A STUDY ON PARKING OCCUPANCY OF RESIDENTIAL CONDOMINIUMS IN METRO MANILA, PHILIPPINES

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Abstract: As the link between transportation and land use, parking for condominiums plays a vital role in urban planning and transport policy especially in the midst of the need to minimize traffic congestion while preserving the socio-economic activities of an area. Supply of residential condominium parking facilities, which vary from city to city and from one developer to another, has indeed become a controversial issue since it influences the transport system. To determine how certain supply variables affect the occupancy of these facilities, cross-tabulation, correlation, and mathematical modeling analyses were employed using parking occupancy data leading to the estimation of parking occupancy per independent variable. The models generated are recommended as indices that can be used to estimate future parking requirements for similar developments from the perspective of the supplier.

Keywords: parking occupancy, mathematical modeling, residential condominiums

1. INTRODUCTION

The provision for parking is critical for urban developments where land is limited. While there is a need to support the area's socio-economic activities by meeting the requirements for parking spaces, caution should also be exercised in order to at least minimize traffic congestion. In Western countries, standards for parking requirements have been reoriented towards limiting the use of private car in congested central areas but maintaining minimum levels to preserve city center activities. This is most feasible in central business districts, or CBDs, where activities are interrelated because of the mix of land uses and given an efficient public transportation system that would decrease reliance on private cars.

Parking policy, as a regulating tool for the use of cars in urban areas, plays a vital role in defining urban planning and transport policy. By setting appropriate standards for parking requirements, the urban transport and land use systems are supported. The amount of parking supplied influences such systems and even the characteristics of the market.

However, supply of parking varies for every land use, and even for similar land uses, depending on several factors. These include development size, density and mix, policy requirements, location as well as parking cost.

Generally, parking spaces are related to some quantitative measure of land use. The Institute for Transportation Engineers (ITE) identifies the number of dwelling units as the variable determining the number of parking slots. From parking occupancy studies, the ITE developed parking generation rates, defined as the number of parking spaces per unit of independent variable. Other foreign studies suggest using building floor area and number of bedrooms as qualitative measures. Notably, these studies stress the need to undertake localized parking studies from which to base such requirements.

This paper focuses on residential condominium parking occupancy in Metro Manila CBDs. With the overall aim of establishing rates that would estimate parking slot requirements for future similar developments from the supplier's perspective, it seeks to:

- Identify the various factors as variables influencing the supply of parking facilities
- Evaluate these variables as to how they influence the occupancy of residential condominium parking facilities; and
- Develop mathematical models for estimating parking occupancy

Although parking occupancy results from the interaction of two forces, the demand and the supply, this paper focuses on the supply side only believing on the premise that parking supply can affect the characteristics of its target users.

As a backgrounder, a section on parking policies and residential condominium development in the country is hereby provided. This is followed by the analytical framework, which discusses the methodologies undertaken in order to accomplish the abovementioned objectives, as well as the variables and indicators. The outputs of these methodologies are then presented. A summary of the findings, conclusions and recommendations follow.

2. PARKING POLICIES AND RESIDENTIAL CONDOMINIUMS IN THE PHILIPPINES

In the Philippines, parking requirements are based on the minimum standards set by the National Building Code (NBC). The Code, published in 1975, is currently under review as to how it suits current trends and needs. In the local level, parking provision is governed by zoning ordinances in the form of minimum requirements based on the desired and allowed development density of the area. Generally, condominium developers determine the amount of parking supplied based on market studies, target markets, and past projects while observing the limitations set by existing parking policies.

The NBC stipulates one parking slot per 8 living units if each living unit measures less than 50 square meters; 1 per 4 living units if each unit measures 50 to 100 square meters; and 1 slot per living unit if its area is greater than 100 square meters. The Makati Commercial Estates Association (MACEA), a group composed of building and unit owners in the Makati CBD, specify one slot per 100 square meters of gross floor area. Meanwhile, the counterpart group in Ortigas CBD, the Ortigas Center Association (OCA), specifies 1 slot per 90 square meter of floor area. Developers allocate parking slots per type of unit. For instance, one slot is given to 1- or 2-bedroom units and 2 slots for each 3-bedroom unit.

