

An Analysis of the Utilization of Diagonal Parking on Urban Boulevards in Riyadh, Saudi Arabia

Howard Roland Bradsher-Fredrick

*Department of Planning, College of Architecture and Planning,
King Saud University, Riyadh, Saudi Arabia*

Key words: Parking, arterials, boulevards, on-street, commercial, frontage, congestion, double-parks, queuing, simulation, model, regulation, policy.

Abstract. A majority of the primary arterial roadways in Riyadh, leading from the CBD to the northern part of the city, can best be characterized as divided with three or four lanes of traffic leading in each direction and commercial property access provided through the provision of on-street diagonal parking. While this type of urban street design lends itself to great aesthetic quality, the demands made upon these roadways in attempting to attain the dual objectives of rapid movement over substantial distances as well as access to commercial frontage leads to the problems of traffic congestion in the right-hand lanes, hazardous traffic conditions, and difficult access to commercial frontage.

The author chose a section of roadway where this problem appeared to be particularly acute, collected empirical data based upon actual observation, devised, and ran a computer simulation model calibrated with the empirical data to gain further information concerning the magnitude of the problem at that location. Moreover, an argument is presented that this computer simulation model could prove to be useful in assessing the impact on traffic congestion of a commercial development project prior to implementation, thus enabling remedial action prior to development of a traffic congestion problem.

Introduction

In many developing nations, it has become commonplace to include wide avenues and boulevards in the city plan. The rationale behind the inclusion of such grand thoroughfares in the urban design is to enhance the aesthetic appeal of the city in addition to providing for ease of movement. While wide thoroughfares can enhance the beauty of an urban area, to be sure, urban planners must be cautious in designating the land usage patterns and in regulating proper access to commercial development along these thoroughfares.

It is the purpose of this article to scrutinize the utilization of on-street diagonal parking as a means of providing access to commercial strip development along major

inner city thoroughfares. This type of access is heavily utilized in the northern portion of the city of Riyadh along most major arterial streets. Focus was placed on one particular location which was deemed fairly typical of the existing situation. This location illustrated the inability of major thoroughfares to achieve the dual objectives of providing for ease of movement and of providing proper safe access to commercial land while employing on-street diagonal parking.

Empirical data were systematically collected at that location on the activity observed. A computer model was designed for the specific purpose of fully quantifying the implications of the observed results. These results served to support the hypothesis that problems indeed exist in allowing on-street diagonal parking on major thoroughfares in the northern portion of the city of Riyadh. In the final discussion, proposals are advanced to suggest possible areas of future research to help ameliorate the present situation and to suggest regulatory measures to discourage the future occurrence of similar phenomena.

Background

Riyadh has grown rapidly during the past decade, becoming a metropolis of over one million persons. The northern portion of the city has been an area of particular interest in the development plan. The new campus of King Saud University and the new Diplomatic Quarter (in which many of the foreign embassies are now being located) were opened in 1983 and 1986, respectively. King Khalid International Airport was opened beyond what might be considered the city boundaries; this occurred in the early 1980's. These major development projects, in addition to the major commercial development projects of Al-Akariyah, Al-Shola, the New Al-Akariyah, the new Dallah Suq and many other smaller commercial development projects, are all important attractors of persons. All of this commercial development has been opened during the past few years in the northern part of Riyadh in the Malaz, Olaya and Sulamaniyah districts.

There are presently six major thoroughfares linking the northern districts of the city with the Central Business District. From west to east these are Al-Dariyah Rd., Takhassusi Rd., Themaneen St. (a.k.a. Makkah Rd.), Olaya Rd., Old Airport Rd., and Sitteen St. All of these streets are characterized by a center divider, relatively high traffic volume, and a relatively high speed limit. These major arterials vary in width from 30 to 80 meters, with the number of traffic lanes available varying from three in each direction with a single center divider, to six in each direction with multiple dividers. Some of these streets permit on-street diagonal parking through part of their length to provide access to commercial strip development. See Fig. 1 for a graphical description of these principal thoroughfares and their location within the city of Riyadh, indicating the sections of road in which on-street diagonal parking is generally permitted.

