

TRAFFIC GENERATION AND PARKING DEMAND OF THE QATAR INTERNATIONAL SQUASH AND TENNIS CENTRE

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ABSTRACT

In early 1992 the Government of the State of Qatar decided to construct a new squash and tennis centre. Ministry of Municipal Affairs and Agriculture (MMAA) staff made an assessment of the centre's probable traffic generation and parking demand. When the first international tournaments began at the end of the year, the MMAA had the opportunity of surveying the actual generation and demand.

This study explains how staff made the initial assessment and compares the observed with the predicted traffic figures. The paper illustrates the pattern of traffic behaviour during the tournaments and discusses aspects of the design and traffic analysis which assessors of similar major facilities could consider in the future.

The forecast data for the Tennis Tournament Centre are similar to the observed values although the distribution of arrivals between accesses was different. Traffic flows at the Squash Tournament were lower than expected.

INTRODUCTION

Qatar is an Emirate on the eastern edge of the Arabian Peninsular (Fig.1). Its population in 1990 was 484,000 and it has a surface area of 11,427 sq.km. The main industries are the production of oil and natural gas. Much of the country's population resides in the capital city of Doha. The Government of Qatar is keen to encourage the continuing development of the State and its infrastructure, and is particularly interested in providing more recreational and sports facilities for both local users and visiting tourists. With this in mind, in early 1992 the Government of Qatar decided to construct a new, International Sports Centre for Squash and Tennis Competitions. They chose a site in Doha,

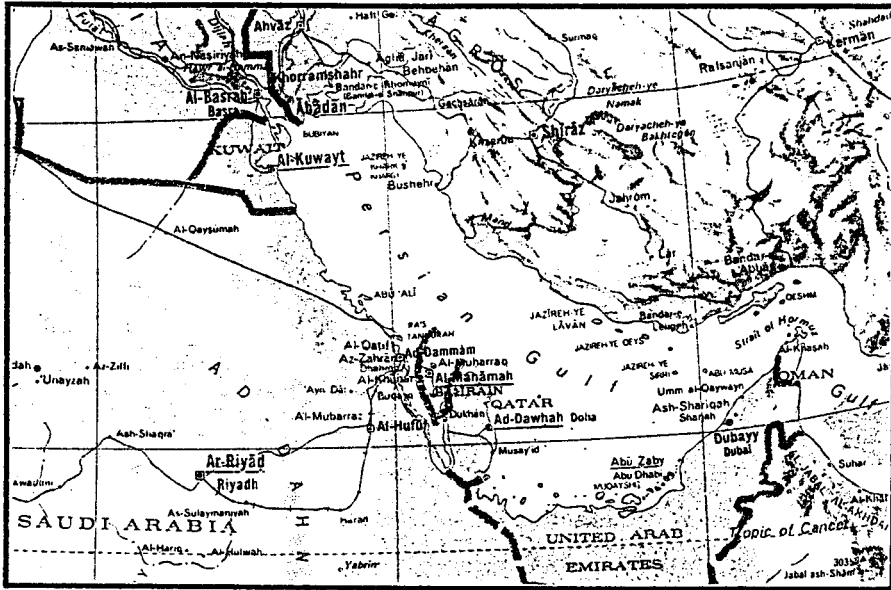


Figure 1: Regional location

about half-way between the Central Business District (CBD) and the new residential district of West Bay. The MMAA ran the project as a fast-track design and construction scheme, and were able to complete it by the beginning of December 1992. The Centre opened in the same month and the first international squash tournament started on the 17th December. The first international tennis tournament followed in early January, 1993.

