

Parking Demand Rates for Some Selected Land Uses in Egyptian Cities

Osama Okail, Ahmed Mohamady, Ehab El-Gamal

Abstract— This research presents the estimated parking demand rates (PDR) for some selected land uses in Egyptian cities Specifically, in the Greater Cairo Region which is the representing model. The aim of the research is to estimate (PDR) for these activities so that they are representative and appropriate to the circumstances and the Egyptian conditions rather than using parking rates studies from other countries such as ITE in the United States of America (USA) which are different from the Egyptian conditions. The research also aims at estimating (PDR) for activities not defined by ITE or any other codes.

In this study nine land uses, namely: universities (public (PU-U), private (PR-U), and higher institutes (HI)), schools (secondary public (S-PU-S), primary public (P-PU-S), secondary private (S-PR-S) and primary private (P-PR-S)), wedding Occasions halls (WOH), and consolation Occasions halls (COH). (PDR) for these land uses were estimated and results are different from the ITE for the same land uses.

Keywords— Parking demand, Parking generation rate, Egypt, and ITE.

I. INTRODUCTION

The objective of this study is to determine the parking rates for selected land uses. where the Egyptian code does not contain the parking rates for many land uses, Also ITE rates cannot be used in Egypt because it will not be appropriate for the Egyptian conditions.

The research covers Nine land uses namely: universities (public (PU-U), private (PR-U), and higher institutes (HI)), schools (secondary public (S-PU-S), primary public (P-PU-S), secondary private (S-PR-S) and primary private (P-PR-S)), Occasions halls (wedding (WOH), and consolation (COH)).

The study was limited to Greater Cairo region (Cairo, Giza, 6th October, 15 May, Heliopolis, Helwan, and The New Cairo).

In terms of application, it is very important that Egypt has a comprehensive code that contains PDR for all land uses because it's very important in planning cities and urban communities.

II. LITERATURE REVIEW

The parking rates in the Egyptian Code of Practice are based on the ITE rates [1]. The ITE 106 land use parking rates are suitable to the US general conditions. However, many US states produced different PDR that suit the individual conditions of each state. State of Arizona an example. The Arizona State University (ASU-ITE 2013) [2], and The Department of Transportation of Alabama state (2011) [3]. Many countries have adopted parking rates that suit their conditions, such as the UAE where (The Department of Transportation Abu Dhabi, 2012) produced a manual for parking and trip rates for some land uses, the manual classified the cities into three categories: Abu Dhabi city, Al Ain city and other cities within the UAE, each category has its own parking rates [4].

In (2011) Douglass and Abley [5] conducted a study to figure the New Zealand, Australia data of trip and parking rates related to land uses, this study based on The Australian Roads and Traffic Authority, (RTA 2002) [6].

Nedal T. Ratrouf et al. (2016) studied the parking generation in public and private schools in Al-Khobar-Dhahran metropolitan area in kingdom Saudi Arabia [7].

Al-Sahili, Hamadneh, J (2016) conducted parking rates for Residential, office, and retail in the west bank area in Palestine and obtain local parking rates [8].

The Ministry of Housing, Utilities and Urban Development issued the Egyptian Code of Safety Requirements for Multipurpose constructions in 2007. The first part of the code for garage mentioned some parking rates for a limited number of land uses. Almost taken from the ITE rates and does not represent the reality of cities and Egyptian conditions [9].

This research represents practical results of PDR for some land uses specifically in Greater Cairo region according to the Egyptian conditions.

III. STUDY PLAN, RESULTS AND ANALYSIS

A. Study Plan

the following steps explained study plan:

1) Identifying land use

The Nine selected land uses for the study are: public universities (PU-U), Private universities (PR-U), Higher institutes (HI), secondary public schools (S-PU-S), primary public schools (P-PU-S), secondary Private schools (S-PR-S), primary private schools (P- PR-S), Occasions halls (wedding (WOH), and consolation (COH)). ITE depends on a very limited number of samples but in this research more samples were used to ensure accuracy.