This paper looks into the following parking-related issues: (1) the applicability of the Code to the changing transport needs and development trends; (2) cases of under- and oversupply of parking facilities; and (3) the continued development of residential condominiums which makes parking facilities a crucial consideration in the planning stage.

Parking facilities of residential condominiums are either below- or aboveground. Developers normally allocate parking according to the size of the units with bigger units having more slots. For instance, one-bedroom units are assured of at least one parking slot while two- or three-bedroom units may have 2 slots. Such allocation is determined by the developer who either sells the slot or rents it out. The price of the slot may also be built-into the cost of the unit, or separated. The location of the slot is either the choice of the tenant, or is pre-assigned by the developer. Since exclusive use of a slot by its owner is observed, there is hardly any case of illegal parking by a neighbor or a visitor.

3. ANALYTICAL FRAMEWORK

Figure 1 demonstrates the sequence and the various analytical methodologies applied in order to achieve the objectives of the study. To come up with the list of factors affecting parking supply, a review of related literature and interview with key informants (developers) were undertaken. The factors in the list formed the bulk of the questions in the parking occupancy survey conducted. Analyses include frequency distribution, cross-tabulation, correlation, and mathematical modelling yielding profile of condominiums, variables affecting parking occupancy, and mathematical models, respectively.

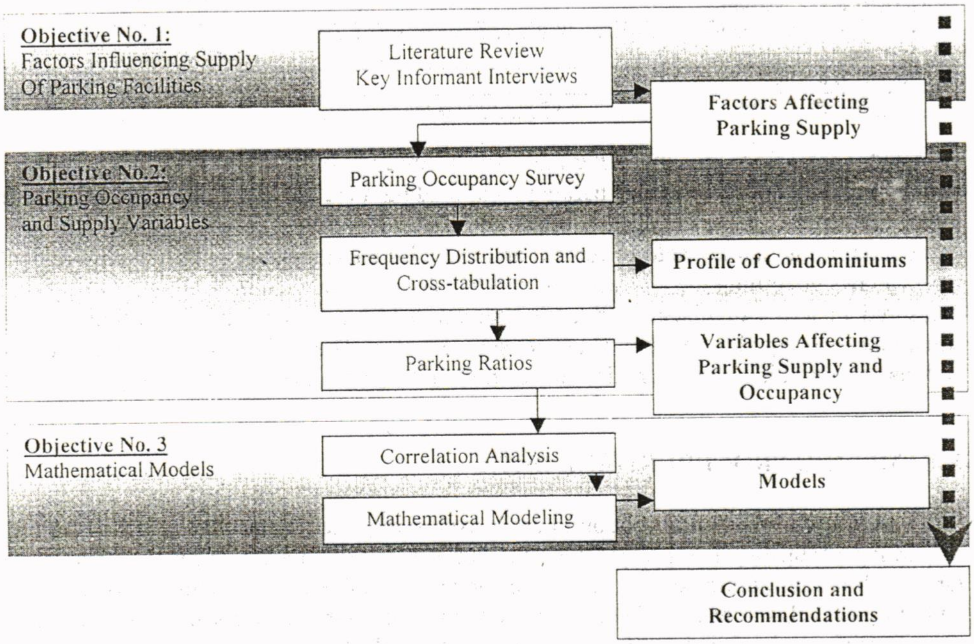

Figure 1. Analytical Framework

4. VARIABLES, INDICATORS AND UNITS OF ANALYSIS

The paper identifies the variables affecting parking supply as: (1) development size; (2) development density; (3) development mix; (4) policy requirements; (5) location; and (6) parking cost. Each variable has its own corresponding indicators and units of analysis as shown in Table 1.