THE DEVELOPMENT

The site of the new sports centre is close to an intersection of two of Doha's secondary routes (Fig. 2). Khalifa Road lies to the south of the site and Majlis Al Ta'awon along its eastern side. Markhiya Road, a tertiary distributor, runs along the north of the site. The chosen site is also close to other sports and recreational facilities, such as the Corniche promenade and the Qatar Sports Club (Fig.3). The site has three accesses, each by a two-way, minor T junction onto one of the three adjoining main roads. The Majlis Al Ta'awon access is restricted to VIPs. After some local and international research, the MMAA decided to include the range of facilities shown in Table 1. They observed the possibility of adding more facilities to the site at a later date. The figure shows the general arrangement of the project (Fig. 4).

Traffic Generation and Parking Demand of the Squash and Tennis Centre

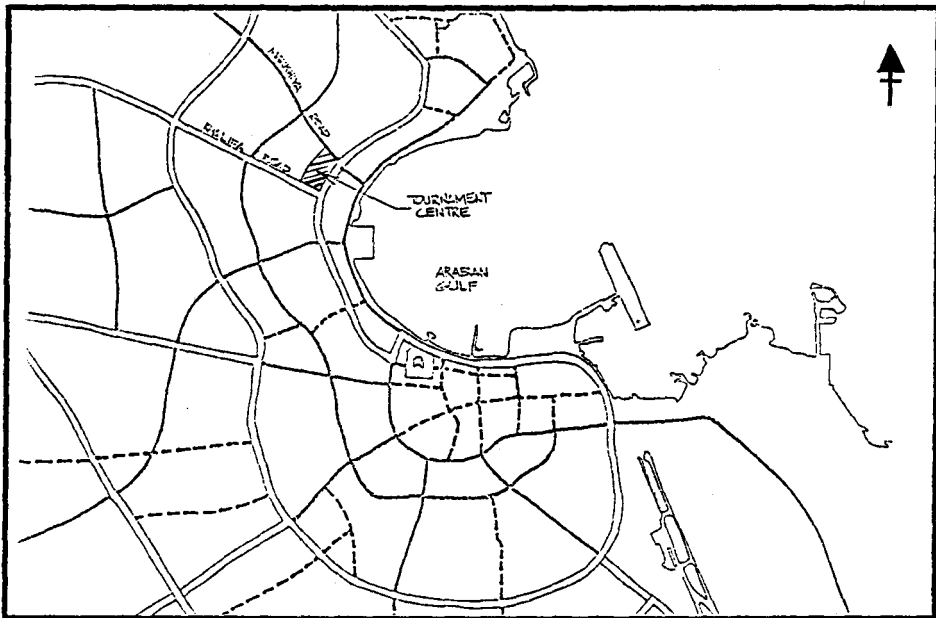


Figure 2: Doha and the location of the tournament centre

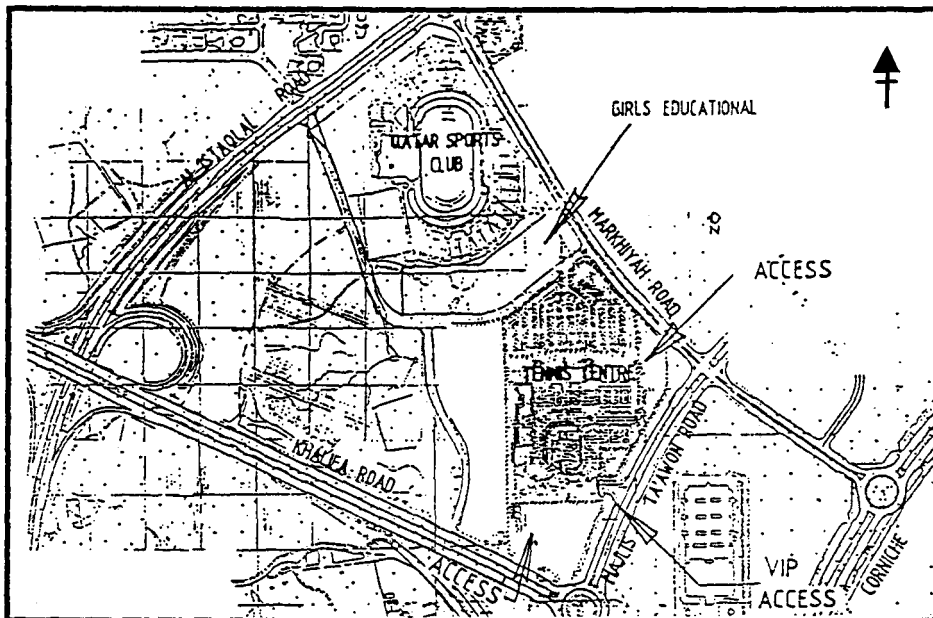


Figure 3: Adjoining land uses

Table 1: Summary of facilities and their use

| FACILITY | NUMBERS | | |
|--------------------------|------------|------------------------|--------|
| | Normal use | Use during tournaments | |
| | | tennis | squash |
| TENNIS FACILITIES | | | |
| Tennis Courts | 5 | 9 | 5 |
| Spectators | 100 | 4000 | 100 |
| VIP Visitors | | 200 | |
| Tournament Officials | | 50 | |
| TV, Press and Security | | not known | |
| SQUASH FACILITIES | | | |
| Squash Courts | 4 | 4 | 4 |
| Spectators | 20 | 20 | 1000 |
| VIP Visitors | | | 50 |
| Tournament Officials | | | 20 |
| TV, Press and Security | | not known | |
| ADMINISTRATION | | | |
| General Admin Staff | 40 | 40 | 40 |

SOURCE: pre-construction discussions with the Architect.

NOTE : - the figure for tennis spectators is the seating capacity of the 3 stands (Centre Court and Courts 1 and 2).

PRE-CONSTRUCTION ASSESSMENT

The initial assessment of the project considered three separate aspects: traffic generation, parking demand and the impact on the surrounding road network. The traffic generation analysis used the 'first principles' technique. This started with the assumptions that during peak-use, every seat for spectators will be filled, there will be a considerable number of visiting VIPs, and there will be a full squad of tennis players. It then reasoned how each of these users would gain access to the facility. Table 2 shows some of the assumptions made about the use of the facilities and the characteristics of the mode and time of travel of players and spectators. Local knowledge and a review of the literature supported these assumptions. The speed of the project was such that it did not allow any traffic surveys to be made of major events at other, similar facilities in the region.