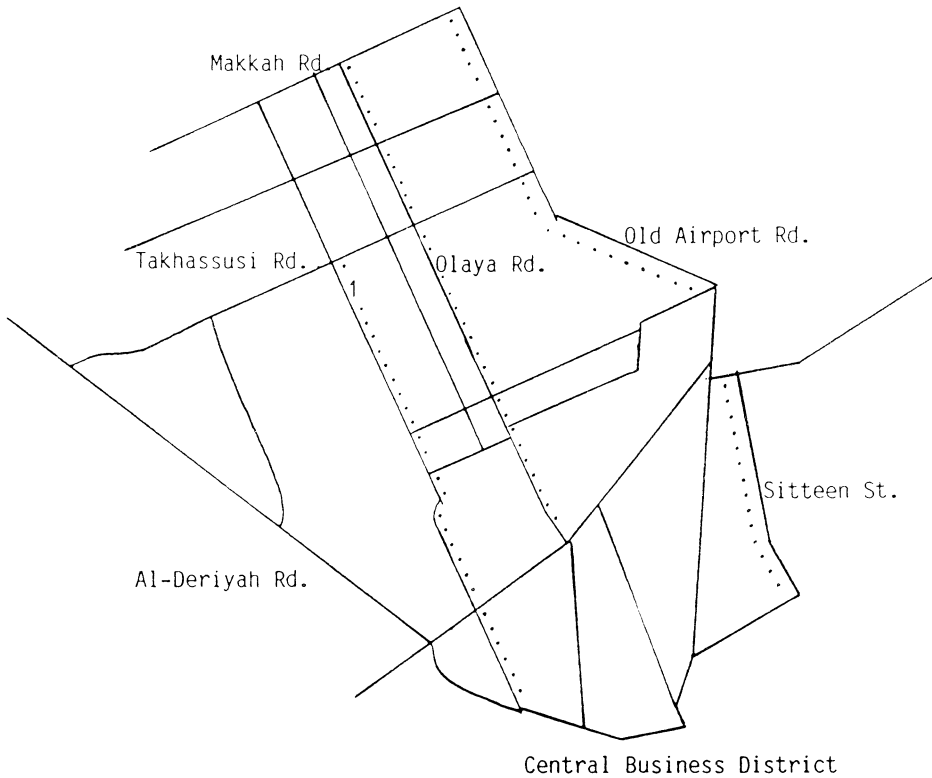


Fig. 1. Locations with on-street diagonal parking on major North-South arterials in Northern Riyadh.

- . Locations with on-street diagonal parking allowed
- 1 Location of study area

The Study

The principal objective of this study was to provide empirical evidence to support the hypothesis that the utilization of diagonal parking on urban boulevards was, at times, inappropriate in the Riyadh setting. Casual observation indicated that during peak traffic hours, when commercial shops were in operation, boulevards no longer fulfilled their dual role of providing for ease of movement of traffic and direct access to commercial development while utilizing on-street diagonal parking.

In the academic literature, attention has been given to the issue of providing diagonal on-street parking along major traffic arteries. Gallion and Eisner state their criteria as follows:

So while diagonal on-street parking is not recommended on main streets unless they have ample width for vehicles to back out of parking spaces without disturbing the traffic flow, [1, p. 283].

C. A. Junker describes his designs for contending with the problem of having commercial frontage along out-lying major roads. He provides both prosaic and schematic descriptions; a portion of his prosaic description follows:

through traffic lanes in the center of the road, with rows of trees separating these lanes from lanes for local traffic to the side; another row of trees comes next, and finally walks or access drives in front of the shops and garages. The local traffic lanes are for the special use of motorists using roadside services, allowing them to cruise more slowly, thereby eliminating the traffic conflicts which normally occur on such roads, [2, pp. 58-59].

A short commercial strip (approximately 50 meters long) on Takhassusi Rd. was chosen as an area where closer study would take place. This strip is located between Al-Arruba Rd. and Tahlia St. on the east side of Takhassusi Rd, (see Fig. 1). The shops located on this commercial frontage include a catering equipment shop, a small grocery, a small restaurant, a pharmacy, and a bathroom fixture shop. Twenty-four spaces of diagonal on-street parking spaces are provided; no stripes are employed to designate individual parking spaces.

