PARKING GENERATION MODEL FOR CITY CENTERS

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ABSTRACT

Car parking is an integral part of a transportation system, as well as a significant factor in the growth and development of communities. Traditionally, parking requirements have been established to ensure that sufficient parking will be provided for public streets. The goal has been to enhance access, improve traffic circulation, and prevent parking problems. More recently, the goals of such requirements have been adjusted for encouraging the use of environment-oriented transport systems such as public transport. This paper intended to analyze parking behavior in city center, Alexandria city center as a case study, and to determine a base parking generation model for different land uses in city center.

Keywords: Transpotation planning, Parking survey, Parking generation, Parking Models, Parking, Amasment, Parking characteristics, City centers, Parking requirements.

INTRODUCTION

Parking management was adopted to proposed development in order to control the level of local traffic and thus protects the environment. Historically, parking management was adopted by planning authorities in order to ensure that all parking associated with development could be accommodated within the curtilage of the site. This would reduce the need for cars to park in the surrounding roads, inconveniencing other road users. However, parking management has in recent years been increasingly used as a policy tool to restrict the level of traffic generation.

Parking requirements were seen as an integral element of the overall traffic requirements, with the following potentially conflicting objectives:

* to provide adequate access to facilities in and around the city centers, minimizing the inconvenience of searching for parking and walking to the final destination;
* to assist the efficient operation of the transport systems in the cities;
* to allocate parking space in terms of the need for access;
* to support the economic activity of the city;
* to protect the environment by controlling traffic levels;
* to achieve the optimal use of land available in the city

The procedure for estimating parking demand is complex. It involves many factors, including land use, type and number of persons expected to visit the site, availability of different transportation modes, and the time frame of the analysis. This paper is divided into three major sections. The first section analyzes the important factors that affect parking generation in city centers. The second section presents data collected from a parking survey in Alexandria city center, and introduces an analysis for the results of the parking survey. The final section examines a parking generation model in city center, and summarizes the results.

FACTORS AFFECTING PARKING GENERATION

There are a number of elements that influence parking generation in city centers:

* City size,
* Population characteristics,
* Land use,
* Alternative transportation modes,

* Traffic access,
* Parking facility congestion,
* Parking supply,
* Locations,
* Parking policies, and
* Parking fares

Generally, the city size is a particular factor in city center parking generation. The total parking demand increases as the size of city increases, but at decreasing rate [1].

Basic characteristics of population affect parking demand. These include family size, age distribution, income, car ownership, and residential density. Within the normal driver age limits, the younger group has the more pronounced influence on parking needs.

The term "land use" normally involves the principal activity or use of a given site. Parking generation may be related to a land or building area, to persons in occupancy, such as employees, visitors, or shopper, or to units such as seat in a theater or cinema.

The alternative to parking is to use another transportation modes include walking, taxi, group riding, public transport, and auto pickup/drop off. Whatever the alternate method of arrival and departure, it reduces parking demand. The availability and attractiveness of the alternative are both important.

Traffic access affects parking and vice versa. The amount of total parking demand for a facility may be limited by the inability of access streets.

Congestion, as measured in unacceptably long waits to enter or leave a parking facility, will reduce the demand.

Parking use also is influenced by the available parking supply. A deficiency in available parking space, as related to needs, will result in a subnormal use.

The location of a parking facility in relation to the user's destination is a prima factor in parking use. Convenience is measured in terms of walking distances, as motorists dislike walking.

A parking policy can be a very important component of an overall transportation policy which affects parking demand [11].

Finally, parking fares affect parking generation. When fares are increased, parking demand falls, as people either change mode for all or part of their journey, divert to alternative destinations, combine activities into fewer journeys or forego activities rather than pay the higher cost of travel. Long stay parking shows a trend of decline as fares increased [5, 16].

PARKING SURVEY

From the previous section, it is clear that parking generation in city center depends on the type and intensity of land use and socioeconomic characteristics of land users. Cultural conditioning and the availability of alternative travel modes also influence parking needs.