Table 1. Variables, Indicators, and Units of Analysis

Indicators	Unit of Analysis
VARIABLE 1: Building Size	
▪ Gross floor area (GFA) ▪ Gross saleable area (GSA) ▪ Number of units	GFA refers to residential spaces only and accessories, excluding commercial and/or offices spaces for rent/sales within the building. It also excludes parking slots and driveways. GSA excludes parking Total number of residential units (occupied and supplied)
VARIABLE 2: Development Density	
▪ Land area ▪ Gross floor area (RGFA) ▪ Gross saleable area (RGSA) ▪ Floor area ratio ▪ Number of units	*FAR = (GFA) / (LA)* where GFA refers to that used for residential uses excluding compatible uses such as office or commercial. Number of units per 1,000 m^2 of GFA or GSA.
VARIABLE 3: Development Mix	
▪ Percentage of type of residential unit to total units provided ▪ Percentage of residential area to total area	Number of unit types Percentage of Studio units to total number of units Percentage of 1-BR units to total number of units Percentage of 2-BR units to total number of units Percentage of 3-BR units to total number of units
VARIABLE 4: Policy Requirements	
▪ Number of units ▪ Size of units	Number of slots required as per National Building Code (NBC) Number of slots required as per development guidelines (MACEA and OCA)
VARIABLE 5: Location	
▪ Distance from the public transport stop	Walking distance from the nearest public transport stop in meters
VARIABLE 6: Cost	
▪ Parking slot cost	Cost of 1 parking slot

GFA is the total floor area including the exterior building walls of all floors of a building or structure and excludes vehicular parking area, loading area, and the floor area occupied by utility systems. Gross saleable area, or GSA, represents revenue-generating areas (residential units that are sold or rented) and excludes parking spaces. Policy requirements refer to laws governing the allocation of parking slots as discussed in Section 2. Location is measured in terms of distance from the nearest public transport stop. Parking cost per square meter is equal to the unit's cost per square meter. These, the rest of the indicators, as well as other parking characteristics are covered in the parking occupancy survey.

5. SAMPLING PROCEDURE AND DATA

Since parking for residential condominium is exclusively used by the one who owns or rents it, parking occupancy is represented by the number of slots bought or rented. The survey targeted building administrators and/or developers of residential condominiums in Makati and Ortigas CBDs in Metro Manila. The condominiums targeted for sampling must be: (1) a residential condominium currently occupied although it may contain compatible uses in some of its floors such as commercial and/or office uses; (2) high-rise (more than nine storeys); and (3) have at least one floor dedicated for off-street parking facility.

Various data sources identify these two areas as the concentration of condominium developments An ocular inspection was conducted to identify those that fit the criteria for sampling. Because of the inconsistency among these data sources, only an approximate number of residential conodominiums was reached. Table 2 shows the number of respondents targeted and the actual return percentage.

Table 2. Number of Respondents and Return Percentage

Location	Appromixate No. of Built Condominiums	No. of Survey Forms Sent	Percentage	No. of Forms Returned	Return Percentage
Makati CBD	85	70	82%	35	50%
Ortigas Center	22	14	64%	6	43%
TOTAL	107	84	79%	41	49%

Due to incomplete or missing data entries, data from only 29 samples were considered for the analysis. Low return percentage and missing data entries were mostly due to strict data confidentiality observed by certain developers and building administrators.

5.1 Profile of Residential Condominiums

In terms of general condominium characteristics, majority of the samples have compatible uses within the building (usually on the ground floor or may extend to the first few floors above) such as commercial and/or office uses. Almost all of the condominiums surveyed cater to high-end users and were constructed in the 1990s, coinciding with the peak years of condominium developments. Majority of the residential units are sold. These are shown in Table 3.

Table 3. General Condominium Characteristics

PROFILE	VARIABLES	PERCENTAGE
Compatible Uses	Residential Only	27
	With Commercial or Office Units	**73**
Type of Market	**High-Income**	**93**
	Middle-Income	7
Year Occupied	1975-1979	7
	1980-1984	0
	1985-1989	7
	1990-1994	**33**
	1995-1999	**33**
	2000 and up	20
Type of Residential Unit Ownership	**Owned**	**67**
	Rented	7
	Mixed	27

In terms of building size, more than a third of the samples measured from 10,500-18,499 m^2 in gross floor area (GFA) while almost half of the samples were 10,000-17,999 m^2 in gross saleable area (GSA). Also, almost one-third of the samples consisted of 15-69 residential units. Development density in terms of floor area ratio, computed using GFA and land area data, yielded FAR values of 3-16 as the most common. Nearly half of the samples had 5-10 residential units per 1,000 m^2 GFA and more than 70% had 1-10 units per 1,000 m^2 GSA. In terms of development mix, represented by the number of unit types in one condominium, majority had either 1 unit type only or all 4 types. Distribution of these units per unit type is illustrated in Figure 2. Location, measured in terms of distance from the nearest public transport stop, of most of the samples is from 216-425 meters. Table 4 lists down the frequency distribution of these variables in percentages.