This particular strip was chosen because it met specific criteria of interest. These criteria include the following:

- 1- The commercial strip is located on one of the principal arterials leading to the northern part of the city. (Takhassusi Rd. has four lanes of traffic running in each direction, with a center divider and designated diagonal on-street parking in many locations along the commercial strip development).
- 2- Traffic is fairly heavy along this street, providing a major thoroughfare for vehicles travelling to King Khalid International Airport from the western part of the city.
- 3- The speed of the traffic is fairly rapid along this roadway (the speed limit is 70 k.p.h. through the study area).
- 4- At the particular location to be studied, there are no reasonable alternatives to the on-street diagonal parking provided (i.e., no local streets are readily available in the area to offer an alternative to the parking spaces provided).
- 5-From observing traffic in northern Riyadh on boulevards with designated on-street diagonal parking, this particular strip seems fairly typical in terms of its general congestion. At various times during the day, particularly when commercial shops first begin to open in the morning (9 a.m.) and in the afternoon (5 p.m.), congestion in the right-hand lane can be very heavy.

Methodology

It is the intention of the next portion of this article to describe the empirical evidence gathered and the methods employed in gathering the data. These data were

collected from direct observation of the study area, as previously defined, while observing during a time period of significant commercial activity.

The specific question to be answered was related to the issue of what portion of the time would all parking be filled in the given location and would one or more vehicles remain “unserved” in attempting to locate a parking space. This occurrence is of particular interest because of the undesirable actions taken by drivers of vehicles in this event. What normally transpires is one of three undesirable actions:

- 1- The driver “double-parks” his vehicle, blocking one or two vehicles already parked and also blocking one-half or more of the extreme right-hand lane of traffic.
- 2- The driver waits in the right-hand lane of traffic for a parking space to become available. This activity also normally blocks traffic in that lane.
- 3- The driver cruises past all of the filled parking spaces very slowly, attempting to determine if a space is available or will soon become available. This activity serves as a great impediment to traffic flow.

This question of the proportion of time was answered through the following methodology. The study area was observed on a daily basis at approximately the same time (beginning between 9:00 and 9:15 a.m.) with the following data noted:

- 1- The number of parking spaces (upon arrival).
- 2- The precise arrival time (to the nearest second) of each vehicle arriving (or attempting to “arrive”) during the period of study.
- 3- The precise departure time (to the nearest second) of each vehicle departing (or attempting to “depart”) during the period of study.

This period of study normally lasted approximately twenty minutes.

A sufficient number of data points were collected so that one could be relatively confident that the data were representative of the phenomena being studied. These data were to be utilized to calibrate a computer simulation model designed to answer the question, “Based upon these data, what portion of the time during peak commercial activity will traffic be impeded in the right-hand lane of traffic due to a complete lack of available parking spaces when parking spaces are yet being sought?” The assumptions underlying the model are the following:

- 1- All parking spaces under consideration are equally attractive to the driver of the vehicle.
- 2- Vehicle drivers do not consider parking spaces available outside of the study area (e.g., across the street) as viable alternatives.
- 3- The sample collected was a reasonable approximation to the total population.

Results

From a sample of vehicle arrivals and departures ($n = 32$) over a period of ten days, it was found that the average number of available parking spaces upon arrival

(when the researcher/observer first arrived on the scene for the purposes of data collection) was approximately equal to 1. The average time between arrivals approximated a normal distribution with a mean of 7.2 minutes and a standard deviation of 4.4 minutes. The average time between vehicle departures also approximated a normal distribution with a mean of 6.9 minutes and a standard deviation of 5.3 minutes.

These parameters were utilized to calibrate the queuing model devised. (See Fig. 2 for a schematic diagram of the computer model). The model required this set of data and initial conditions in order to ascertain the initial number of parking spaces available and to simulate a sequence of vehicle arrivals and departures to correspond with observed phenomena. It should be noted that this computer model is not a standard queuing model typically utilized in analyzing queue length and waiting times. This model utilizes inter-departure times rather than service times. The rationale for utilizing this type of analysis is the following. Study of this system required the collection of data related to a queuing system already in progress, without previous knowledge of the time of arrival of each vehicle already being served (i.e., already parked). The output of interest was also not typical of the usual analysis of queuing systems. Typical waiting line analysis is primarily concerned with the analysis of length of waits, length of queues and the cost of serving clients. This analysis was only concerned with the portion of time a queue existed (i.e., vehicles were waiting or searching unsuccessfully for a parking space).