A parking survey was done, taking Alexandria's city center as an example. The objective of this survey was not only to count the parking accumulation for different land uses in city center, at the time of peak parking demand, but also to collect parker interview data such as trip purpose, destination and parking duration.

According to an observation, parking for the shopping purpose would generally peak in the evening period (from 5.30 P.M. to 9.00 P.M.) and on Fridays. Parking for work purpose (Bank, office building) and bank business would peak during working days, Sunday to Thursday, in the morning period (8.00 A.M. to 3.00 P.M.).

Two parking policies are available in Alexandria's city center; parking system with a fixed fare for a whole morning, evening, or night period (SYS1), and another with a so-called parking meter (SYS2).

Sites to be studied were carefully selected to be representative of most parts of the city center. Shops, shopping centers, banks of various sizes, and office buildings were selected. Five sites were surveyed in Alexandria city center (Manshya; Four sites with SYS1, P1 to P4, and Sant Catrin; one site with SYS2, P5); during the weeks of March 19 to April 16, and June 11-25, 1994. The parking survey was conducted between 7 A.M. and 11 P.M. for six weeks, at half-or one hour intervals. For each site included in the survey the maximum hourly parking accumulation observed on any day was noted, together with the time of the day at which it occurred. From the parker interview data trip purpose, destination, and duration of parking for each trip purpose were determined. Sites selected and the format of data collected are illustrated in Figure (1) and Table (1).

Table 1. Data collected
City center parking survey

Site: El Manshya
Name: El Etahad El-Eshtraky
Morning period
Date:
Day :

Time	In	Out	Accumulation
7.00-8.00	28	--	28
8.00-9.00	108	10	126
9.00-10.00	28	25	129
10.00-11.00	17	--	146
11.00-12.00	--	--	146
12.00-13.00	--	--	146
1300-14.00	5	20	131
14.00-15.00	--	99	32

Table 1. Data collected (Continued)

Time		Trip purpose				Parking Duration (h)	Destination
In	Out	work	Shopping	Bank Business	Other		
8.30	4.30 P.M.	+				8	Bank of
8.00	5.00 P.M.	+				9	Cairo
12.00	1.30 P.M.		+			1.5	Shasa

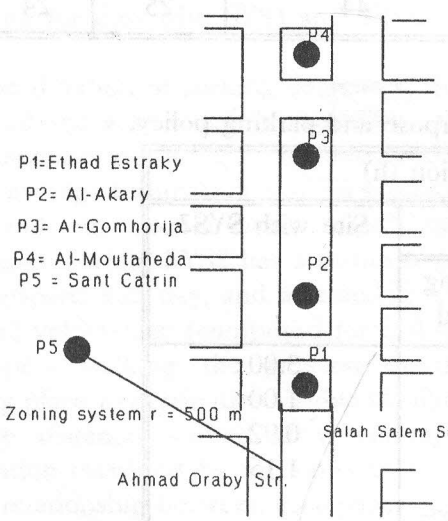

Figure 1. Parking sites selected in the study area.

The wide range in parking demand values clearly illustrates the difficulties in establishing a single requirement that will accurately reflect parking demand in every case. A number of variables are responsible for the variation in demand among sites. For shops and shopping centers, gross floor area (GFA) is the most important variable in determining peak parking demand. Parking generation for banks and office buildings are based on employees number. The number of parking spaces required per unit of area, or employment varies directly with the degree of motorization and modal split.

A zoning system was used to estimate the parking generation model. This system was selected depending on the average estimated walking distance from the parking place to destination. This value was estimated to be 500 m.

The number of vehicles parked on (or near) the site was related to the GFA of the shops and shopping centers or the number of employees of the surveyed zone according to trip purpose of the parked car. Other basic data, such as car ownership, and modal split were acquired at the study case.

