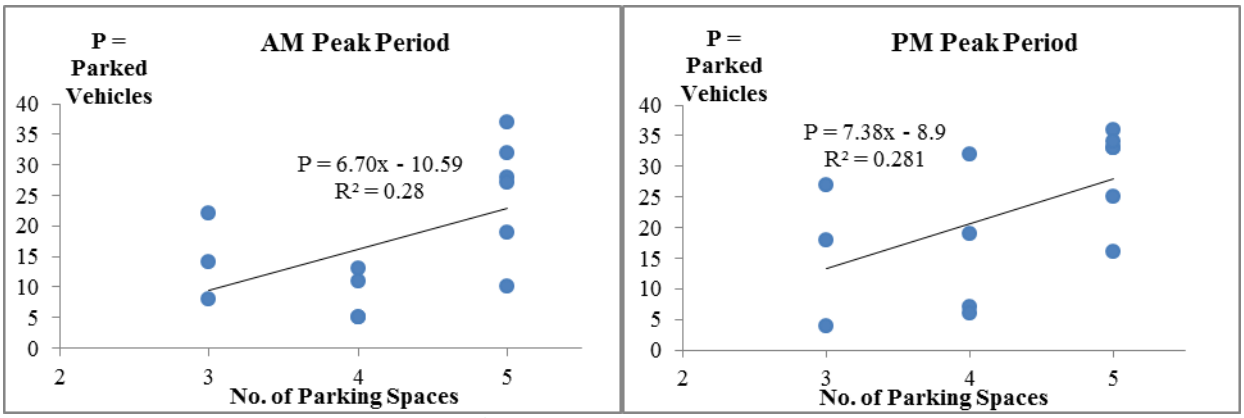


Figure 3 Plot of parking demand versus provided parking spaces

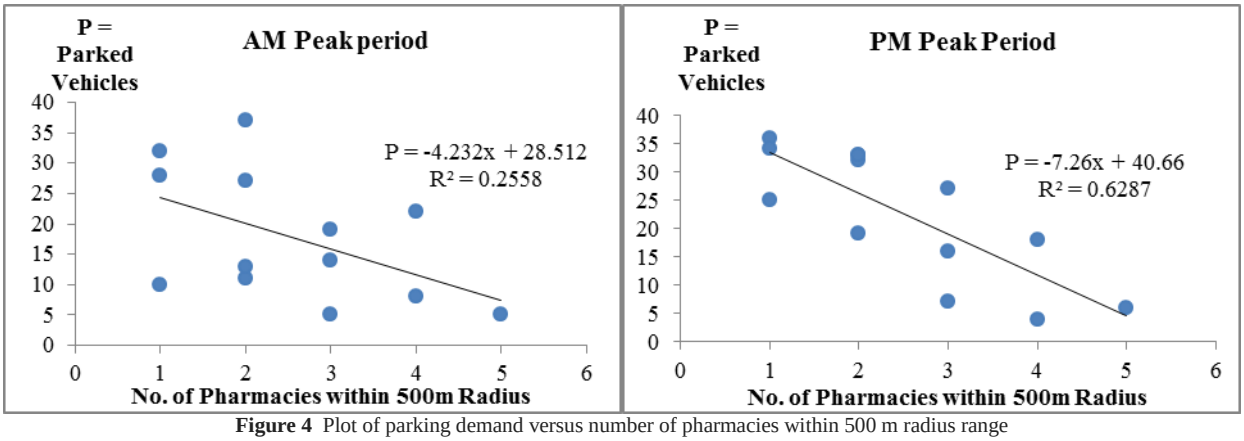


Figure 4 Plot of parking demand versus number of pharmacies within 500 m radius range

The result revealed that the R2 values were higher and the coefficient of the variable was significant. Since the parameter was significant hence, the prediction of parking generation models (AM, and PM Peak period) based on gross floor area could be developed.

Attempts were made to develop multiple regression models to improve the predictive accuracy of the simple linear models. Based on the analysis, no multiple linear regression model could be fitted for the AM peak hour condition; however, a multiple regression model for the PM peak hour could be developed that is capable of predicting the Parking Generation during the PM peak hour of the generator with an R2 value of 0.896 and Standard Error of 4.05. Equation 3 shows the relationship between the PM parking generation rate and the two significant variables.

$P = 0.54\ x1 - 3.35\ x2 - 38.87$ - - - Eq. 3

Where,

*x1 - Gross Floor Area in Square Meter

*x2 - Presence of Pharmacies within 500 m radius range

Table 1 Details description for parking generation study for "Pharmacy" land use type

Details	ITE Parking Generation Manual 2010	This Study, Johor Bahru Location	
Peak Period	2.00-4.00 p.m.	9.00-11.00 a.m.	4.00-6.00 p.m.
No. of study sites	5	13	13
Ave. size study sites	15,100 Square Feet GFA	129.54 Square Meter GFA	129.54 Square Meter GFA
Regression Linear Model	P = 2.01x + 2	P = 0.63x – 62.86 - -Eq-1	P = 0.75x – 73.2 - - Eq-2
R^2	0.69	0.69 - -Eq-1	0.81 - -Eq-2
Multiple Regression Model	N/A	N/A	$P = 0.538x_1 – 3.354x_2$ -38.87 - - Eq-3
R^2	X	X	0.896 - -Eq-3

*P - Parked Vehicles. * x and x_1- Gross Floor Area Variable, x_2- Number of Parking Spaces

4.0 CONCLUSIONS

According to the ITE Parking Generation manual 2010 [1], parked vehicle rates at Pharmacy/Drugstore without Drive-through window were based on the gross floor area of the establishment for evening (PM) peak period. There are only five (5) data points used in the manual. The data collected in this study attempted to determine the parking generation rates based on the gross floor area, number of available parking spaces and number of pharmacies within 500 m radius range. Statistical analyses revealed that the parked vehicles rates at the pharmacy have weak relationship based on availability parking spaces and number of pharmacies within 500 meter radius. However, the regression value for evening peak period based on gross floor area showed that the relationship was reasonably strong and the coefficient of the independent variable was significant. A multiple regression analysis model for the PM peak hour was developed that is able to predict PM peak hour parking demand with better accuracy than the simple regression models.

This study results were also compared with the ITE Parking Generation manual 2010. The comparison showed that the rates mentioned in the manual did not show any significant relationship (R^2 = 0.69). Linear regression models and the multiple regression model for the PM peak hour developed through this study are more capable of predicting parking generation by the "Pharmacy" land use type. The parking generation rate models developed in this study will facilitate transportation professions to better estimate anticipated parking for this land use type especially considering the local enviroment. Therefore, the developed models are recommended to be used by the professionals for the Johor Bahru, Malaysia local environment.

Acknowledgement

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