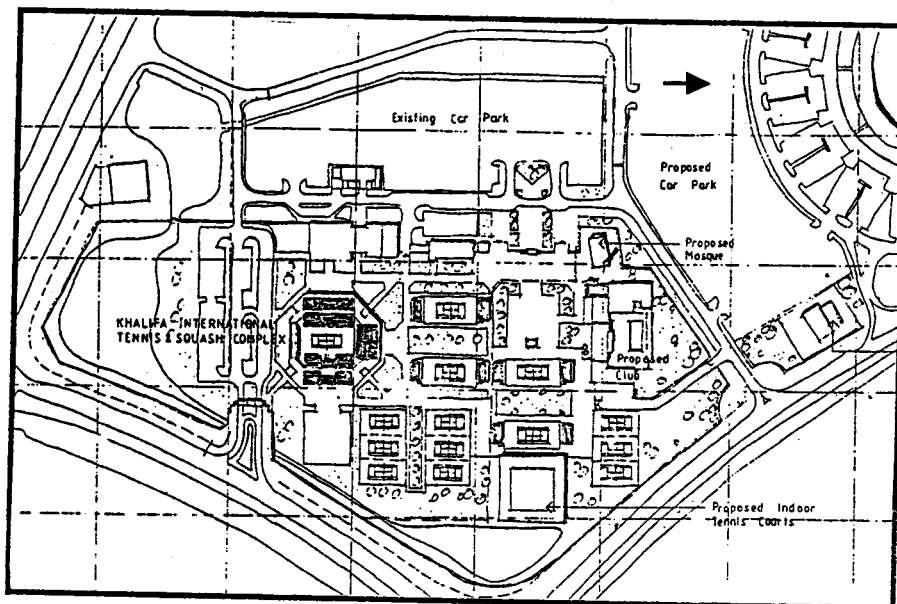


Figure 4: Layout of the centre

The full list types of user which the study addressed included:-

- players (normal squash and tennis players, tournament squash and tennis players).
- spectators (normal use, and for squash and tennis tournaments).
- VIPs (for squash and tennis tournaments).
- TV and press reporters, and security staff (for squash and tennis tournaments).
- officials (normal administrative staff, special staff for squash and tennis tournaments)
- goods vehicles.

Estimates of the demand for parking also used the assumptions outlined in Table 2. For example, when seats for spectators are full, all those who arrived by car will have left their vehicles to "accumulate" in the car parks. For 100 spectators at a tournament, allowing for modal split and car occupancy, the figures would suggest there would be 40 cars in the car park.

Traffic Impact:

Doha is in the happy state where most of its road network operates below capacity, and even during the off-peak periods. This is partly because many of

the suburban areas are not as fully developed as the city's extensive main road network. The study made a manual assessment of additional flows on the external road network by:-

- basing trip generation on the assumption that the centre will be full for an international tennis tournament
- distributing trips on the basis of existing zonal populations; and
- manually assigning the resulting zonal trips to the main road network.

Table 2: Assumptions used in estimating traffic and the demand for parking

| | |
|---|--|
| <p>Players Number Modal Split Vehicle Occupancy Arrival & Departure Times</p> | <p>4 per court normal use 100% by car; tournament use 50% by car, 50% by taxi. normal and tournament use: 1.0 per car & 1.0 player per taxi normal use 50% arrival and departure during main road traffic peaks; tournament use 100% arrival 9.00 to 10.00 hours, 100% departure between 18.00 and 19.00 hours, and 25% arrivals and departures during intermediate hours.</p> |
| <p>Spectators Number Modal Split Vehicle Occupancy Arrival & Departure Times</p> | <p>normal use tennis 100, squash 20; during tennis tournament 4,000, squash tournament 1,000 (Architects figures) normal use 100% by car; tournament use 80% by car, 10% by taxi and 10% by school bus/minibus. normal use 1.5 per car; tournament use 2 per car, 1.5 per taxi, 20 per school bus/minibus normal use 50% arrival and departure during main road traffic peaks; tournament use 100% arrival 9.00 to 10.00 hours, 100% departure between 18.00 and 19.00 hours, and 25% arrivals and departures during intermediate hours.</p> |

POST-CONSTRUCTION ASSESSMENT

The First International Squash Tournament Survey Results

The opportunity to carry out follow-up traffic surveys came at short notice, and some details of both the squash and the tennis tournaments, in particular the start and end times of matches, were not recorded. However, traffic counts of all the entrances to the site did cover the full days' events. The counts started at 13.00 hours on Thursday, 17th December 1992 and finished at 23.00 hours the same day.

The survey results (Table A1) show that vehicle - arrivals peaked between 14.15 to 15.15 hours, with a flow of 196 veh/hr, whilst vehicle - departures peaked between 17.15 and 18.15 hours (125 veh/hr) and again between 19.00 and 20.00 hours (100 veh/hr). The maximum car parking accumulation was just over 250, but only for a short period. There were more than 200 cars parked on site (80% of the maximum observed demand) for only just over two hours. Most traffic, about 60% arrived by the Khalifa Road access and just over half, 51%, left by the Markhiya Road access. About 14% of traffic used the VIP access from Majlis Al-Ta'awon Road whether arriving at, or departing from, the site.