Table 4. Frequency Distribution of Several Supply Variables

Building Size by Gross Floor Area (GFA)		Building Size by Gross Saleable Area (GSA)		Building Size by Number of Units	
Range of Values	Frequency (Percentages)	Range of Values	Frequency (Percentages)	Range of Values	Frequency (Percentages)
2,500-10,499	24	2,000-9,999	28	**15-69**	**31**
10,500-18,499	**35**	**10,000-17,999**	**49**	70-124	21
18,500-26,499	14	18,000-25,999	7	125-179	21
26,500-34,499	10	26,000-33,999	10	180-234	10
34,500-42,499	7	34,000-41,999	3	235-289	17
42,500-50,499	7	42,000 & up	3		
50,500 & up	3				

Development Density by FAR		Development Density by Number of Units per 1000 m^2 RGFA		Development Density by Number of Units per 1000 m^2 RGSA	
Range of Values	Frequency (Percentages)	Range of Values	Frequency (Percentages)	Range of Values	Frequency (Percentages)
3-9	**31**	0 to <5	42	**0 to < 10**	**70**
10-16	**31**	**5 to <10**	**49**	10 to < 20	24
17-23	21	10 to <15	3	20 to < 30	3
24-30	10	15 to <20	3	30 to <40	3
31 & up	7	20 to <25	3		

Development Mix By Number of Unit Types		Development Mix by Number of Units Per Unit Type		Distance from Public Transport (in Meters)	
Range of Values	Frequency (Percentages)	Range of Values	Frequency (Percentages)	Range of Values	Frequency (Percentages)
1 unit type only	**27**	Studio	22	5-215	21
2 unit types	21	1-BR	21	**216-425**	**48**
3 unit types	24	2-BR	24	426-635	31
4 unit types	**28**	**3-BR**	**30**		

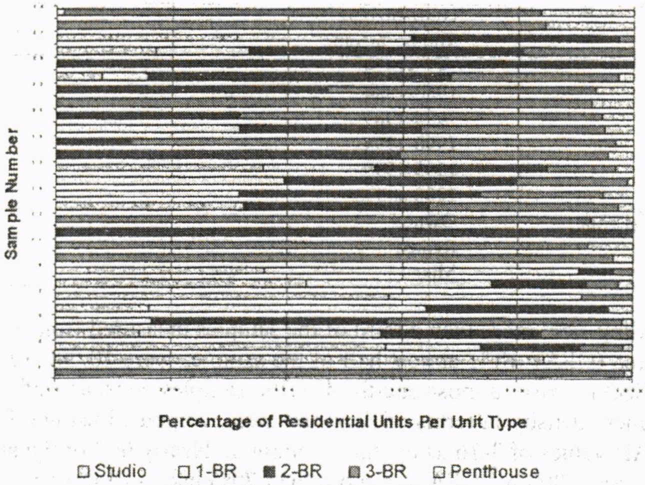

Figure 2. Distribution of Residential Units

5.2 Parking Occupancy in Relation to Supply Variables

Parking occupancy is related to residential unit occupancy. As of the survey, out of the 3,505 residential units supplied, only 2,447 (70%) have been occupied. Majority of the samples attained 80-99% unit occupancy followed by those attaining 60-79% unit occupancy. Only about 14% were fully occupied but not all of them have full parking occupancy (Figure 3). Some samples whose units were partially occupied already had full parking occupancy. Nearly half of the samples attained full parking occupancy (Figure 4). Full parking occupancy is observed for smaller-sized samples (Figures 5 and 6). Majority of the samples with smaller number of units attained full parking occupancy although there were samples having higher number of units that attained full parking occupancy as well (Figure 7). Parking occupancy rates vary for samples with varying number of unit types (Figure 8). With majority of the samples distanced from 215 to 425 meters from the nearest transport stop, nearly half of these attained full parking occupancy (Figure 9). Almost half of the samples located beyond 426 meters from transport stops also attained full parking occupancy. Ironically, samples closest to these stops had varying parking occupancy rates with only a very few attaining full occupancy. Only about 12 samples out of 29 provided information on parking cost, in terms of selling price per square meter, with a minimum of approximately PhP 20,000 and a maximum of PhP 98,000.