The following table shows No. of sites and independent variable for each land use:

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Categories	No	Land use	No. of sites	Independent variable
Universities	1	Public	3	No. of students
	2	Private	2	No. of students
	3	Higher institute	2	No. of students
Schools	4	Secondary public	4	No. of students
	5	Primary public	3	No. of students
	6	Secondary private	2	No. of students
	7	Primary private	2	No. of students
Occasions Halls	8	Wedding	5	No. of seats
	9	Consolation	7	No. of seats

2) Selection of site location and size

All research sites were in Greater Cairo region, cities of (Cairo, Giza, 6th October, 15 May, Heliopolis, Helwan, and the New Cairo).

The adopted methodology for choosing sites in this study was based on the following criteria:

- The site must have been established since a long time.
- Site occupancy should not less than 80 percent.
- The site must be clear to control counting parked vehicles on it.
- No abnormal constructions around the selected sites.

The study places targeted by the research are:

PU-U: Al-Azhar University for Boys in Cairo, Helwan University, and Ain Shams University. **PR-U:** 6th October University and Misr University for Science and Technology (MUST) in 6th October. **HI:** The Higher Institute of Engineering in 15 May City, and The Higher Institute of Applied Arts in 6th October. **S-PU-S:** Al Tabary school in Giza, Al Marg American language school (ACCGLS), Al Marg school for boys, and Talat Harb school in Ain Shams. **P-PU-S:** Al Horia school in Ain Shams, Suzan Mubarak school in Qatamia, and Omar ben Abd-Al Aziz school in Al Marg. **S-PR-S:** Akhnaton international school and Manor house international school in 90 street, fifth settlement, New Cairo city. **P-PR-S:** Al Helal school and Manaret Al Sharq school in Al Marg. **WOH:** Al Masah in Abbas El Aqad street Nasr city, Dar Al moshah in Ismaeil El Fangary street, Alqoba, Al Nasr in Al Nasr sports club Heliopolis, Panorama 6th October in Salah Salem street, and AL Nour mosque in Abbasya. **COH:** Al Hamd mosque, Al Sharbatly mosque, and Al Rashdan mosque in New Cairo city, Al Salam mosque in tayaran street Nasr City, Armed force mosque in Nozha, Dar ben Al Arqam in Makram Ebeid street Nasr City, and Occasions hall of Police in 6th October City.

3) Time Durations

As expressed by ITE, the time of counting relates to the objective of the study, since there is a diversity in the nature of land use, therefore it's required to count parked vehicles during two periods (AM, PM) for universities and schools

land uses. While Occasions hall was counted during the event which was usually at (PM period). For all types of land use, it should be used appropriate time interval which was (15-minutes). Moreover, this study does not address weekends, holidays and any unusual day of the week.

4) Form Design

The required data were specified based on international sources. Special forms had been designed to collect the important data of each chosen site and to obtain the estimated parking demand by the prescribed needed variables.

5) Data Collection

Counting of parking demand for every chosen site was based upon the characteristics and the surrounding area. Two weekdays were used in counting for every selected site. Two periods were selected in counting as follows: 8:00-10:00 AM and 13:00-15:00 PM for schools and universities, while Occasions halls were conducted during the event time and this is usually counted in the evening (PM) period. The average maximum of parked vehicles represented by the average's maximum of parking accumulation through the two days of counting.

B. Results and Analysis

Different forms of regression models were investigated such as linear, logarithmic, etc. The correlation is considered satisfactory when the coefficient of determination (R^2), equals 0.5 or higher, according to the stated by ITE. The following points show the different Parking rates results for the various Nine land uses.

1) parking rates results for universities.

Table (1) shows PDR results for the studied land uses based on its independent variable and its R^2 . The Egyptian code rate is much higher than the conducted rate. For example, PDR in the Egyptian code is 0.2 spaces per student, while the actual demand rate in this study is 0.073 spaces per student. After the separation between land uses, the research showed that the rate of PR-U is higher than the rate of HI and the rate of HI is higher than the rate of PU-U.

Table (1) PDR results for universities.