The figures of arrival and departure profiles (Figs. 5 & 6) show a sharp peak in vehicle arrivals to the squash tournament, with lower, flatter peaks in the curve of vehicle departures. Vehicle accumulation (Fig. 7) reached a maximum about an hour after the peak in the arrival flows (Fig. 8). Peak accumulation did not last for long; the core peak period lasted just over 2 hours. Figures 7 and 8 show curves for parking accumulation. There is some difference between the two due to different scales used in plotting. Figure 7 plots accumulation at 15 minutes intervals, whilst Fig. 8 shows a simpler curve, with points at intervals of one hour. Figure 8 assumes an empty site at the start of the survey period.

Comparison of observed and forecast values

The observed peak hour flows were much less than those predicted, at 26% to 42% of the predicted figures (Table 3), but attendance at the tournament was low. The estimates were based on capacity attendance. For the same reason the observed, peak parking demand was less than half the predicted figure. It was also expected that most traffic would arrive and leave the site by

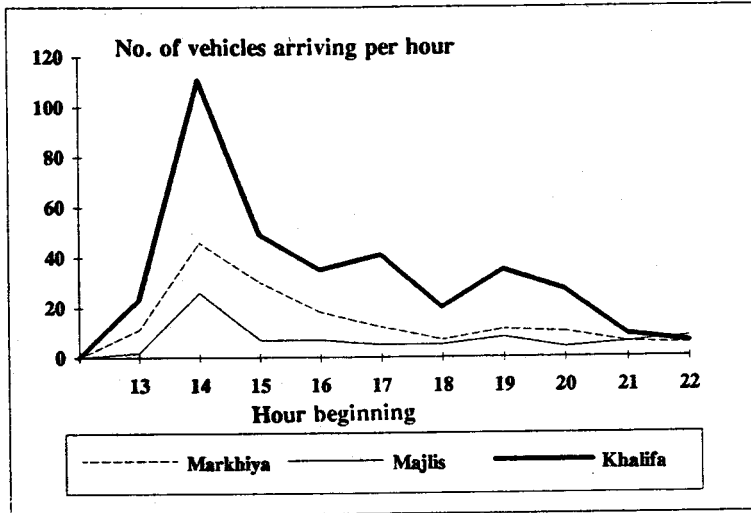


Figure 5: Squash tournament, arrivals (veh/hour)

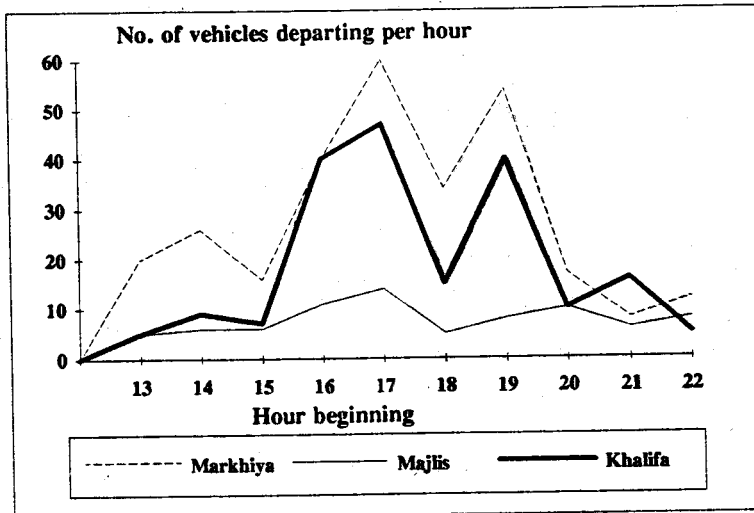


Figure 6: Squash tournament, departures (veh/hour)