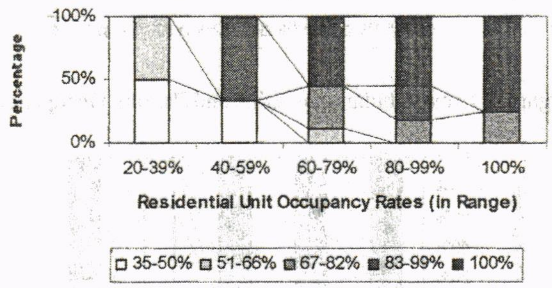

Figure 3. Cross-tabulation of Residential Unit Occupancy and Parking Occupancy

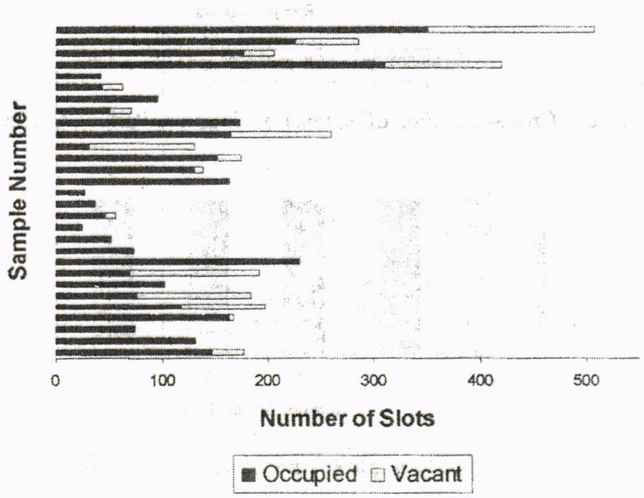

Figure 4. Actual Parking Supply and Occupancy

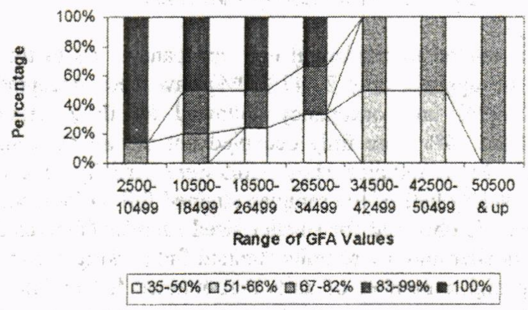

Figure 5. Cross-tabulation of GFA and Parking Occupancy

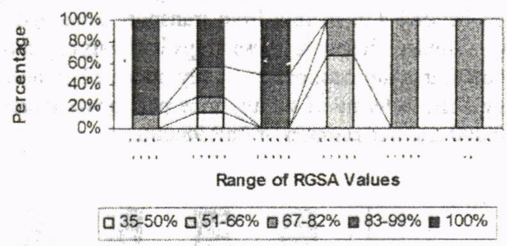

Figure 6. Cross-tabulation of GSA and Parking Occupancy

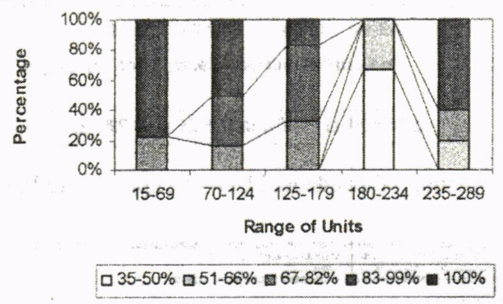

Figure 7. Cross-tabulation of Number of Units and Parking Occupancy

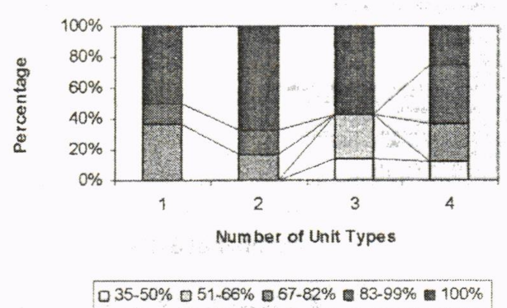

Figure 8. Cross-tabulation of Number of Unit Types and Parking Occupancy

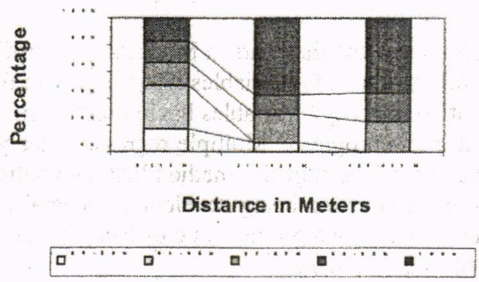

Figure 9. Cross-tabulation of Distance from Stop and Parking Occupancy

Supply and occupancy data are also compared with the minimum requirements set by the National Building Code (NBC), the MACEA, and OCA. These requirements were computed using data on number of units and sizes. From Figure 10, the NBC elicits the least minimum requirements. Generally, both MACEA and OCA call for higher minimum requirements. For most of the samples, the MACEA and OCA requirements are twice as many as the NBC's (1.1 to 5.3 times more for MACEA and 1.2 to 5.9 times mores