NO	Land use	Model	R^2	Rate
-	Universities And higher institute	$P = 0.0655(X) - 47.884$	0.837	0.073 spaces per Student
1	Public universities	$P = 0.039(X) - 745.108$	0.962	0.02 spaces per Student
2	Private universities	-	-	0.1 spaces per Student
3	Higher institutes	-	-	0.07 spaces per Student

2) parking rates results for schools.

Table (2) shows PDR results for schools' land uses. The Egyptian Code for Garages mentioned only the private schools' land use, furthermore, it doesn't take into consideration the school stage. Initially, the parking rates for the selected land use were conducted without dividing, and then they were divided to see the variations in the PDR. The research found that the parking rate for secondary schools higher than PDR of primary schools, and the parking rate for secondary schools located in an area characterized by a high social class higher than PDR for secondary schools located in another area characterized by low social class.



Table (2) PDR results for schools.

No	Land use	Stage	Social class	Model	R ²	Rate
-	Public schools	-	-	$P = 0.059(X) - 3.245$	0.701	0.056 spaces per Student
4		Secondary	-	$P = 0.066(X) - 0.096$	0.858	0.066 spaces per Student
5		Primary	-	$P = 0.012(X) - 2.669$	0.769	0.044 spaces per Student
-		Secondary	High	-	-	0.077 spaces per Student
-		Primary		-	-	0.04 spaces per Student
-		Secondary	Low	-	-	0.054 spaces per Student
-		Primary		-	-	0.0475 spaces per Student
-	-	-	-	$P = 0.1(X) - 5.34$	0.77	0.1 spaces per Student
6	private schools	Secondary	High	-	-	0.115 spaces per Student
7		Primary	Low	-	-	0.072 spaces per Student

3) parking rates results for Occasions halls.

Table (3) shows PDR results for Occasions halls which is acceptable since R² higher than 0.5. The Egyptian Code for Garages doesn't take into consideration WOH or COH, although it is a very important activity.

Table (3) PDR results for Occasions halls.

NO	Land use	Model	R ²	Rate
8	wedding Occasions halls	$P = 0.183(X) + 43.124$	0.87	0.29 spaces per Seat
9	consolation Occasions halls	$P = 0.548(X) - 158.03$	0.957	0.355 spaces per Seat

4) Comparison of research rates with international and local rates.

The following table presents the comparison which was conducted between the ITE rates in (USA), Abu Dhabi Rates in (UAE), parking requirements in the current Egyptian code, and the research rates for all land use.

Table (4) comparison of parking rates for all land uses.

No	Land use	ITE	Abu Dhabi	Egyptian code	Research results
1	Public universities	0.33	0.225	0.2	0.02
2	Private universities	0.33	0.225	0.2	0.1
3	Higher institute	0.18	0.167	0.2	0.07
4	Secondary public schools	0.23	0.265	NA	0.066
5	Primary public schools	0.17	0.292	NA	0.044
6	Secondary private schools	0.39	0.186	0.05	0.115
7	Primary private schools	0.39	0.186	0.05	0.072
8	Wedding halls	0.07	0.4	NA	0.29
9	Consolation halls	0.06	NA	NA	0.355

The following points illustrate the result of the comparison for the studied land uses:

A) universities land uses.

The following figures show clearly the differences between parking rates for PU-U, PR-U, and HI land uses respectively.

