Developing Demand model of On Street Parking at Congested Area in Yangon

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Abstract: Parking lots are very important and necessary for all vehicles. In Yangon city, there are unexpected growth of population and vehicle number. The availability of free land space for parking is very few. This condition leads to on street parking and illegal parking. This type of parking causes traffic congestion and accident. So, parking surveys have been carried out for collecting data about parking space availability and requirement and its remedial measures on present scenario. The data shows the number of car parked along Hledan Road. Data collection was carried out by both questionaries' survey and in-out survey. The objective of the study is to analyze on street parking demand and introduce parking demand model. First, demand supply analysis is carried out by in-out survey data. Then, parking demand model for regarding varying price of parking fee can produce. Finally, on street parking demand rate produced from the model.

Keywords: Parking, on-street parking, Parking Problem, Remedial measures.

1. INTRODUCTION

Transportation is one of the most discussed issues. Transportation planning is the basic tool for solving the problems of transportation. Due to lack of proper urban planning, there are many transportation problems in Yangon city. People use various transportation systems to get their desired destination. However, there are not enough transportation facilities, planning, laws and regulation. This is resulting transportation problem in metropolitan city, Yangon. The high number of private cars and taxi create parking problem. In Yangon, parking has become serious problem not only for vehicles but also for traffic flow. Hledan road is one of the busiest and most important roads in Yangon. Various land use can be treated to be mostly responsible for traffic attraction. So parking problem is the most popular and main cause of traffic congestion. The rapid growth of vehicle number causes difficulties for the availability of parking space.

There are two types of parking .They are on street parking and off street parking. On street parking defined as parking vehicle on the street, anywhere on or along the road. The advantages of on street parking are parallel parking at curb can be a useful traffic management tool that provides a safety barriers for pedestrians, easy for entering and leaving, getting desired destination as near as possible, free parking fee and reduce walking time. The disadvantages of this type of parking are this can affect the traffic stream, sometime takes more searching time, more dangerous for pedestrian at blind point, can also cause some conflict between drivers. Off street parking is parking where vehicle can park along defined area. This type of parking includes parking facilities such as garages, parking sign, etc. The different between on street parking and off street parking are cost and time of construction, physical and operational requirements.

Off street parking is available in some Mark, Centre and some few public places in Yangon. The availability of land for off street parking is much less than the growth rate of vehicle number. Most flats in Yangon do not contain parking. It is well known that the limited availability of parking in metropolitan city contributes to roadway congestion, air pollution and driver frustration. Parking policies can be thus designed and employed to influence mobility behaviour in urban areas for instance, the accessibility of some zones can be greatly reduced by imposing high parking fee and providing loading and unloading zone for Taxi.

In this study, in out survey and questionaries' survey about on street parking are carried out. When taxi wants to pick down their passenger, it finds some space to park. However, there is no space to park. Therefore, it parks on traffic stream, which cause traffic congestion and accident. The vehicles of flat owner and food and good selling cars are parked on street for a long time. Regarding parking fee can remove these cars from on street parking. This study aims at analysing the demand and supply situation of different commercial land use along Hledan road and produces parking demand model. This will provide an overview existing parking along Hledan road.

Parking demand and supply analysis of different commercial land use along Mirpur road which is summited by Shancharpath described parking volume, parking accumulation, parking load, parking index, average parking duration, parking turnover and parking spillover. Short stay car parking choice behaviour in MSc planning and transport include developing parking demand model from parking choice behaviour by using binary logistic regression in SPSS software. On street parking management plan and cost – benefit analysis for Daharwad city, India from IJERA developed parking demand model from purpose by using linear regression model and then financial analysis was carried out by cost benefit analysis. Parking demand forecast model in CDD also generated from parking generation rate, land use type and area.

This study aims at analysing the demand and supply situation of different commercial land use along Hledan road and produces parking demand model. This will provide an overview existing parking along Hledan road and also obtained parking demand rates based on parking price. The remedial measure for parking problem can also be obtained from the study.

Finally, with the point to explore the possibilities of managing the parking space by communicating to the users has to be exploring in the city. The demand model can determine which appropriately applied management system can significantly reduce the number of parking spaces required in the particular situation.

2. RELEVANT STUDY BACKGROUND

Parking is one of necessary components of motor vehicle travels. There are many other research papers about parking demand analysis. In saying parking, there are two types of parking. These are on street and off street parking. For rapid and unplanned developing countries, parking is one of the most serious problems. The unprecedented growth of vehicles has increased parking spaces demand. The less available of land for parking lead to on street parking. Traffic stream is mostly disturbance because of on street parking without laws and regulations. In traffic planning, the possibility of traffic congestion, accident and other relative conditions must consider. For planning on street parking, it is very necessary to know parking demand condition. The location and nature of parking opportunities depends heavily on the land use function and density as well as on a wide variety of public policy and planning issue.

Parking demand analysis can be carried out by many other program. There are many other parking demand equations. These are obtained by using regression model in SPSS and any

other software. Regression model contained linear regression, logistic regression. Linear regression is used when the study wants to predict the value of a variable based on the value of another variable. The variable we want to predict is called the dependent variable. The variable we are using to predict the other variable's value is called the independent variable. If we need to obtain two or more variables, rather than one, we need to use multiple regressions. For obtaining two variables, binary logistic regression is used. In this study, park or not park for parking pricing analysis is carried out. So, binary logistic regression model is used for this analysis.

Travellers usually attach great importance to the conditions of parking (Clinch and Kelly 2003). Before any measures for the betterment of the conditions of parking can be formulated, it is required to obtain information concerning the capacity and usage of existing parking facilities (Kadiyali, 2007; UIdaho, 2013). In the scenario of ever increasing private car ownership, there is a challenge of traffic planner for providing suitable parking spaces. Wong et al. generated a simple model to estimate the forecasted parking demand of Hong Kong city. In this study, only land use factor is considered. Donald C. Shoup estimate parking demand based on trip generation including local trip. Saptrashi et al. produced on street parking demand model based on three parameters viz. the average number of 4-wheelers owned, average duration (in hour) , and mode choice. Priyanka Kolhar has developed on street parking demand model by linear regression analysis. Sa (1987) used regression techniques and concluded that regression techniques outperform traditional time series models or historical averages. McGill (1995) developed a multivariate multiple regression to test the correlation in multiple booking classes. Several researchers have also used simple smoothing techniques as a forecasting tool.

In this study, on street parking demand equations are generated based on different parking pricing. Parking price are divided into three grouped ; 200, 300, 500 MM kyats per hour. SPSS software is used in this study. Binary logistic regression is used for estimating parking demand. In this study, dependent variables are park or not park of pricing parking. The independent variables are income, purpose, frequency, parking duration and origin destination. Data collection is carried out by questionnaires survey in both weekday and weekend.