PARKING CHARACTERISTICS IN CITY CENTERS

Analysis of the survey data showed that, parking for work purpose, long-period parking, is concentrated on sites with SYS1, while parking for shopping, Bank business, and other purposes; short-period parking, is concentrated on sites with SYS2.

The higher percentage of parking facilities use in city center was recorded for both sites with SYS1 and SYS2 as following:

Sites with SYS1:

* during working days, for work, morning period (from 8.00 A.M. to 3.00 P.M.) 66% and evening period, for shopping (from 5.30 P.M. to 9.00 P.M.) 54%, and
* on Fridays, for shopping, namely 56%.

Parking for Bank business was account for morning period 18%, and the remaining 16% involves shopping and other purposes such as doctor visits and service (Table 2).

Sites with SYS2:

Mainly for shopping, Bank business, and other purposes, namely 92% for morning period, 98% for evening period, and 95% on Fridays.

Table 2. Parking demand in Alexandria's city centers classified by trip purpose and parking policy.

Trip purpose	Site with SYSI			Site with SYS2		
	During week %			During week (%)		
	Morning period	Evening period	Friday (%)	Morning period	Evening period	Friday (%)
* Work	66	18	19	8	2	5
* Shopping	3	54	56	27	73	71
* Bank Business	18	--	--	21	--	--
* Other	13	28	25	44	25	24

Table 3. Parking duration according to trip purpose and parking policy.

Trip purpose	Duration (h)		
	Site with SYS1		Site with SYS2
	Morning period	Evening period	
* Work	8.50	4.00	3.00
* Shopping	2.25	2.50	1.00
* Bank Business	1.75	--	0.92
* Other	2.50	2.75	1.15

According to the parking policy performed, parking duration varies with the type of trip for morning and evening periods. Table (3) shows the relationship between parking duration and trip purpose for sites with SYS1 and SYS2. As shown in Table 3, workers make the greatest duration of parking, while Bank business parking makes the lowest duration of stay in parking areas.

Parking meter (SYS2) restricts the duration of parking for all trip purposes. Figure (2) illustrates a comparison between duration of parking for sites with SYS1 and SYS2.

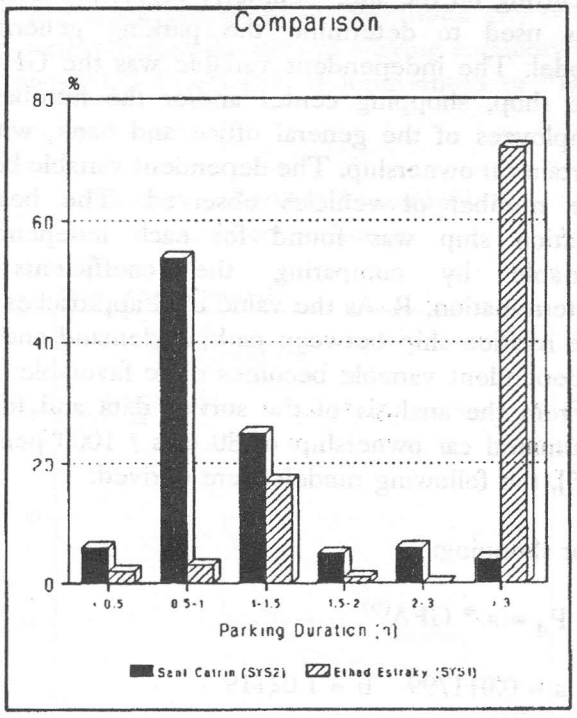

Figure 2. Comparison between duration of parking for sites with SYS1 and SYS2.

As the duration of parking decreases, the turnover rate, and the accumulation capability of a parking place increase. According to the surveyed data, SYS1 has an average turnover rate of 3.6 vehicle/space and day, and an accumulation capability of 756 vehicle/day, while SYS2 has a turnover rate of 14.2 vehicle/space and day, and accumulation capability of 2,982 vehicle/day (computed for 210 spaces).

