PEAK PARKING DEMAND ESTIMATION CASE STUDY OF HOTELS IN KANO METROPOLIS

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ABSTRACT

The estimation of parking demand expected at a hotel was the focus of the study. A twelve-hour parking habit survey was carried out at the premises of twenty hotels in Kano metropolis. Relevant inventories of facilities were also taken at each hotel. Analysis of results showed that a linear relationship exists between peak parking demand, total area covered and the total number of rooms in the hotel. Regression models indicated peak parking demand values of 2.54, 6.43 and 4.22 vehicles per room for hotels located at the central business district, at the periphery of the central business districts, outside the central business district respectively. The peak parking demand values of 8.693, 10.693 and 11.593 vehicles per total area of land covered by hotel were generated by hotels located at the central business district, periphery of the central business district, and outside the central business district respectively. Models developed from the study, can be used to determine the parking requirements of hotels if the total area to be covered by hotels or total number of rooms are known.

Introduction:

Hotels provide recreational, catering services, halls for seminars and conferences and accommodation for their patrons. The importance of providing adequate parking facilities at hotel premises can hardly be overemphasized, since inadequacy of parking at such locations can quite easily degenerate into vehicles being parked on adjoining streets and neighbouring properties.

The demand for parking at a given hotel is strongly influenced by its facilities, level of services, and the location of the hotel, with respect

to its proximity to the Central Business District (CBD).

Kano, the focus of this study is the capital of Kano State of Nigeria, which from ancient time, has been known for its commercial activities. This status has equally necessitated the presence of reasonable number of hotels located within, at the periphery and at the outskirts of the CBD.

The presence of hotels in Kano has also increased parking problems associated with most urban centers, as hotels with inadequate and no parking facilities will induce their patrons to park on adjacent street thereby aggravating the problem associated with on street parking.

It is desirable to ensure that adequate parking facilities are provided at hotel premises, so that patrons of such hotels can park conveniently and without aggravating problems of on-street parking. This desire has prompted this research, which is aimed at generating mathematical models that can be used for estimating parking demand for hotels.

Literature Review

Pignataro (1973) described parking as a major urban land use, and that any one who drives a car needs no introduction to the difficulties of finding a parking space in areas which are intensively used for business, commercial and residential purposes. The parking problem becomes more pronounced as the size of the city increases, which gives rise to increase in population and increase in number/ownership of cars.

The importance of parking, according to Brierley (1962) can hardly be over-estimated. There are 8,760 hours in a year, if it assumed that the average distance covered per year per car is 16,000 km (10,000 miles) and the average speed is 40 km (25 miles) per hour, the total traveling time will be 400 hours. This leaves 8,360 hours per year when the car is parked.

Recognizing the importance of parking, Abbett (1956) recommended the use of on-street parking, supplemented where feasible by the development of off-street facilities, to solve parking problem. Kadiyali (1983) referred to on-street parking or curb parking facilities as parking provisions made on the streets with vehicles parking parallel, at angles of 30^{o}, 45^{o}, 60^{o} and at right angle to the curb.

According to the Dhaka Transport Coordination Board (DTCB, 2005) Street capacity reduction, accidents, fire hazards and increased travel time are problems associated with on-street

parking. The use of off-street parking facilities can eradicate parking problem, Brierley (1962) O'Flaherty (1988) and Seely (1992) classified such facilities as surface car parks or garages, multi-storey car parks, roof parks, mechanical car parks, and peripheral car parks.

In solving parking problems using off-street facilities, there is need for proper projection of the parking demand expected to be generated at any given location. This work is aimed at developing models that can be used to determine peak parking demand by relating peak parking demands to some features of the hotels.

Materials and Method

Parking habit survey was carried out at the premises of carefully selected twenty (20) tall and large buildings used as hotels in Kano metropolis. Hotels with less than twenty (20) rooms were not selected for the study since reconnaissance survey showed that parking generated by such hotels was insignificant. Locations spanned by the study included central business district (CBD), periphery of the central business district (PCBD) and areas outside the central business district (OCBBD).

The parking habit survey entailed a twelve (12) hour continuous monitoring with periodic scanning spaced at intervals of thirty minutes (30) minutes of vehicles that are parked at the hotel premises, and those that parked at other positions, but with the hotel serving as their occupants destination. The count spanned from 8.00 am to 8.00 pm each day for two weeks. Table 1, summarizes the inventory of relevant data taken at each hotel.

Results and Mathematical Modelling.

Peak parking demand value was taken as the maximum number of vehicles parked at any hotel premises within the thirty minutes duration, during the twelve hours parking habit survey for two weeks.

In the analysis of data, dummy variables X_1 and X_2 were used to account for the different locations of the hotels. In using the dummy variables a scheme wherein $(X_1, X_2) = (1,0)$ for CBD hotels, $(X_1, X_2) = (0,1)$ for PCBD hotels and $(X_1, X_2) = (0,0)$ for OCBD hotels was adopted. The use of extra sum of squares principles (Adebisi, 1981, and Draper and Smith (1981) justified the inclusion of dummy variables as it made the models more statically significant.