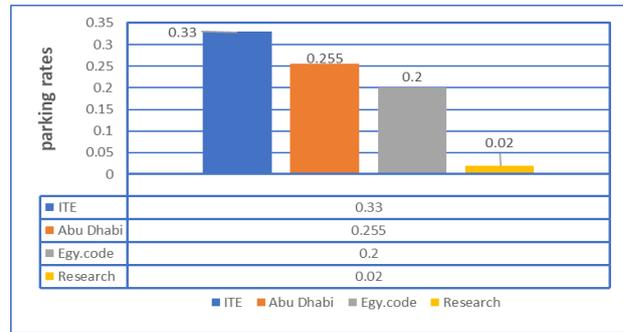
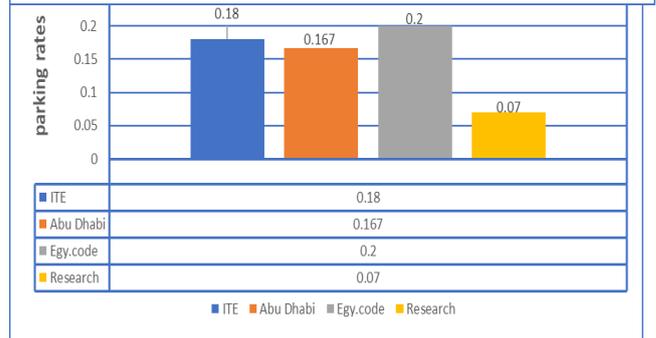
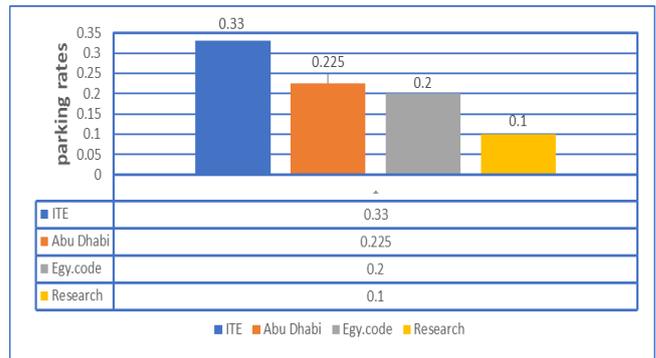


Figure (1): Research rates vs. international and local rates for PU-U.

The figure above shows that the research rate is less than the ITE rate by 1550 %, less than the Abu Dhabi rate by 1025%, and less than the Egyptian code rate by 900%.

Figure (2): Research rates vs. international and local rates for PR-U.



The figure above shows that the research rate is less than the ITE rate by 230 %, less than the Abu Dhabi rate by 125%, and less than the Egyptian code rate by 100%.

Figure (3): Research rates vs. international and local rates for HI.

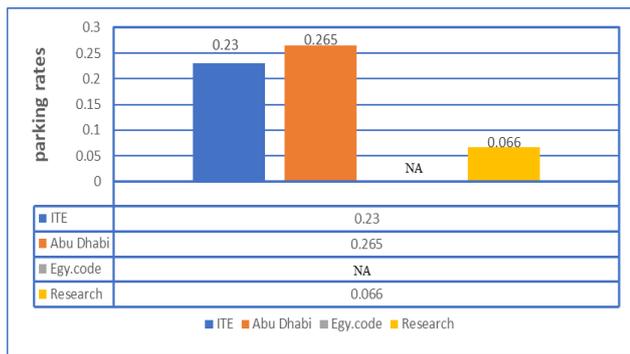
The figure above shows that the research rate is less than the ITE rate by 157 %, less than the Abu Dhabi rate by 138.6%, and less than the Egyptian code rate by 185.7%.

For the research rates, it is noticed that the PDR of PR-U higher than the PDR of HI by 42.86%, and PDR of HI higher than PDR of PU-U by 250%. This is due to two reasons, first; car ownership in PR-U higher than car ownership in HI and both are higher than PU-U, second; the number of students in PU-U is very higher than PR-U, and HI.



B) schools' land uses.

The following figures show clearly the differences between parking rates for public and private schools



respectively.

Figure (4): Research rates vs. international and local rates for S-PU-S.

The figure above shows that the research rate is less than the ITE rate by 248.5 % and less than the Abu Dhabi rate by 301.5% while the Egyptian code rate not specified.