Shoppers walking the greatest distances from parking place to destination. Table (4) illustrates the average distance walked from parking place to destination classified by trip purpose.

The relationship between time parked and walking distances from a parking place to a destination for shopping, Bank business, and other purposes, is given in Figure (3). This Figure shows that the parking duration increases as the walking distance increases.

Table 4. Average walking distances as a function of trip purpose.

Trip purpose	Distances wallked (m)
* Work	50
* Shopping	1150
* Bank Business	275
* Other	660

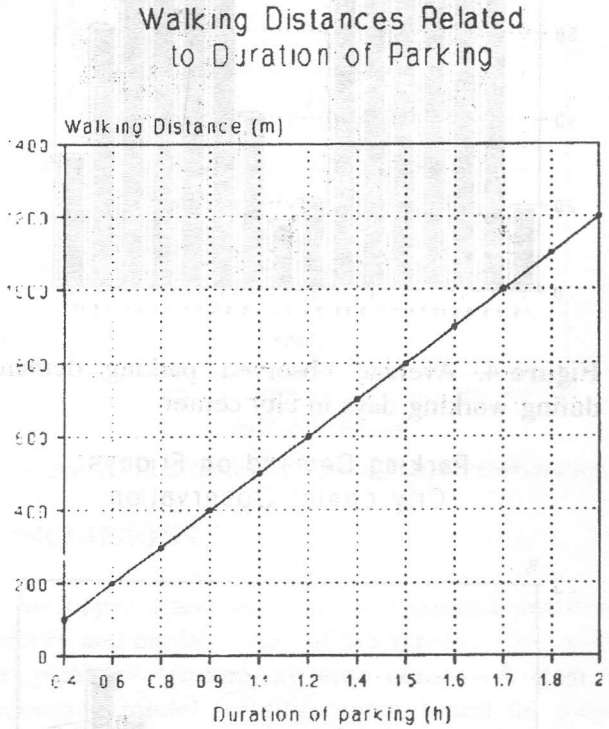

Figure 3. Length of time parked in relation to distance walked from parking place to destination for shaping. Bank business and other purposes.

Figure (4) and (5) show the average observed parking demand in Alexandria's city centers during the working days and on Friday. The parking demand for a typical working day in Alexandria's city centers showed a morning peak between 11.00 A.M. and 1.00 P.M. and an evening peak between 6.00 and 9.00 P.M.. On Friday between 11.00 A.M. and 1.00 P.M. in the morning period and between 6.00 and 9.00 P.M. in the evening period.

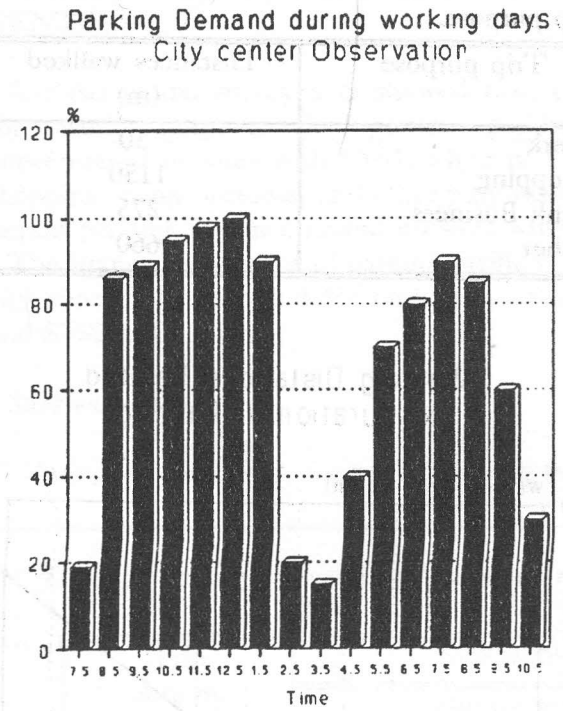

Figure 4. Average observed parking demand during working days in city center.