for OCA), suggesting a strong disparity among the specifications of these regulations. The number of slots supplied and occupied were generally less than the requirements of MACEA and OCA (only 84% of the MACEA requirements and 76% of OCA) but higher than that of the NBC. For most of the samples, occupancy of the slots was from 1.1 to 6.0 times more than the NBC requirements.

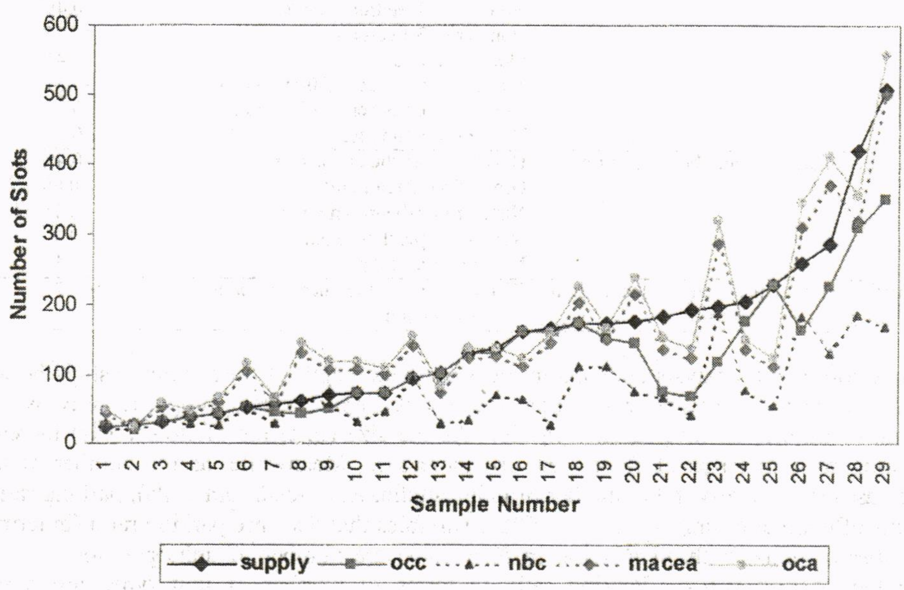

Figure 10. Comparison of Parking Occupancy, Supply and Various Requirements

5.3 Correlation and Mathematical Modeling Analysis

Correlation analysis was done using the Pearson Product-Moment Correlation Coefficient of Statistica software in order to check for variables that are vital in the regression equation as well as to check for multicollinearity. Variables having high correlation with the dependent variable are marked red in the program. Multiple regression analysis, also using Statistica software, was undertaken using the stepwise method that automatically eliminates variables that are not significant to the equation being developed. Several equations were developed and selection of the model was based on the value of R-square as well as on the t-statistics and p-levels of the independent variables.

