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 that publishes and updates the information on parking generation for various land use types in USA. In Malaysia, no parking generation guidebook exists. 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

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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].

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.

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. 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.

2.0 METHODOLOGY

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) parameter 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.
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.

\[ P = 0.54x_1 - 3.35x_2 - 38.87 \]  
\[ \text{Eq. 3} \]

Where,

*\( x_1 \) - Gross Floor Area in Square Meter
*\( x_2 \) - Presence of Pharmacies within 500 m radius range

### Table 1

Details description for parking generation study for “Pharmacy” land use type

<table>
<thead>
<tr>
<th>Details</th>
<th>ITE Parking Generation Manual 2010</th>
<th>This Study, Johor Bahru Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Period</td>
<td>2.00-4.00 p.m.</td>
<td>9.00-11.00 a.m.</td>
</tr>
<tr>
<td>No. of study sites</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Ave. size study sites</td>
<td>15,100 Square Feet GFA</td>
<td>129.54 Square Meter GFA</td>
</tr>
<tr>
<td>Regression Linear Model</td>
<td>( P = 2.01x + 2 )</td>
<td>( P = 0.63x - 62.86 ) - Eq-1</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.69</td>
<td>0.69 - Eq-1</td>
</tr>
<tr>
<td>Multiple Regression Model</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

*\( P \) - 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 environment. Therefore, the developed models are recommended to be used by the professionals for the Johor Bahru, Malaysia local environment.

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References