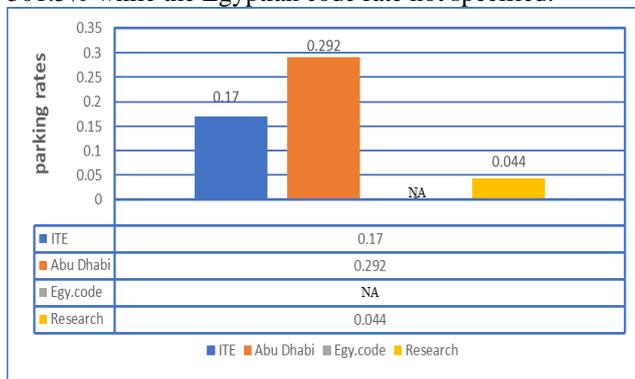


Figure (5): Research rates vs. international and local rates for P-PU-S.

The figure above shows that the research rate is less than the ITE rate by 286.4% and less than the Abu Dhabi rate by 563.6% while the Egyptian code rate not specified.

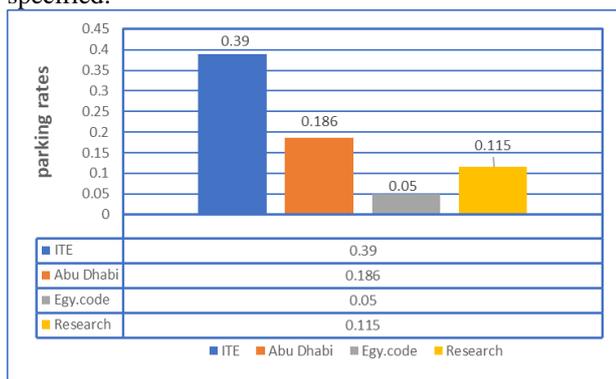


Figure (6): Research rates vs. international and local rates for S-PR-S.

The figure above shows that the research rate is less than the ITE rate by 239.1 %, less than the Abu Dhabi rate by 61.74%, and higher than the Egyptian code rate by 130%.

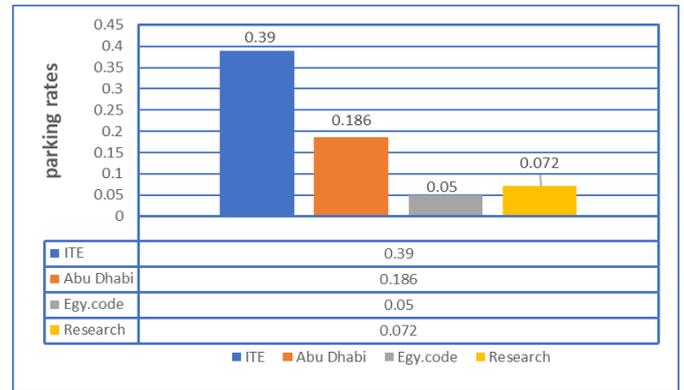


Figure (7): Research rates vs. international and local rates for P-PR-S.

The figure above shows that the research rate is less than the ITE rate by 441.7%, less than the Abu Dhabi rate by 158.3%, and higher than the Egyptian code rate by 44%.

For the research rates, it is noticed that the PDR of S-PR-S higher than PDR of S-PU-S by 74.2% and the PDR of P-PR-S higher than PDR of P-PU-S by 63.6%. This is attributed to car ownership in private schools higher than public schools.

C) Occasions halls land uses.

The following figures show clearly the differences between parking rates for WOH and COH respectively.

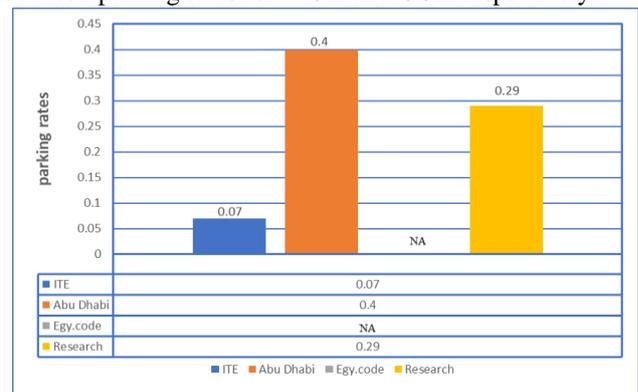


Figure (8): Research rates vs. international and local rates for WOH.