Data was converted to parking ratios, expressed as the number of occupied slots per unit of supply variable. The parking ratio serves as the dependent variable and takes on various definitions that were subjected to correlation and modeling analyses. The various supply variables serve as the independent variables. Table 5 lists down the various definitions of parking ratios and the corresponding independent variables they are highly correlated with.

Table 5. Correlation Results for Various Parking Ratios

Parking Ratio	Highly Correlated Supply Variables	Correlation Coefficient
Number of slots per 1,000 m^2 of GFA	Number of units per 1,000 m^2 GFA	+0.56
	Number of units per 1,000 m^2 GSA	+0.45
Number of slots per 1,000 m^2 of GSA	Number of studio units	+0.43
	Number of 1-bedroom units	+0.53
	Number of units per 1,000 m^2 GFA	+0.57
	Number of units per 1,000 m^2 GSA	+0.59
Number of slots per residential unit	Number of residential units	-0.44
	Number of studio units	-0.49
	Number of 1-bedroom units	-0.49
	Number of 3-bedroom	+0.38
	Floor area ratio	-0.41
	Number of units per 1,000 m^2 GFA	-0.51
	Number of units per 1,000 m^2 GSA	-0.59
	Number of unit types	-0.52
Number of slots per number of unit types	Distance from the city center	-0.49
	Gross Floor Area in m^2	+0.69
	Number of 3-bedroom units	+0.78
	Number of penthouse units	+0.70
	Number of unit types	-0.42
Number of slots per meter distance from the public transport stop	Distance from the nearest public transport stop	-0.71

Since correlation analysis attempts to measure the strength of linear relationships between two variables, a positive correlation coefficient implies direct proportionality while a negative implies an inverse relationship. As the size (in terms of floor areas) increases, parking ratio in terms of floor area also increases. Meanwhile, as the number of units increases (particularly, total number of units, studio, and 1-bedroom units), parking ratio in terms of number of units decreases. Other variables that decrease parking ratio (in terms of number of units) with an increase in their value are number of units per floor area and number of unit types. Parking ratio in terms of number of unit types are directly proportional with GFA, number of 3-bedroom and penthouse units but the ratio decreases as the location of the condominium gets near a public transport stop. Finally, parking ratio in terms of its distance from public transport stop is inversely proportional with distance from this stop.

Several sets of regression analyses were undertaken using different parking ratios as the dependent variable. Parking ratios expressed in terms of the number of slots per residential unit, as well as number of slots per 1,000 m^2 of either GFA or GSA, were selected using the criteria cited earlier. Multicollinearity, which arises when two or more regressors in an equation are highly correlated and hence should not be put in the same equation, was also ruled out. Two equations representing two parking ratios are hereby presented.

$$Y = 6.46 + 0.08X_1 + 0.009X_2 + 5.07X_3 - 3.92X_4 \quad \text{(Eq. 1)}$$

t-stat: (+4.04) (+5.99) (+3.21) (+4.95) (-3.10)
p-levels: (4.8E-04) (3.5E-0.6) (3.8E-03) (4.7E-05) (4.8E-03)

where Y = number of occupied slots per 1,000 m^2 of GSA
X_1= number of 1-bedroom units;
X_2= distance from the nearest public transport stop in meters;
X_3= manner of slot assignment, 0 = pre-assigned by the developer
1 = tenant's choice, first-come first-serve basis; and
X_4= manner of slot payment, 0 = separate payment
1 = built into the residential unit cost

Equation 1 estimates parking ratio in terms of the supply variables pertaining to size (per 1,000 m^2 GSA) and location (meter-distance from public transport). An increase in the number of 1-bedroom units increases parking occupancy as indicated by the positive sign of the coefficient. The farther the location of the condominium from a public transport stop also increases parking occupancy. Two dummy variables affecting parking occupancy have also been included in the model. Based on the assigned values, slots that are allocated based on tenant's choice tend to increase the ratio. Meanwhile, slots whose costs are built into the residential unit cost decreases parking ratio. With an R-square of 0.69, the model shows that about 69% in the variation of parking ratio in terms of GSA can be explained by the variation in the supply variables discussed above. The t-statistic values of each dependent variable are higher than the tabulated value of 2.064 making the equation statistically significant. The p-levels are also acceptable.