3. STUDY AREA

The study area is situated in Yangon City; the largest economic centre in Myanmar, with a population of about 5.2 million as of 2014 is organized with thirty-three townships. There are 45 townships in Yangon Region. The availability of less space in urban area has rising demand for parking space mainly in not only central business district but also crowed areas with various land use.But in this research, Kamayut Township which is mixed of landuse is chosen as study area. Hledan road is chosen as study area which is the most attracted and a congested area in Yangon, there is a lot of illegal parking which create traffic jam. Hledan road is located in Kamayut Township with over 80000 million population north central part of Yangon. This township is also known as collage town of Yangon. It is situated at north latitude 16˚49'15" and east longitude 96˚8'0".

The land use pattern along Hledan road is complex including education centre, office, market, store, shopping centre, food shop, etc. These land use attracts various trips to the study area. These trips use various transportation facilities. Among these facilities, trips by own cars and taxi and good transportation vehicles use parking lots and these are the source of existing parking problem. The strategy of the situation requires developing parking

management system with the demand model in the study. For this reason, this area was selected as a case study. The location of the study area is shown in Figure 1.

Figure 1. Location of the study area

4. METHODOLOGY

4.1 Data Collection

In parking study, there are many types of data collection can be carried out. These are questionnaires survey, in – out survey, license plate survey, and fixed period sampling survey. In this research, questionnaires survey and in – out survey are used for data collection. The survey methods are briefly described in the following

4.1.1 Questionnaires survey

This type of survey is carried out by asking questions or distributing question form to the respondents. A questionnaire form includes a series of questions used to gather information from a group of respondents. Such surveys can be used for either qualitative or quantitative analysis depending on the type of questions being asked. Depending on key question and subject area, either use pre-validated questionnaires or modify existing questionnaires can be used to suit your specific objectives for carrying out this research. Once gather the responses, then assess the responses and perform statistical analysis if required for appropriate interpretations for the survey population. Such surveys help in gathering and assessing information from small or large populations of respondents.

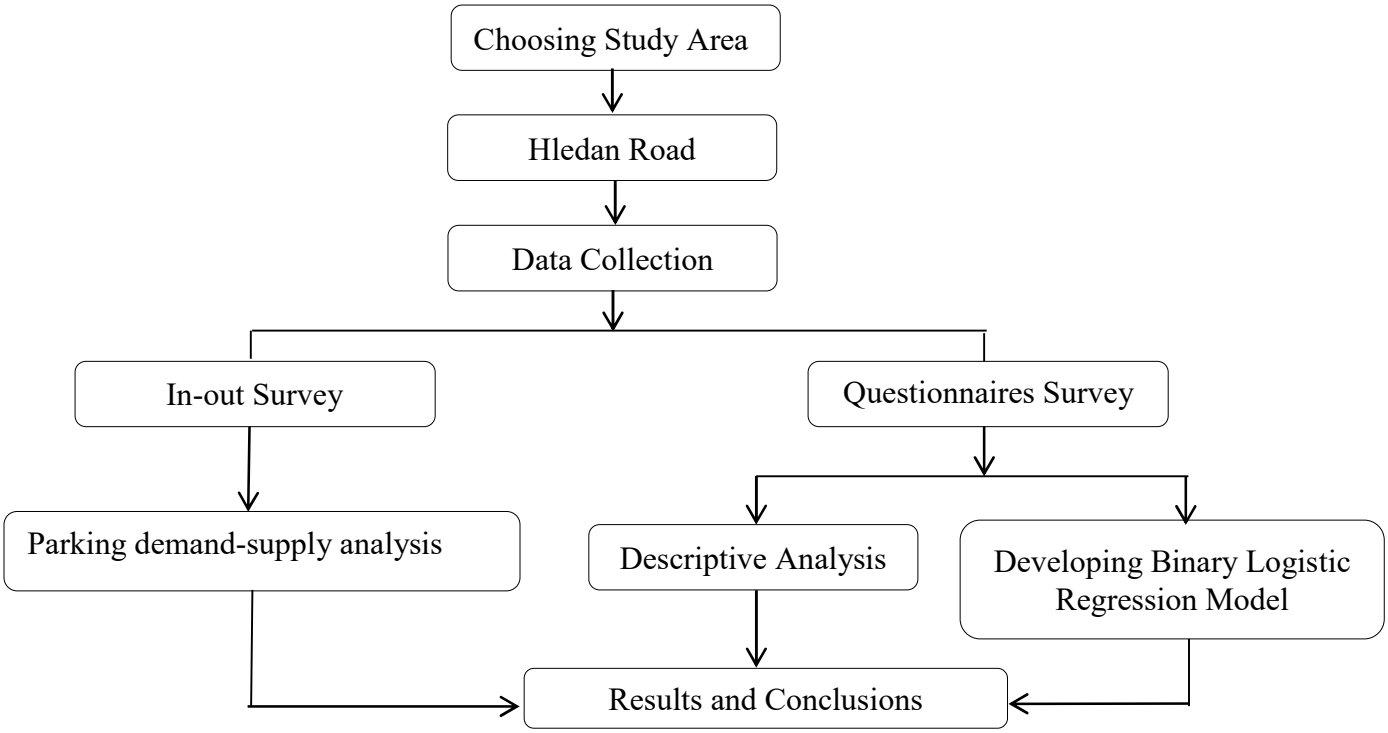
4.1.2 In-out survey

In this survey, the occupancy count in the selected parking lot is taken at the beginning. Then the number of vehicles that enter the parking lot for a particular time interval is counted. The number of vehicles that leave the parking lot is also taken. The final occupancy in the parking lot is also taken. Here the labour required is very less. Only one person may be enough. But we won't get any data regarding the time duration for which a particular vehicle used that parking lot. Parking duration and turnover is not obtained. Hence, we cannot estimate the parking fare from this survey. For quick survey purposes, a fixed period sampling can also be done. This is almost similar to in-out survey. All vehicles are counted at the beginning of the survey. Then after a fixed time interval that may vary between 15 minutes to i hour, the count is again taken. Here there are chances of missing the number of vehicles that were parked for a short duration.

4.2. Data

Two types of data: obtained from questionnaires survey and in-out survey were used in this analysis. Questionnaires data were used for estimation of parking demand and descriptive analysis. In-out survey data were used for demand and supply analysis of on street parking.

4.3 Methods



4.3.1 Choosing study area

In this paper, study area is firstly determined. On street parking is most serious in not only in CBD but also in mixed of land use area which are the most attracted areas. Hledan road is one of the most attracted areas with mixed of land use. Along Hledan road, there are markets, shopping centres, food stall, stores, and training centres. Therefore, people attracted to this area come with various form of transportation. For market, the loading unloading cars of good and passengers mostly use on street parking, Moreover, the flat along the road don't contain parking.