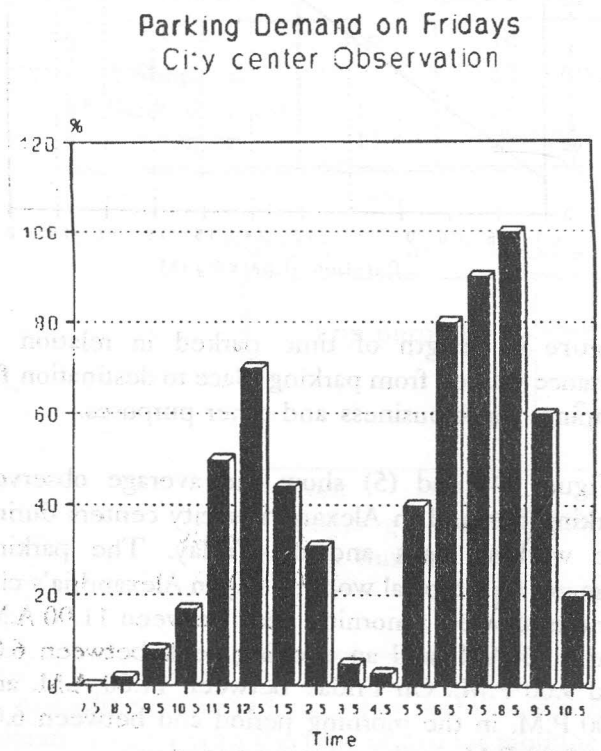

Figure 5. Average observed parking demand on Fridays in city center.

PARKING GENERATION MODEL

The calculation of a parking demand model for each site was based on the GFA of the development (or other parameter) and the parking accumulation occurring on the site. Geometry regression analysis was used to determine the parking generation model. The independent variable was the GFA of the shop, shopping center and/or the number of employees of the general office and bank, with a certain car ownership. The dependent variable being the number of vehicles observed. The best-fit relation ship was found for each independent variable by comparing the coefficients of determination, R. As the value of R approaches 1.0, the relation ship between parking demand and the independent variable becomes more favorable.

From the analysis of the survey data and for an estimated car ownership of 80 cars / 1000 persons [15], the following models were derived:

For shopping:

$$P_d = a * GFA^{(b)},$$

$$a = 0.011799 \quad b = 1.02119$$

$$R = 0.85 \qquad (1)$$

For work:
Morning period: (peak)

$$P_d = c * E^{(d)},$$

$$c = 0.06977 \quad d = 1.19716$$

$$R = 0.9858 \qquad (3)$$

Evening period:

$$P_d = c * E^{(d)},$$

$$c = 0.02977 \quad d = 1.19716$$

$$R = 0.91 \qquad (4)$$

where:

P_d :parking demand
GFA: gross floor area of the shop or shopping center in square meters
E : number of employees in general office or banks
R : coefficient of regression
a,b,c,d: constants

Derived from the previous models, shopping parking requirements in Alexandria city center will be 1.3 spaces/100 Sq. M. GFA. Work parking requirements range from 7 to 17 spaces/100 employee. A comparison between shopping parking requirements (Sq. M./ space provided) in Alexandria city center and corresponders in cities of varying economy and car ownership levels [10] is represented in Figure (6).