Multiple linear regressions incorporating the stepwise method of analysis was used in model formulation, with the aid of Statistical Package for Social Sciences (SPSS/PC$^+$) computer programme.

Models were developed and subjected to standard statistical tests, to determine their level of significance. Table 2, summarizes the models which were developed. More on the mathematical aspect of the analysis can be obtained from Milton and Arnold (1990), Lucey (1991).

Mathematical Modelling and Discussion of Results

In the mathematical modelling for peak parking demand, the total number of rooms and total area covered by the hotels were used because the two properties can easily be determined for a new hotel to be built, and on existing ones, using their building plans. Besides, the two parameter showed high correlations with the peak parking demand. Table 2 gives the summary of results obtained.

Model No. 1 from Table 2 is:

$PPD = 4.02 - 1.68X_1 + 2.22X_2 + 0.20TNR$ ..... (1)

PPD = peak parking demand; (X_1X_2) = dummy variables previously explained; TNR = Total number of rooms.

The model describes the relationship between the peak parking demand and the total number of rooms in the hotels studied and it indicates that the peak parking demand generated by hotels per room is approximately 0.20 irrespective of the location of the hotel. This, however, is in addition to the constant values of 6.24, 4.02 and 2.34 vehicles for PCBD, OCBD and CBD hotels respectively. These values can be viewed as the minimum peak parking demand values that will be generated by hotel staff vehicles and service vehicles. These values also depict the peak parking demand values that would be generated even in hypothetical situations when no patrons are served.

The model clearly indicates that the peak parking demand of hotels within the PCBD is higher than those located within the CBD and OCBD, while those hotels at the OCBD also generate higher parking than those at the CBD. The trend is normal as those traveling to the CBD are more likely to use public transport. Based on the findings, the results for the PCBD been selected as the basis for recommending parking supply standards for hotels in Kano metropolis. The results for the PCBD is derived from equation (1) by incorporating the appropriate values for X_1 and X_2 as in equation 2

$PPD = 6.23 + 0.20TNR$ ..... (2)

Similarly, Model Number 2 in Table 2 is :

$PPD=11.59-2.90X_1-0.90X_2+0.0033TAC$.....(3)

Where:

PPD = Peak Parking Demand; X_1, X_2 = Dummy Variables

TAC = Total area covered by hotel (m^2)

This model describes the relationship between the peak parking demand generated at a hotel and the total area covered by the hotel. In the determination of peak parking demand by using total area covered by hotels. OCBD model is recommended for use, as it gives the highest parking demand of all the other locations. The model is as shown in equation 4,i.e.

$$PPD = 11.59 + 0.003TAC \quad \ldots\ldots (4)$$

In terms of statistical validity, both equations 2 and 4 are statistically significant. Which model is adopted is a matter of convenience but it would appear that the model in equation 2 is slightly more liable and is even likely to be of wider applications in other cities besides Kano. Equation 4 is likely to be specific for Kano and be inapplicable to cities where the hotels have Floor Area Ratios that are very different from Kano's. For the specific case of Kano, it is recommended that either model can be applied.

The results obtained appear to confirm that some standard on the number of parking stalls to be provided at a hotel may actually be in existence, otherwise, a wider scatter should have been observed. Nonetheless, it is clear that a standard needs to be introduced and enforced. Another study will examine this aspect in detail and make specific recommendations.

CONCLUSION AND RECOMMENDATIONS:

From the result of the study carried out the following conclusions can be drawn:

(1). Peak parking demand can be estimated, if the total number of rooms in a proposed hotel is known. Peak parking demand per room of 0.20 in addition to 6.23 vehicles was recommended for use irrespective of hotel location.

(2). Peak parking demand can equally be determined if the total area covered by a hotel is known, peak parking demand per total area covered by hotel in metres of 0.0033 in addition to 11.59 vehicles, irrespective of hotel location was recommended for use.

(3). In estimating peak parking demand for old/ new hotels, the highest peak parking demand value obtained from the use of models relating peak parking demand to total area covered and that to total number of rooms in the hotel was recommended for used.

On the basis of findings from this study the use of models specified for the determination of peak parking demand and number of parking stalls for

new and old hotels in Kano metropolis have been recommended.

The outcome of this research is very vital in the formulation of standard and parking policies for hotels in Nigeria. Therefore, similar studies should be undertaken for other cities in Nigeria and for other major parking generators, so that comprehensive standard specifications and design charts that can be used for the provision of parking facilities for different land use can be fashioned out for the country.