4.3.2 Determine sample size

In this paper, the sample size required for analysis is determined by Solvin's formula is used in sample size calculator.

$$n = N / (1 + Ne^2)$$

Where:

n = Number of samples,
N = Total population and
e = Error tolerance (level)

The population of Yangon city is 5.2 billion. Therefore, the sample size required to response is obtained as 400 numbers.

4.3.2 Preparing question form and data collection

Questionnaires survey and in-out survey are carried out for data collection.

The in-out survey was collected to know the total number of vehicle loads parked in the study area. From this survey, the parking duration for each vehicle, types of vehicles, exact arrival and departure time could be observed definitely. The survey data could calculate the parking turnover rate, parking accumulation, average parking duration, parking supply and adjustment factor for parking. This in-out survey was collected for peak period. Morning peak is from 10:30 AM to 12:30PM and evening peak is from 2:30PM to 4:30PM.

The Q-form includes socio-economic factors include gender, age, work, financial status, and car ownership while behavioural characteristics include trip purposes, searching time, reasons of parking choice, etc., The variables obtained from questionnaires survey are required for estimation of parking demand. Questionnaires survey is carried out in both weekday and weekend. People who use on street parking are asked some questions and marking the multiple choices in question form. These answers from parker are used for both descriptive analysis and producing parking demand model.

4.3.3 Prepare and entry collected data

The collected data are grouped into three groups based on parking price per hour. The parking price groups are 200 MM kyats per hour, 300 MM kyats per hour and 500 MM kyats per hour. The data are filled in SPSS software.

4.3.4 Developing demand model

Parking price in study area is free. Moreover, there is lack of parking management system. So, various parking angles are used. Parking fee is added in the model because the vehicles are parked for long period. The results of these condition, the traffic congestion, accident to other road user. Moreover, the difficulty of finding parking is very serious. In some condition, the search time for parking is at around 15-30 minutes. It is also impossible to develop parking demand model without obtaining existing parking condition and factors that play vital role for solving parking problem. So, the demand model with required factors is developed to determine which parking management system is suitable for solving parking problems. Moreover, which parking users wanted to pay parking pricing per one hour can also be obtained. These are the generality for developing demand model.

During data collection, parking price in study area is free and off street parking price at Hledan center which is located on Hledan road is 500 MM kyats/hr. The parking price in CBD area is 300 MM kyats/hr. So parking price is chosen and grouped into 200, 300 and 500 MM kyats per hour. The data obtained from the survey is arranged into three divided groups: 200 MM kyats per hour, 300 MM kyats per hour, and 500 MM kyats per hour. Then, the data are first entry into excel and input into SPSS software.

4.3.5 Variables in the analysis

The analysis includes dependent variables and independent variables. The dependent variables are park or not park of parking pricing.

The independent variables include five groups. These are income, purpose, frequency, parking duration and origin destination. The study area is located in mixed of land use. This attracts all trips for various purposes. So, purpose is taking place as an important role for this analysis. Moreover, people with various incomes make the trip to the study area. Income is also important as socio data. From the parking user income, parking price range can be determined. Frequency also have an impact on parking demand. How many times of trips to the study area by one person is also considered as variable for the study. Parking duration plays a vital role for parking demand. Parking duration effects the parking price range and average parking duration. Origin destination describe whether the study area is the origin or destination and then which area are attracted by the study area. These variables are coded in SPSS.

The model outputs are shown result and discussions sections.

5. RESULTS AND DISCUSSIONS

5.1 Descriptive Analysis

From the questionnaires survey, the highest percentage of income is medium income at 35% as shown in figure 5.1. Nothing income and low come are not much different at 21% and 23%. Finally, high income is 27% as shown in figure 5.1.

The percentages of the purpose groups are 24%, 19%, 28%, 35% as shown in figure 5.2.

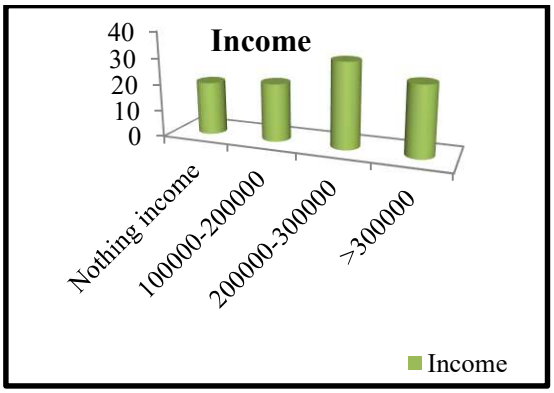


Figure 5.1 Income

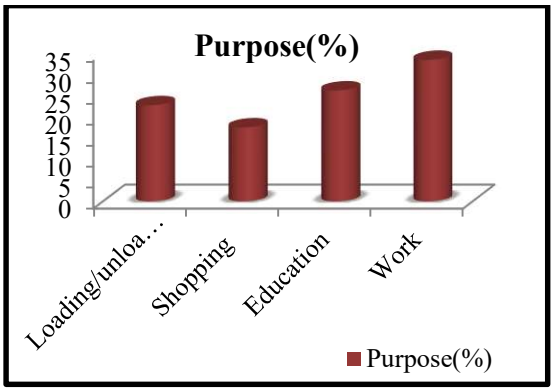


Figure 5.2 Purpose

From the pie chart in figure 5.3, the percentages are also seen in the pie chart. Frequency is required for analysis in the paper.

Parking duration also take places the important role for analysis. The percentages of parking duration which are obtained from questionnaires survey are shown in figure 5.4.

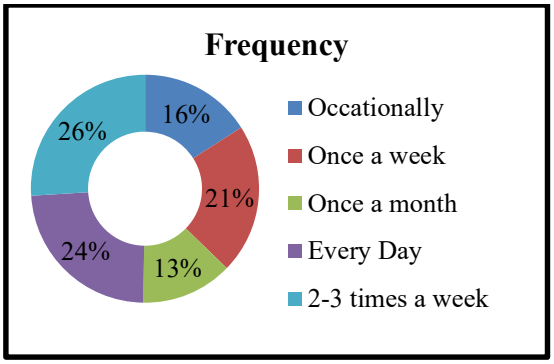


Figure 5.3 Frequency

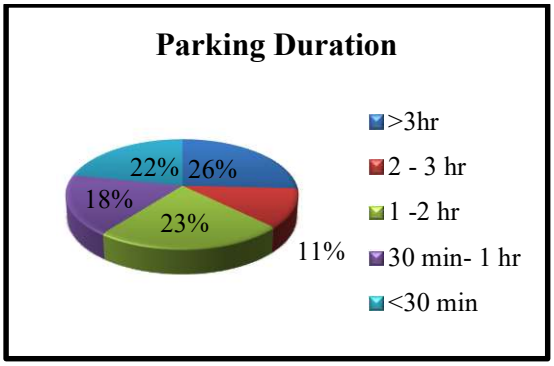


Figure 5.4 Parking Duration

The bar chart in figure 5.5 shows not only origin but also the attraction rate of the study area. The people from both downtown and other come to the study area because it is mixed of land use. The percentage of other origin is greater than downtown.