The figure above shows that the research rate is higher than the ITE rate by 314.3% and less than the Abu Dhabi rate by 37.93% while the Egyptian code rate not specified.

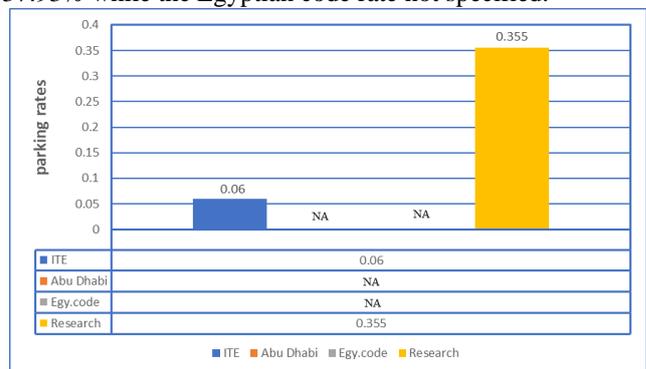
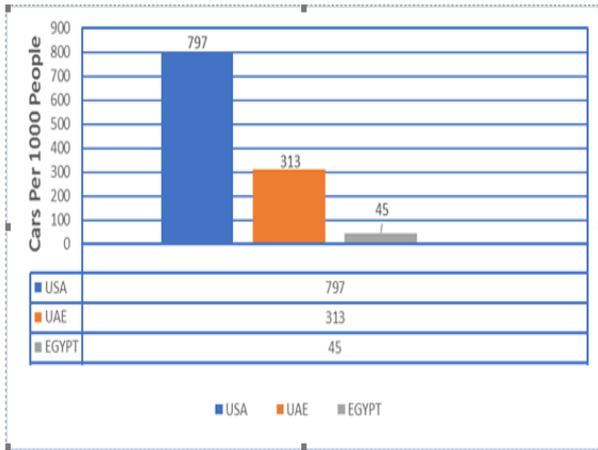


Figure (9): Research rates vs. international and local rates for COH. The figure above shows that the research parking rate is higher than the ITE rate by 491.7%, while the Abu Dhabi rate and the Egyptian code rate not specified.



D) Discussion of comparisons.

All previous comparisons show that there are significant differences between parking rates in this research compared to other countries. It's due to the fact that car ownership in Egypt is much less than those countries. (Figure 10) contains car ownership per 1000 people in the USA, the UAE, and Egypt, respectively. The Figure shows that car ownership in Egypt much less than the USA by 1671%, and much less than the UAE by 595.6%. So, it was obvious that PDR in Egypt



will be much less than PDR in those countries.

Figure (10): Car Ownership Per 1000 People (2017).

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions:

The following points were concluded:

- The Parking Demand Rates (PDR) in Greater Cairo region, Egypt are defined and shown in the following table:

No	Land use	Research results (Parking Demand Rates) (PDR)
1	Public universities	0.02 spaces per student
2	Private universities	0.1 spaces per student
3	Higher institutes	0.07 spaces per student
4	Secondary public schools	0.066 spaces per student
5	Primary public schools	0.044 spaces per student
6	Secondary private schools	0.115 spaces per student
7	Primary private schools	0.072 spaces per student
8	Wedding halls	0.29 spaces per seat
9	Consolation halls	0.355 spaces per seat

- Universities: PDR for private universities higher than PDR for higher institutes, and PDR for higher institutes higher than PDR for public universities. This is attributed to the higher car ownership.
- Schools: PDR for private schools are different from those for public schools. This is attributed to the higher car ownership.
- Occasions Halls: Good correlation was found when conducting (PDR) for wedding and consolation halls

(0.87 and 0.957) respectively.

- The research rates are less than ITE rates in all activities except for Occasions Halls, less than the current Egyptian Code rates for universities, and higher from the private schools' rate in The Egyptian Code.

B. Recommendations:

- This study should be expanded to include all activities in Egypt.
- To address the impact of some factors such as a social class on parking demand rates.

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