For ultimate flexibility, the computer model was coded in the FORTRAN IV programming language and run on VAX hardware. For 200 randomly generated cases (viz., according to the constraints previously mentioned), the results are shown in Table 1.

Table 1. Output data generated by computer simulation model

Sample size = 200		
Total number of parking spaces = 24		
Initial number of spaces occupied = 23		
Inter-arrival statistics:		
Mean = 7.2 minutes		
Std. Dev. = 4.4 minutes		
Inter-departure statistics:		
Mean = 6.9 minutes		
Std. Dev. = 5.3 minutes		
Number of Spaces Occupied	Number of Vehicles in Queue	Portion of Time (%)
21	0	0.0
22	0	1.8
23	0	19.5
24	0	47.6
24	1	29.9
24	2	1.2

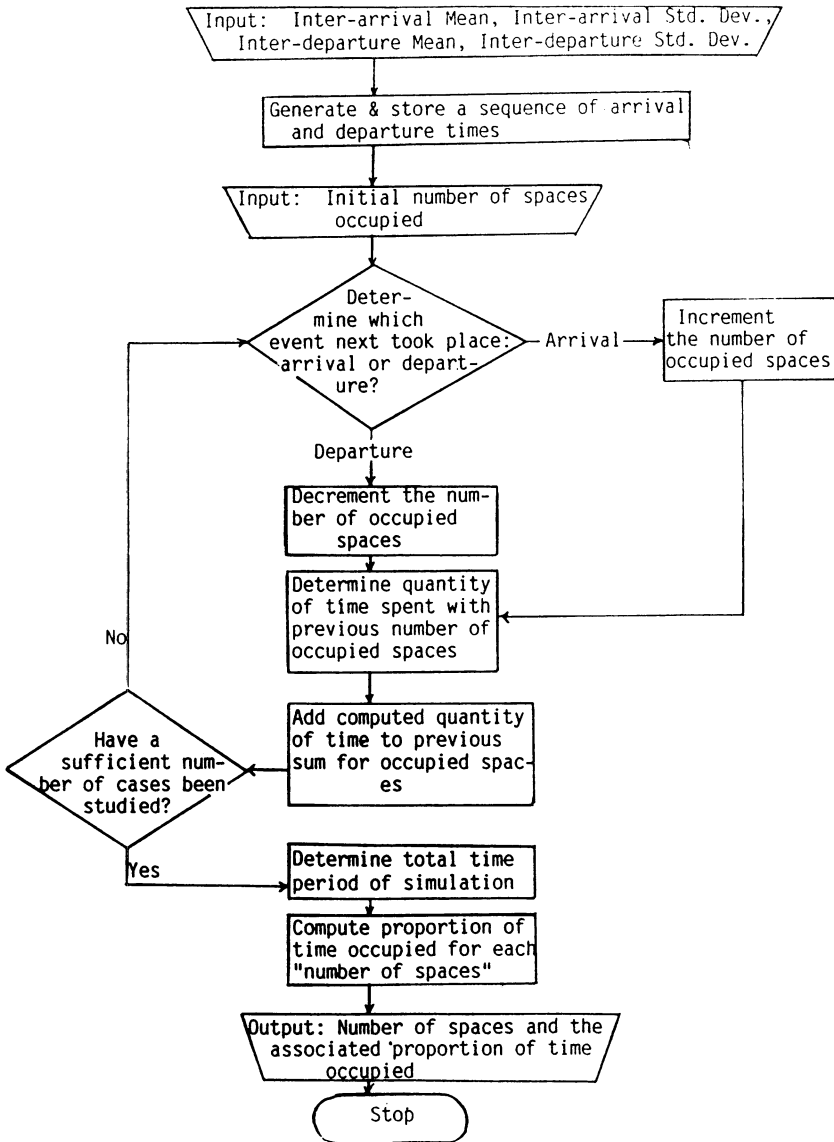


Fig. 2. Schematic Diagram of the Queuing Model utilized

One can readily compute from these model-generated data, that on average 31.1% of the time (during peak time periods) one or more vehicles will be attempting unsuccessfully to locate a space to park, with all of the concomitant hazards and inconvenience mentioned in the previous section.