In figure 5.6, the parking volume in morning peak is 943 vehicles per two hours and in evening is 963 vehicles per two hours. From this, the parking volume of evening peak is higher than that of morning peak.

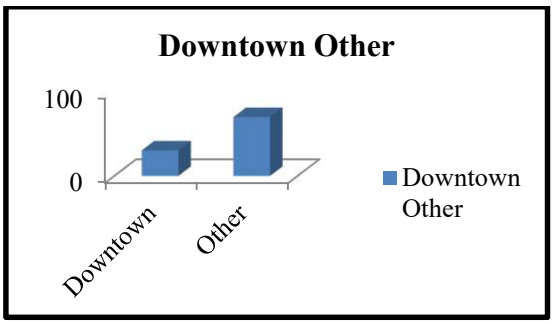


Figure 5.5 Organisation

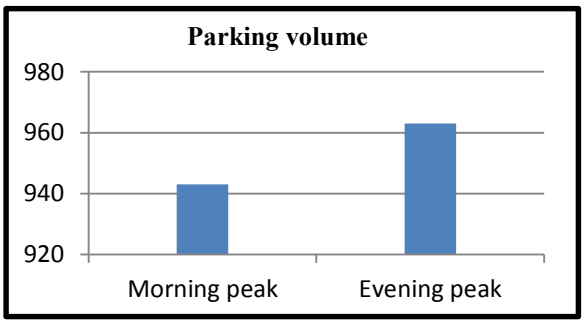
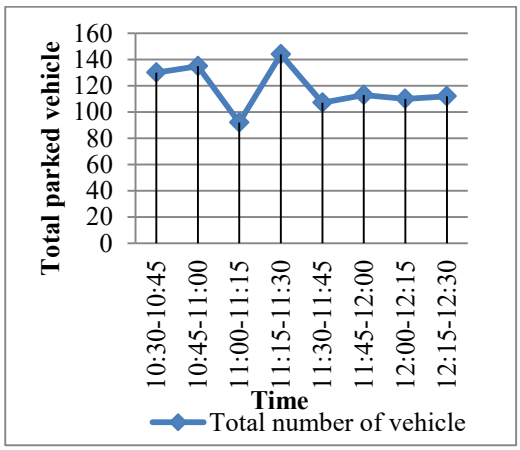


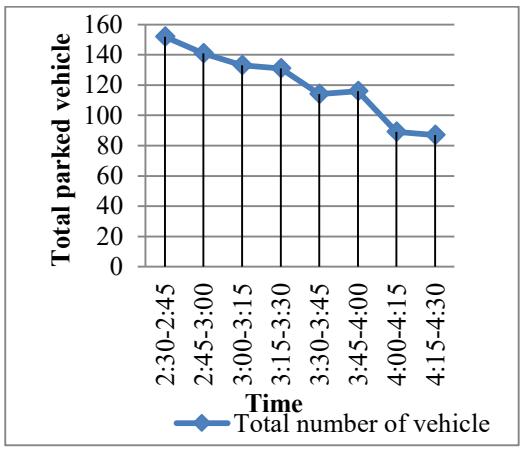
Figure 5.6 Parking Volume

5.2 Demand and Supply Analysis of On street parking

5.2.1 Parking accumulation curve for morning peak and evening peak

Parking accumulation is defined as the total number of vehicles parked at any given time.(Roger P . Roess : Traffic engineering, Fourth edition). This shows the variation of parking accumulation during a day. (Nicholas J. Garber Lester A. Hoel)





$$TR = \frac{N_T}{P_S * T_S}$$

Figure 5.7. Parking Accumulation Curve for morning peak and evening peak

From the curve, parking accumulation is minimum at 92 during 11:00 and 11:15.The maximum is 144 between 11:15 to 11:30. The average accumulation is 118 vehicles (per 15 minutes) shown in figure 5.7.

From the curve in figure 5.7, parking accumulation is maximum at 152 during 2:30 and 2:45.The minimum is 87 between 4:15 to 4:30. The average accumulation is 120 vehicles (per 15 minutes).

5.2.2 On street parking turnover rate

$$TR = \frac{NT}{Ps*Ts} \qquad (1)$$

where TR = parking turnover rate

N_T = total number of parked vehicles observed

P_S = total number of legal parking stall

T_S = duration of the study period

For morning peak in 2 hours period = (943/120) /2= 3.93 vehicles per stall per hr

For evening peak in 2 hours period = (963/120)/2 = 4.02 vehicles per stall per hr

5.2.3 Average parking duration

$$D = \frac{\Sigma_x(N_x*X*I)}{N_T} \qquad (2)$$

Where D = Average parking duration (h/veh)

N_x = Number of vehicles parked for x interval

X = number of interval parked

I = Length of observation interval (hr)

N_T = Total of parked vehicle observed

$D_{Morning}$ = 1.095 h/veh

$D_{evening}$ = 1.02 h/ veh

5.2.4 Parking index and spill over

- ✓ Parking Index = (Total parked vehicle ÷ Parking Capacity) x 100
- ✓ Parking Spillover = Total parked vehicle – No. of space available

Parking Index and Parking Spill over for morning peak

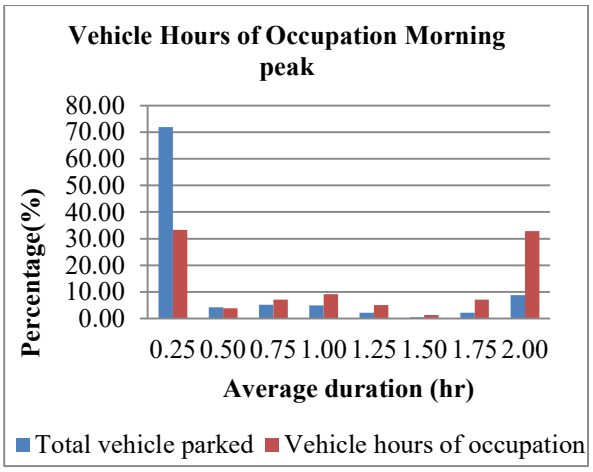
Time	Total parked vehicle	No. of space	Parking Index	Parking Spill over
10:30-10:45	130	120	108.33	10
10:45-11:00	135	120	112.50	15
11:00-11:15	92	120	76.67	0
11:15-11:30	144	120	120.00	24
11:30-11:45	107	120	89.17	0
11:45-12:00	113	120	94.17	0
12:00-12:15	110	120	91.67	0
12:15-12:30	112	120	93.33	0
Average			98.23	