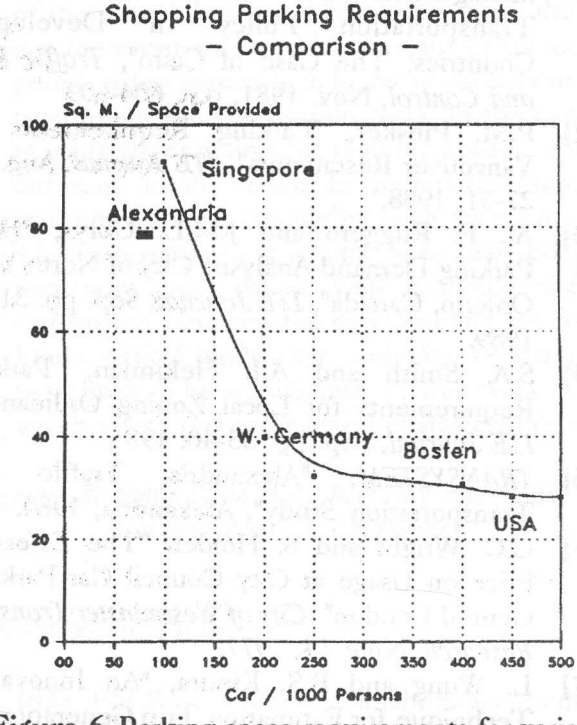

Figure 6. Parking space requirements for various cities of varying car ownership levels.

As shown in Figure (6), the number of parking *spaces required per unit area GFA, varies directly* with the degree of motorization. In other words, as the number of cars per 1000 persons increases, there is a corresponding decrease in the area of GFA required per parking space.

Derived from the model in equation (1) and Figure (6), a relationship between car ownership and the factor "a" is estimated in Figure (7).

According to Smith [14], the value of 70 to 75 spaces/100 employee for parking demand of office buildings is suggested as a good minimum base requirement. That means, the present standard of parking in Alexandria city centers is seriously deficient in relation to real demands and should be amended to a new general standard.

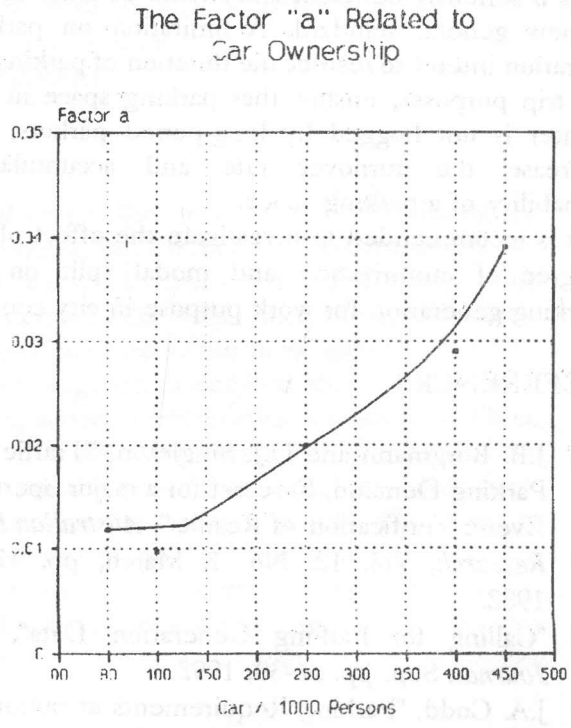

Figure 7. The factor "a" related to car ownership.

CONCLUSIONS

This paper attempts to analyze parking behavior, identify and explain some of the variables that affect car parking demand at city center. A parking generation model for city center, based on shops, shopping centers-, banks-, office buildings size, and car ownership in catchment area, has been derived. It is suggested that parking generation takes account of city center acting.

Parking spaces required being determined as a fixed per unit area of shopping centers, and/or per number of employees of banks and office building, for a certain degree of motorization. The number of parking spaces required per unit area (or another parameter) varies directly with the degree of motorization.

Excluding the summer season, Parking Index value in the catchment area (expressed as the number of parking spaces per 100 M^2 shopping area) were derived to be 1.3. Parking indexes for banks and office buildings (expressed as the number of parking spaces per 100 employee) were observed to range

between 7 and 17.

The present standard of parking in the catchment area is seriously deficient and should be amended to a new general standard. A limitation on parking duration intend to restrict the duration of parking for all trip purposes, ensure that parking space in city center is not hogged by long-period parkers, and increase the turnover rate and accumulation capability of a parking space.

It is recommended to investigate the effect of the degree of motorization and modal split on the parking generation for work purpose in city centers.

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