This “prediction” of the model corresponded reasonably well with the data utilized to calibrate the model (27.6%) and data collected at a later date utilizing a smaller sample size over a three-day time period (22.9%).

Discussion and Conclusions

Based upon the empirical evidence and computer analysis as well as informal observation performed as the basis for this article, evidence has been presented to show that problems have been created in northern Riyadh through the provision of diagonal on-street parking when providing direct access to commercial strip development. This poses a particularly severe problem when the commercial development is located along arterial streets, both with respect to gaining access to commercial development and with respect to impeding the flow of traffic. There are many instances in which this type of urban design is utilized in this portion of the city.

The computer simulation model created to analyze the problem of congestion and access with respect to on-street diagonal parking served as a reasonably reliable predictor of the number of vehicles waiting to be served. It was able to “predict” the observed data from which it was calibrated and it predicted the congestion problem at a later date within a reasonable degree of error. For other types of on-street parking (e.g., parallel parking), the model should be equally capable of characterizing the existing situation. The only question relates to whether driver behavior varies for different types of parking. If the driver “double-parks” his vehicle, waits in through-traffic or engages in other types of behavior which impedes traffic flow, then the model can be successfully applied. Casual observation in Riyadh indicates that the problem created by allowing parallel parking is not as widespread as with diagonal parking. However, the problems of congestion and access appear to exist with parallel parking as well.

The true utility of the model should manifest itself if it can be employed to predict the impact on street congestion of various parking schemes before the implementation of the commercial strip project. Under this proposal, the developer would be required to assess the number of vehicles to be attracted during peak hours and a profile of the expected service time (dependent upon the type of commercial establishment proposed). The model could then be utilized to determine if an adequate number of on-street parking spaces can be provided in order to service all clients, subject to probabilistic criteria (e.g., the parking provided should be expected to meet peak demand 99% of the time). Under such a regulation, off-street parking would be required as part of the proposed development if on-street parking were to cause an undesirable impact on traffic congestion.

References

- [1] **Gallion, Arthur B. and Eisner, Simon**, *The Urban Pattern*, 4th ed. New York: Van Nostrand Reinhold Company, 1983.
- [2] **Junker, C.A.** "Sub Urban Design", In: *The Growth of Cities*, Lewis David ed., London: Elek Books, 1971.

تحليل استعمال مواقف قطرية للسيارات على الطرق الرئيسية في الرياض، المملكة العربية السعودية

هاورد رولاند برادشر - فريدريك

قسم التخطيط والدراسات العمرانية، كلية العمارة والتخطيط، جامعة الملك سعود

الرياض، المملكة العربية السعودية

ملخص البحث . إن معظم الطرق الرئيسية بمدينة الرياض الممتدة من المركز التجاري عبر الجزء الشمالي من المدينة مقسمة إلى ثلاثة أو أربع خطوط في كل اتجاه . . . وقد تم تخطيط مواقف للسيارات أمام المحلات التجارية المطلة على هذه الشوارع ومع أن هذا النوع من تخطيط الطرق يتعرض بالكثير من الخصائص الجمالية إلا أن محاولة الجمع بين سرعة الحركة للمسافات الطويلة من جهة والوصول إلى المحلات التجارية من جهة أخرى قد أدى إلى مشكلات عديدة في الجزء الذي يقع إلى أقصى اليمين من الطريق الرئيس نتيجة لقربه من مواقف السيارات للمحلات التجارية .

لقد تم اختيار جزء من طريق رئيس كمثال جيد لدراسة هذه المشكلة . . . وقد جمعت المعلومات والبيانات اللازمة ثم تحليلها ومعالجتها بواسطة برنامج للحاسب الآلي . وقد توصل إلى بعض الملاحظات التي تؤكد جدوى استعمال هذا البرنامج في تقويم أثر وجود المحلات التجارية على جانبي الطرق الرئيسية على حركة السيارات وبالتالي يمكن الاستفادة من نتائجه في عملية تخطيط الشوارع ودراسة الحركة .