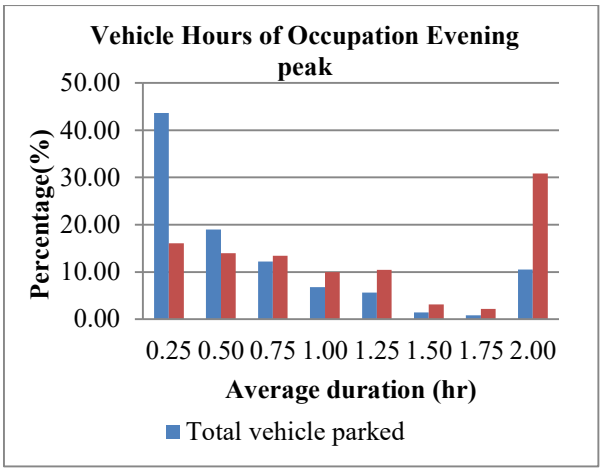
Parking Index and Parking Spill over for evening peak

Time	Total parked vehicle	No. of space	Parking Index	Parking Spill over
2:30-2:45	152	120	126.67	32
2:45-3:00	141	120	117.50	21
3:00-3:15	133	120	110.83	13
3:15-3:30	131	120	109.17	11
3:30-3:45	114	120	95.00	0
3:45-4:00	116	120	96.67	0
4:00-4:15	89	120	74.17	0
4:15-4:30	87	120	72.50	0
Average			100.31	

5.2.5 Vehicle hours of occupation

Maximum amount of vehicle(71.92% morning peak) and (43.63% in evening peak) average duration of parking is 15 minutes. This is because parker come to study area for shopping and loading and unloading passenger. The average vehicle hour of occupation are 0.54 for morning peak and 0.68 for evening peak. It indicates that on an average one vehicle is expected to stay on the parking area 0.54 hour (32minutes)for morning peak and 0.68hour(40minutes) for evening peak





5.2.6 Parking load and parking capacity

- Parking Load
  - For morning peak, Parking load=943 x (15/60) = 235.75veh hr.
  - For morning peak, Parking load=963 x (15/60) = 240.75veh hr.

➢ Parking capacity = 120 x 10 hr. = 1200veh hr

5.3 Demand Model of Parking with Price

Dependent variable and in dependent variables for parking demand model

Y(dependet variable)	=	Parker to defined price
Independent variables		
I_1	=	Income (100000-200000)
I_2	=	Income (200000-300000)
I_3	=	Income (>300000)
P_1	=	Purpose (Shopping)
P_2	=	Purpose (Education)
P_3	=	Purpose (Working)
F_1	=	Frequency (once a week)

Independent variables		
F_2	=	Frequency (once a month)
F_3	=	Frequency (Everyday)
F_4	=	Frequency (2-3 times a week)
PD_1	=	Parking Duration (2-3 hr.)
PD_2	=	Parking Duration (1-2 hr.)
PD_3	=	Parking Duration (30min-1 hr.)
PD_4	=	Parking Duration (<30min)
O_1	=	Origin (Other)

5.3.1 Binary logit model for on street parking demand of 200 MM kyats parking pricing

The enter method of model fitting that consists the entering of all variables at the same step. The results indicate the model chi-square and the significance levels for the test of the null hypothesis that all the coefficients are equal to zero.

The model chi-square value which is obtained from the difference between the null model and the current (full) (chi-square values =125.519), the null hypothesis is rejected since the p-value is less than 0.05 (significance level), implying that the addition of the independent variables improved the predictive power of the model. The block and the step values are equal to the model values because all values were entered at the same time.

Model summary values indicate how good the model fits the data. The -2 Log likelihood (goodness of fit test) value for the model is 199.378. This insinuates that the addition of the variables fitted in the model improved the prediction power of the model.

Cox & Snell R Square and Nagelkerke R Square values, which are both methods of calculating the explained variation. These values are sometimes mentioned as pseudo R square values (and will have lower values than in multiple regressions). However, they are explained in the same manner, but with more caution. Therefore, the explained variation in the independent variables based on model is ranging from 34.4% to 51.8% , depending on Cox & Snell R Square and Nagelkerke R Square methods, respectively, Nagelkerke R Square is a modification of Cox & Snell R Square , the latter of which cannot achieve a value of 1. For this reason, it is preferable to report the Nagelkerke R Square value.

The Hosmer-Lemeshow test explores whether the predicted probabilities are the same as the observed probabilities. An overall goodness of fit of the model is specified by p-values > 0.05. This model produced a significant obtaining from difference between the observed and predicted probabilities indicating a good model fit in this result.

A classification table which shows how well the model predicts cases to the two dependent variable categories. This produces the overall percentage of cases that are correctly predicted by the full model. In this study, the proportion of the correctly classified not park for parking pricing was 52.9% and the proportion of the correctly classified park for parking pricing was 93%. The overall percentage correct classification was 83.6%.

Table 5.1. The maximum likelihood estimates of the Binary Logit Model

Parking Price 200 MM kyats/hr	B	S.E.	Wald	df	Sig.	Exp(B)
Low Income	1.553	0.567	7.494	1	0.006	4.727
Medium Income	1.051	0.507	4.291	1	0.038	2.861
High Income	3.251	0.822	15.659	1	0	25.821
Purpose_Shopping	1.475	0.628	5.512	1	0.019	4.369
Purpose_Education	1.572	0.487	10.436	1	0.001	4.816
Purpose_Working	2.173	0.628	11.95	1	0.001	8.781
Frequency_Once a month	1.528	0.744	4.222	1	0.04	4.608
Frequency_Once a week	2.684	0.628	18.291	1	0	14.649
Frequency_Everyday	2.803	0.596	22.122	1	0	16.489
Frequency_2-3times a week	2.366	0.628	14.206	1	0	10.656
Parking duration_2-3hrs	1.29	0.607	4.509	1	0.034	3.632
Parking duration_1-2 hr	2.431	0.601	16.339	1	0	11.366
Parking duration_30min-1hr	1.764	0.736	14.083	1	0	15.858
Parking duration_<30min	2.608	0.607	18.475	1	0	13.57
Orgin_Other	1.855	0.874	4.503	1	0.034	6.39
Constant	-5.201	0.885	34.513	1	0	0.006

$$Y_{\text{parker to 200 MM kyat/hr.}} = -5.201+1.553I_1+1.051I_2+3.251I_3+1.475P_1+1.572P_2+2.173P_3+1.528F_1+2.684F_2+2.803F_3+2.366F_4+1.290PD_1+2.431PD_2+2.764PD_3+2.608PD_4+1.855O$$

(a) Monthly income

The signs of all monthly income are positive indicating that holding other variable constant as the income increases the preference of higher relative to 200 kyats parking pricing per hour increase by 1.553, 1.051 and 3.251. The Wald test statistics for the predictor cost are 7.494, 4.291 and 15.659with associated p-values of 0.006, 0.038 and 0.000, which are less than 0.05, therefore the regression coefficients for all income have found to be statistically significant.