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TABLE 1: VEHICLE PARKING FEATURES AND RELEVANT INVENTORY TAKEN AT THE DIFFERENT HOTELS

S/NO	NAME OF HOTELS	LOCATION	TOTAL NUMBER OF ROOMS	NUMBER OF DOUBLE ROOMS	NUMBER OF SINGLE ROOMS	NO. OF CONFERENCE HALLS	TOTAL AREA COVERED BY HOTEL (m2)	TOTAL AREA OF LAND COVERED (m^2)	AREA COVERED BY FLOOR (m^2)/STOREY	NO. OF FLOORS (STOREY)	NUMBER OF VEHICLES PARKED ON STREET	NO. OF PARKING STALLS	PEAK PARKING DEMAND (VEHICLES)	SIZE OF PARKING STALL (m^2)
1	Hotel-De-Mikela	CBD	100	75	25	-	1,910	710	600	2	-	20	15	2.4 x 4.90
2	Mbass Hotel	CBD	62	12	50	-	646	200	446	2	8	8	16	2.4 x 5.0
3	De friendship motel	CBD	58	18	40	1	702	108	297	2	2	12	14	2.5 x 5.0
4	International Hotel	CBD	56	48	8	1	820	274	273	2	3	10	13	2.4 x 4.95
5	Ehsons Hotel	CBD	38	28	10	-	540	180	180	2	5	4	9	2.4 x 4.90
6	Criss Park Hotel	CBD	38	29	9	1	740	380	360	2	-	12	11	2.5 x 5.0
7	Sky World Hotel	CBD	36	26	10	1	594	198	198	2	10	-	10	-
8	People's Resort Hotel	CBD	35	23	12	1	584	325	259	2	4	8	12	2.5 x 4.9
9	K. F. C. Hotel	CBD	35	25	10	-	440	180	130	2	4	5	9	2.5 x 4.9
10	Motel-La-Mirrage	CBD	30	21	9	-	692	389	240	2	4	12	16	2.5 x 5.0
11	Fresh Lily Hotel	CBD	28	10	18	-	526	176	176	2	7	-	7	-
12	King's Hotel	CBD	26	12	14	-	510	170	170	2	6	-	6	-
13	Tower Hotel	PCBD	23	4	19	2	486	162	162	2	-	6	5	2.5 x 4.95
14	Royal Tropicana Hotel	PCBD	200	106	94	3	12,775	4,455	2,080	5	-	80	50	2.5 x 5.0
15	Akija Hotel	PCBD	93	80	13	1	2,888	1,216	836	2	-	36	23	2.5 x 5.0
16	Gab Hotel	PCBD	80	37	43	1	2,872	1,352	760	3	-	25	20	2.5 x 5.0
17	Duala Hotel	OCBD	200	184	16	3	9,000	9,000	-	-	-	64	44	2.5 x 5.0
18	Kano Residential Hotel	OCBD	70	56	14	1	800	236	282	2	-	20	17	2.5 x 5.0
19	Prince Hotel	OCBD	36	23	13	2	700	330	370	2	-	15	12	2.5 x 5.2
20	Tahir Guest Inn	OCBD	30	22	8	1	650	350	300	2	-	15	10	2.5 x 5.0

CBD = Central Business District; OCBD = Outside Central Business District, PCBD = Periphery of Central Business District

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TABLE 2: MODELS DEVELOPED FROM DATA ANALYSIS AND THEIR STATISTICS

MODEL NO		MODEL WITHOUT DUMMY VARIABLES	S^2 = SS/DEGREE OF FREEDOM	MODEL WITH DUMMY VARIABLES	R^2	S_e	$\overline{PPD}$	$S/\overline{PPD}$	EXTRA SUM OF SQUARES OF RESIDUAL AFTER INTRODUCTION OF DUMMY VARIABLES.	S_e^2 EXTRA SUM OF SQUARES	$S^2 - S_e^2$	REMARKS
	REGRESSION OF PEAK PARKING DEMAND (PPD) ON THE FOLLOWING VARIABLES											
1.	Total Number of Rooms (TNR)	PPD = 2.21 + 0.216 TNR	10.04	PPD = 4.02 - 1.68X_1 + 2.22 X_2 + 0.20 TNR	0.9392	3.1121	15.95	0.19512	25.75	1.610	8.390	Use of dummy variables upheld
2.	Total Area Covered by Hotel (TAC)	PPD = 9.22 + 3.47×10^{-3} TAC	11.25	PPD = 11.59 - 2.90 X_1 - 0.90 X_2 + 3.30×10^{-3} TAC	0.9299	3.343	15.95	0.20962	23.72	1.482	9.771	Use of dummy variables upheld

Where X_1, X_2 = Dummy variables, S, Standard error of estimate, $\overline{PPD}$ = mean value of dependent variable

R^2 = coefficient of determination, SS = Sum of squares of residual, Se = Mean square of residuals obtained from the Extra sum of squares.

$S^2 - Se^2$ = Difference between the two mean square of Residuals. (X_1, X_2) = (1,0) for CBD Hotels,

(X_1, X_2) = (0,1) for PCBD Hotels, (X_1, X_2) = (0,0) for OCBD Hotels.