Equation 2, expressed in terms of the number of occupied slots per 1,000 m^2 of GSA,

$$Y = 5.67 + 0.19X_1 + 0.14X_2 + 2.46X_3 \quad \text{(Eq. 2)}$$

t-stat: (6.24) (2.80) (-2.47) (+2.75)
p-levels: (2.0E-06) (9.8E-03) (2.1E-02) (1.1E-02)

Where Y = number of occupied parking slots per 1,000 m^2 GFA;
X_1= number of residential units per 1,000 m^2 GSA;
X_2= floor area ratio in terms of gross floor area divided by land area; and
X_3= manner of allocating slots

The coefficient of multiple determination (R^2) of 0.51 indicates that about 51% of the variation in parking occupancy is explained by the variation in development density in terms of number of units per 1,000 m^2 GSA and floor area ratio (FAR). An increase in either of these variables tends to increase the parking occupancy ratio. This implies that more slots are required if the development is more dense. While these models exhibit relatively low R-square values, adding more supply variables to improve these values would not be warranted due to multicollinearity. The t-statistic values of each dependent variable, also given in parentheses, are also higher than the tabulated value of 2.060. The p-levels are also acceptable.

6. CONCLUSIONS, RECOMMENDATIONS, AND DIRECTIONS FOR FURTHER STUDIES

This paper focused on residential condominium parking facilities in order to determine how certain supply factors influence the occupancy of such. Primary data collection was through a parking occupancy survey among developers and/or building administrators. Data collected was then analyzed through correlation and regression analysis leading to the development of two models in terms of parking ratios.

From related literature and key informants, factors affecting the supply of parking facilities include building size, development density, development mix, policy requirements, location, and cost of parking slot. To evaluate how these factors affect parking occupancy rates, cross-tabulation analysis was undertaken using data gathered from the parking occupancy survey. Findings indicate that those that attained full parking occupancy were smaller-sized and more dense condominiums. Apparently, varying parking occupancy rates were observed for samples located within a comfortable walking distance from public transport stops. Full residential unit occupancy also did not translate to full parking occupancy indicating cases of oversupply of parking slots. However, there were also cases of full parking occupancy even for those samples that attained only partial unit occupancy which could indicate parking undersupply.

Furthermore, in terms of policy requirements, most of the samples supplied much more than the minimum requirements of the National Building Code. The rates of the MACEA and OCA guidelines, which are based on gross floor area, are closer to actual parking occupancy and supply. In the Philippines, the minimum requirements stipulated in the National Building Code gives the developers the freedom to supply the amount as long as this falls above the set minimum. Such freedom implies possible under or over-supply of these facilities that consequently leads to any of the following scenarios: traffic congestion, economic inefficiency, or environmental degradation. Planning for condominium parking facilities thus becomes crucial. The option of specifying maximum requirements as well, instead of minimum alone, should be looked into.

From the mathematical models that were developed, expressed in parking ratios (number of occupied slots per supply variable), direct proportionality is observed between parking ratio and building size and density. The models can be used to estimate future parking requirements of residential condominiums. They illustrate that various supply variables can be used to estimate parking occupancy. However, due to multicollinearity, combining several of these variables in one equation will make the regressors statistically insignificant although it will yield high R-square values. Hence, only the strongest variables are kept in the estimated equation.

While only these factors strongly influence the supply and occupancy of parking facilities, the other factors identified in this paper can still be tapped to influence future supply. For instance, an improved public transport system and a transport policy that encourages the use of alternative means of transport may lower the need for parking requirements and will thus promote a more sustainable development.

The parking occupancy survey has limitations based on the scope of this paper. The next step would be to also consider parking demand, vis-à-vis parking supply or capacity, in order to provide a wider and more comprehensive perspective of the topic. One way to do this is by conducting parking surveys that would identify parking demand characteristics such as parking accumulation, car ownership, trip patterns and other information. This would clearly clarify the issue of whether a parking oversupply or undersupply exists.

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