(b) Purpose of trip

The regression coefficients for all-purpose have found to be statistically significant because their p-values of0.019, 0.001 and 0.001 which are less than 0.05. The Wald test statistics for the predictor cost are 5.512, 10.436 and 11.950. All purpose of trip are positive indicating that purposes of trips are likely to prefer higher relative to 200 kyats parking pricing per hour by 1.475, 1.572and 2.173.

(c) Frequency

All frequency include in dependent variables for analysis are positive indicating that frequencies are likely to prefer higher relative to 200 kyats parking pricing per hour by 1.528,2.684,2.803 and 2.366. The Wald test statistics for the predictor cost are 4.222,18.291,22.122 and 14.206 with associated p-values of 0.010,0.000,0.000 and 0.000,

which are less than 0.05, therefore the regression coefficients for travel cost have found to be statistically significant.

(d) Parking duration

The signs of all parking duration groups are positive indicating that holding other variable constant as the income increases the preference of higher relative to 200 kyats parking pricing per hour increase by 1.290,2.431,1.764 and 2.608. The Wald test statistics for the predictor cost are 4.509,16.339,14.083 and 18.475 with associated p-values of 0.034,0.000,0.000 and 0.000, which are less than 0.05, therefore the regression coefficients for travel cost have found to be statistically significant.

(e) Origination

Origination is negative indicating that frequencies are likely to prefer higher relative to 200 kyats parking pricing per hour by 1.855 units while holding all other variables in the model. The Wald test statistic for the predictor cost is 4.503. And p-value of 0.034, which is less than 0.05, therefore the regression coefficient for motorcycle ownership has found to be statistically significant.

Verification for Free Parking Pricing User to Parking Users paying 200 Kyats Parking Pricing per hour

In this study, there are monthly income(high income), purpose(working), frequency(everyday),Parking duration (between 2 and 3hrs), Parking duration (above 5hrs), originations (other townships except downtown townships) are defined as 1 and others are 0 to calculate verification. These variables are the most in questionnaire result.

$$Y_{\text{parker in 200 kyats parking price}} = -5.201+1.553(0)+1.051(0)+3.251(1)+1.475(0)+1.572(0)+2.173(1)+1.528(0)+2.684(0)+2.803(1)+2.366(0)+1.290(1)+2.431(0)+2.764(0)+2.608(0)+1.855(1) = 6.351$$

$$\text{Probability}_{\text{parker in 200 kyats parking price}} = \frac{e^{6.351}}{1+e^{6.351}} = 0.9982 \approx 99.82\%$$

According from the equation, parking users wanted to pay 200 kyats parking pricing per one hour are 99.82%. In this model, most of parking users accept the 200 kyats parking pricing management strategy.

5.3.2 Binary logit model for on street parking demand of 300 MM kyats parking pricing

The enter method of model fitting that consists the entering of all variables at the same step. The results indicate the model chi-square and the significance levels for the test of the null hypothesis that all the coefficients are equal to zero.

The model chi-square value which is obtained from the difference between the null model and the current (full) (chi-square values =148.044), the null hypothesis is rejected since the p-value is less than 0.05 (significance level), implying that the addition of the independent variables improved the predictive power of the model. The block and the step values are equal to the model values because all values were entered at the same time.

Model summary values indicate how good the model fits the data. The -2 Log likelihood (goodness of fit test) value for the model is 220.169. This insinuates that the addition of the variables fitted in the model improved the prediction power of the model.

Cox & Snell R Square and Nagelkerke R Square values, which are both methods of calculating the explained variation. These values are sometimes mentioned as pseudo R square values (and will have lower values than in multiple regressions). However, they are

explained in the same manner, but with more caution. Therefore, the explained variation in the independent variables based on model is ranging from 42.7% to 56.9% , depending on Cox & Snell R Square and Nagelkerke R Square methods, respectively, Nagelkerke R Square is a modification of Cox & Snell R Square , the latter of which cannot achieve a value of 1. For this reason, it is preferable to report the Nagelkerke R Square value.

The Hosmer-Lemeshow test explores whether the predicted probabilities are the same as the observed probabilities. An overall goodness of fit of the model is specified by p-values > 0.05. This model produced a significant obtaining from difference between the observed and predicted probabilities indicating a good model fit in this result.

A classification table which indicates how well the model predicts cases to the two dependent variable categories. This gives the overall percentage of cases that are correctly predicted by the full model. In this study, the proportion of the correctly classified not park for parking pricing was 81.3% and the proportion of the correctly classified park for parking pricing was 84.3%. The overall percentage correct classification was 82.7%.

Table 5.2 The maximum likelihood estimates of the Binary Logit Model

Parking Price 300 MM kyats/hr	B	S.E.	Wald	df	Sig.	Exp(B)
Low Income	2.27	0.619	13.462	1	0	9.68
Medium Income	1.76	0.592	8.828	1	0.003	5.811
High Income	2.676	0.643	17.34	1	0	14.525
Purpose_Shopping	3.606	0.759	22.604	1	0	36.828
Purpose_Education	2.156	0.642	11.267	1	0.001	8.633
Purpose_Working	2.29	0.635	13.011	1	0	9.876
Frequency_Once a month	2.893	0.737	15.405	1	0	18.041
Frequency_Once a week	3.393	0.846	16.097	1	0	29.764
Frequency_Everyday	2.238	0.777	8.29	1	0.004	9.377
Frequency_2-3times a week	1.909	0.736	6.729	1	0.009	6.75
Parking duration_2-3hrs	1.36	0.626	4.727	1	0.03	3.897
Parking duration_1-2 hr	2.653	0.541	24.062	1	0	14.196
Parking duration_30min-1hr	2.688	0.638	17.753	1	0	14.703
Parking duration_<30min	2.999	0.576	27.127	1	0	20.056
Orgin_Other	0.899	0.389	5.347	1	0.021	2.457
Constant	-8.859	1.182	56.215	1	0	0

$$Y_{\text{parker to 300 MM kyat/hr.}} = -8.859+2.27I_1+1.76I_2+2.676I_3+3.606P_1+2.156P_2+2.29P_3+2.893F_1+3.393F_2+2.238F_3+1.909F_4+1.36PD_1+2.653PD_2+2.688PD_3+2.2.999PD_4+0.899O$$

(a) Monthly income

The signs of all monthly income are positive indicating that holding other variable constant as the income increases the preference of higher relative to 300 kyats parking pricing per hour increase by 2.27, 1.76 and 2.676. The Wald test statistics for the predictor cost are 13.462, 8.828 and 17.34 with associated p-values of 0.000, 0.003 and 0.000, which are less than 0.05; therefore, the regression coefficients for all income have found to be statistically significant.

(b) Purpose of trip

The regression coefficients for all-purpose have found to be statistically significant because their p-values of0.000, 0.000 and 0.001 which are less than 0.05. The Wald test statistics for the predictor cost are 22.604, 11.267and 13.011. All purpose of trip are positive indicating that purposes of trips are likely to prefer higher relative to 300 kyats parking pricing per hour by 3.606, 2.156 and 2.29.

(c) Frequency

All frequency include in dependent variables for analysis are positive indicating that frequencies are likely to prefer higher relative to 300 kyats parking pricing per hour by 2.893, 3.393, 2.238 and 1.909. The Wald test statistics for the predictor cost are 15.405, 16.097, 8.29, 6.729 and 8.319 with associated p-values of 0.000, 0.000, 0.004 and 0.009, which are less than 0.05, therefore the regression coefficients for travel cost have found to be statistically significant.

(d) Parking duration

The signs of all parking duration groups are positive indicating that holding other variable constant as the income increases the preference of higher relative to 300 kyats parking pricing per hour increase by 1.36, 2.653, 2.688 and 2.999. The Wald test statistics for the predictor cost are 4.727, 24.062, 17.753 and 27.127 with associated p-values of 0.030, 0.000, 0.000 and 0.000, which are less than 0.05, therefore the regression coefficients for travel cost have found to be statistically significant.

(e) Origination

The signs of orgin positive indicating that holding other variable constant as the income increases the preference of higher relative to 300 kyats parking pricing per hour increase by 0.899 .The Wald test statistic for the predictor cost is 5.347. In addition, p-value of 0.021, which is less than 0.05, therefore the regression coefficient for motorcycle ownership has found to be statistically significant.

Verification for Free Parking Pricing User to Parking Users paying 300 Kyats Parking Pricing per hour

In this study, These variables used in above equation are the most in questionnaire result.

$$Y_{\text{parker in 300 kyats parking price}} = -8.859+2.27(0) + 1.76(0) + 2.676(1) + 3.606(0) + 2.156(0) + 2.290(1) + 2.893(0) + 3.393(0) + 2.238(1) + 1.909(0) + 1.36(0) + 2.653(0) + 2.688(0) + 2.999(0) + 0.899(1)$$

$$= 0.604$$

$$\text{Probability}_{\text{parker in 300 kyats parking price}} = \frac{e^{0.604}}{1+e^{0.604}} = 0.647 \approx 64.7\%$$

According from the equation, parking users wanted to pay 300 kyats parking pricing per one hour are 64.7%. In this model, most of parking users accept the 300 kyats parking pricing management strategy.

5.3.3 Binary logit model for on street parking demand of 500 MM kyats parking pricing

The enter method of model fitting that consists the entering of all variables at the same step. The results indicate the model chi-square and the significance levels for the test of the null hypothesis that all the coefficients are equal to zero.

The model chi-square value which is obtained from the difference between the null model and the current (full) (chi-square values =126.196), the null hypothesis is rejected since the p-value is less than 0.05 (significance level), implying that the addition of the independent variables improved the predictive power of the model. The block and the step values are equal to the model values because all values were entered at the same time.

Model summary values indicate how good the model fits the data. The -2 Log likelihood (goodness of fit test) value for the model is 146.418. This insinuates that the addition of the variables fitted in the model improved the prediction power of the model.

Cox & Snell R Square and Nagelkerke R Square values, which are both methods of calculating the explained variation. These values are sometimes mentioned as pseudo R square values (and will have lower values than in multiple regressions). However, they are explained in the same manner, but with more caution. Therefore, the explained variation in the independent variables based on model is ranging from 43.2% to 61.3% , depending on Cox & Snell R Square and Nagelkerke R Square methods, respectively, Nagelkerke R Square is a modification of Cox & Snell R Square , the latter of which cannot achieve a value of 1. For this reason, it is preferable to report the Nagelkerke R Square value.

The Hosmer-Lemeshow test from in Table 5.13 explores whether the predicted probabilities are the same as the observed probabilities. An overall goodness of fit of the model is specified by p-values > 0.05. This model produced a significant obtaining from difference between the observed and predicted probabilities indicating a good model fit in this result.

A classification table which indicates how well the model predicts cases to the two dependent variable categories displayed in Table 5.14. This gives the overall percentage of cases that are correctly predicted by the full model. In this study, the proportion of the correctly classified ‘not park for parking pricing was 95.5% and the proportion of the correctly classified park for parking pricing was 70.1%. The overall percentage correct classification was 87.9%.

Table 5.3 The maximum likelihood estimates of the Binary Logit Model

Parking Price 500 MM kyats/hr	B	S.E.	Wald	df	Sig.	Exp(B)
Low Income	3.122	0.824	14.358	1	0	22.683
Medium Income	3.432	0.878	15.272	1	0	30.947
High Income	4.399	0.883	24.811	1	0	81.4
Purpose_Shopping	2.646	0.864	9.371	1	0.002	14.098
Purpose_Education	3.006	0.789	14.509	1	0	20.207
Purpose_Working	2.918	0.785	13.816	1	0	18.496
Frequency_Once a month	3.268	0.887	13.578	1	0	26.263
Frequency_Once a week	3.213	0.928	11.987	1	0.001	24.852
Frequency_Everyday	1.775	0.79	5.048	1	0.025	5.9
Frequency_2-3times a week	1.923	0.76	6.404	1	0.011	6.844
Parking duration_2-3hrs	-1.793	0.853	4.412	1	0.036	0.167
Parking duration_1-2 hr	1.542	0.703	4.815	1	0.028	4.672
Parking duration_30min-1hr	1.737	0.776	5.011	1	0.025	5.679
Parking duration_<30min	2.276	0.71	10.281	1	0.001	9.738
Orgin_Other	1.317	0.511	6.635	1	0.01	3.732
Constant	-9.833	1.531	41.272	1	0	0

$$Y_{\text{parker to 500 MM kyat/hr.}} = -9.833+3.122I_1+3.432I_2+4.399I_3+2.646P_1+3.006P_2+2.918P_3+ 3.268F_1+3.213F_2+1.775F_3+1.923F_4-1.793PD_1+1.542PD_2+ 1.737PD_3+ 2.276PD_4+1.317O$$

(a) Monthly income

The income divides into three groups as low, medium and high income. The signs of all monthly income are positive indicating that holding other variable constant as the income increases the preference of higher relative to 500 kyats parking pricing per hour increase by 3.122, 3.432 and 4.399. The Wald test statistics for the predictor cost 14.358, 15.272 and 24.811 with associated p-values of 0.000, 0.000 and 0.000, which are less than 0.05, therefore the regression coefficients for all income have found to be statistically significant.

(b) Purpose of trip

Purpose of tripe includes shopping purpose, education purpose and working purpose. The regression coefficients for all-purpose have found to be statistically significant because their p-values of 0.002, 0.000 and 0.000 which are less than 0.05. The Wald test statistics for the predictor cost are 9.371, 14.509 and 13.816. All purpose of trip are positive indicating that purposes of trips are likely to prefer higher relative to 500 kyats parking pricing per hour by 2.646, 3.006 and 2.918.

(c) Frequency

All frequency include in dependent variables for analysis are positive indicating that frequencies are likely to prefer higher relative to 500 kyats parking pricing per hour by 3.243, 2.084, 2.045 and 2.472. The Wald test statistics for the predictor cost are 13.37, 13.094, 6.493 and 6.312 with associated p-values of 0.000, 0.000, 0.011, and 0.012, which are less than

0.05; therefore, the regression coefficients for travel cost have found to be statistically significant.

(d) Parking duration

The signs of three parking duration groups are positive indicating that holding other variable constant as the income increases the preference of higher relative to 500 kyats parking pricing per hour increase by 1.542, 1.737 and 2.276. The Wald test statistics for the predictor cost are 4.815, 5.011 and 10.281 with associated p-values of 0.028, 0.025, and 0.001 that are less than 0.05; therefore, the regression coefficients for travel cost have found to be statistically significant.

Parking duration of 2 hour to 3 hour is negative indicating that frequencies are less likely to prefer higher relative to 500 kyats parking pricing per hour by 1.793 units while holding all other variables in the model. The Wald test statistic for the predictor cost is 4.412. In addition, p-value of 0.036, which is less than 0.05, therefore the regression coefficient for motorcycle ownership has found to be statistically significant.

(e) Origination

The signs of orgin positive indicating that holding other variable constant as the income increases the preference of higher relative to 500 kyats parking pricing per hour increase by 1.317 .The Wald test statistic for the predictor cost is 6.635. In addition, p-value of 0.01, which is less than 0.05, therefore the regression coefficient for motorcycle ownership has found to be statistically significant.

Verification for Free Parking Pricing User to Parking Users paying 500 Kyats Parking Pricing per hour

In this study, These variables used in above equation are the most in questionnaire result.

$$Y_{\text{parker in 500 kyats parking price}} = -9.833 + 3.122(0) + 3.432(0) + 4.399(1) + 2.646(0) + 3.006(0) + 2.918(1) + 3.268(0) + 3.213(0) + 1.775(1) + 1.923(0) - 1.793(1) + 1.542(0) + 1.737(0) + 2.276(0) + 1.317(1)$$

$$= -1.217$$

$$\text{Probability}_{\text{parker in 500 kyats parking price}} = \frac{e^{-1.217}}{1+e^{-1.217}} = 0.2289 \approx 22.89\%$$

According from the equation, parking users wanted to pay 500 kyats parking pricing per one hour are 22.89%. In this model, most of parking users accept the 500 kyats parking pricing management strategy.

6. CONCLUSION

Parking demand model is very necessary for parking management system. Parking demand management is an important issue. This paper identified demand and supply analysis of on street parking and develops parking demand based on parking price per hour. Existing parking condition is analysed by descriptive analysis and parking equations in the first section. Demand supply analysis include parking volume, parking accumulation, parking turnover rate, average-parking duration, parking index and spill over, vehicle hour of occupation, parking load and parking capacity. Demand supply analysis is carried out by using in-out survey. This survey is carried out by two hrs. duration for morning peak and evening peak.

Parking volume shows the number of existing parked car. From the study parking volume of evening peak is higher than that of morning peak. Parking accumulation curve is obtained by plotting the number of bays occupied with respect to study time. The average accumulation curve indicates that in every 15 minutes 118 vehicles during morning peak and 120 vehicles in evening peak are expected to present as the parking demand. Parking index indicates that parking pressure will be tough to handle if the parking volume is increased. Parking spillover has been calculated to find out the deficiency in the existing parking provision in any certain time period. From parking index and spillover table, it can be seen that parking bays are utilized most efficiently during peak period (11:00-11:15AM, 11:30AM-12:30PM and 3:30-4:30PM). The turn over figure indicates that available parking spaces will be used quite efficiently. It indicates that every space is used by 3.93 vehicles in morning peak period and 4.02 vehicles in evening peak period. From the calculation of vehicle hour of occupation, which time duration parking occurs most can be determined which is an important decision for parking planning. These all calculations indicate existing parking condition.

And the number of vehicles are increasing because the world getting modernized and mechanized. Providing parking spaces in the working hour and in the free hour for all vehicles is a tough job. Various parking management system such as restriction, pricing, fixation of time duration etc. are practiced to minimize this problem.

The various parking demand models are developed by various methods. Wong et al. generated a simple model in which only land use factor is considered to estimate the forecasted parking demand of Hong Kong city. Saptrashi et al. produced on street parking demand model using three parameters viz. the average number of 4-wheelers owned, average duration (in hour) , and mode choice. In earlier study, Priyanka Kolhar has developed on street parking demand model by linear regression analysis, Sa (1987) used regression techniques and concluded that regression techniques outperform traditional time series models or historical averages and McGill (1995) developed a multivariate multiple regression to test the correlation in multiple booking classes.

In the study, the parking price in study area is free. The study aimed to determine parking price for removing some over parking cars. The earlier studies use regression model because of the parking price of their study area has been determined. In the study, parking demand model is developed by two dependent variables; park or not park of parking pricing. Therefore, the parking demand model based on parking pricing is developed by binary logistic regression in SPSS software.

The existing condition is facing the problem of shortage of parking place because of free parking. The study shows that the determination of parking can reduce the usage of parking in above model in terms of percentage. The parking demand rate based on parking pricing is calculated by using the model. In this paper parking price per hour is grouped into three: 200,300 and 500 MM kyats. Parking demand rate for 200 MM kyats is 99.82 %, 300 MM kyats is 64.7% and 500MM kyats is 22.89%.

These models can be easily applied for mixed land use area. Therefore, it is an effective solution to make decision for implementing on street parking. These data are very helpful in the prediction of parking demand condition. The study hopes that this study will help to improve parking demand management system for Yangon City traffic planning and to predict future parking demand condition.

As for further studies, other parking management system such as fixation of time duration, determining parking angle and so on are also can be carried out. Furthermore, cost benefit analysis for implemented on street parking can be carried out.

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