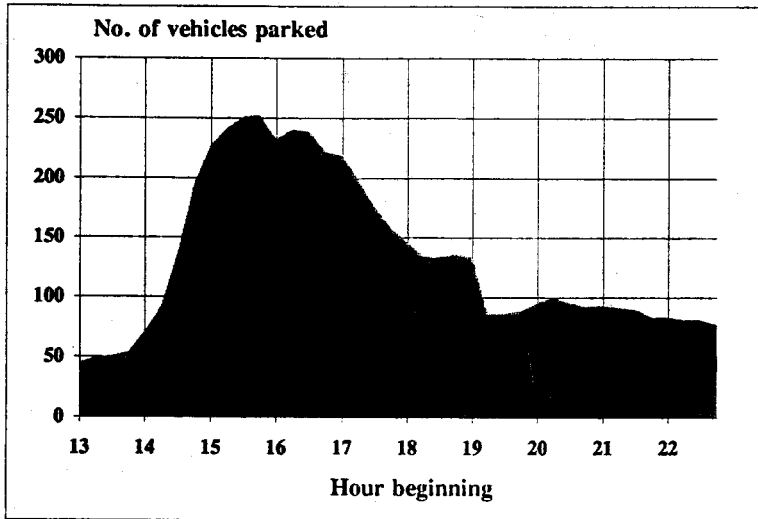


Figure 7: Squash tournament, vehicle accumulation

Note: curve plotted on 15 minute time base.

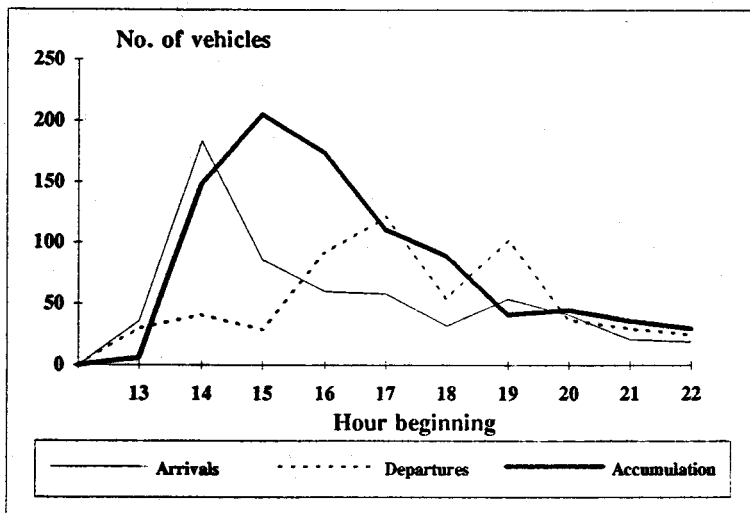


Figure 8: Squash tournament, summary

Note: curve plotted on an hourly base.

the Khalifa (south) access. If VIP traffic using the Majlis Al-Ta'awon access is ignored, then for the total survey period most traffic did indeed arrive by the Khalifa access (70% observed, 60% predicted) whilst most traffic left by the Markhiya access (60% observed, 40% predicted).

Table 3: Squash Tournament: summary of observed and forecast values

| TRAFFIC ELEMENT | | OBSERVED | FORECAST |
|---|------------------|----------|----------|
| Peak Hour Arrivals | total | 196 | 471 |
| | VIP | 23 | 45 |
| Peak Hour Departures | total | 125 | 471 |
| | VIP | 13 | 45 |
| Demand for Parking | | 250 | 575 |
| Distribution of Arrivals ¹ | Markhiya (north) | 30% | 40% |
| | Khalifa (south) | 70% | 60% |
| Distribution of Departures ¹ | Markhiya (north) | 60% | 40% |
| | Khalifa (south) | 40% | 60% |

NOTE: ¹excluding VIP traffic using Majlis Al Ta'awon access.

The First International Tennis Tournament

Survey Results

Two traffic surveys of the tennis tournament covered the last four days of the event, from Thursday the 7th January to Sunday, 10th January 1993. One survey counted vehicles arriving at and departing from the three accesses to the site between 13.00 and 23.00 hours. The second survey recorded the number of parked cars on the site at intervals of 30 minutes, and noted whether they were parked in a formal parking space or whether they were informally (and often illegally) parked. Full results are contained in the appendices (Tables A2 to A6).

The surveys showed the number of vehicles arriving peaked at about the same time each day. The peaks were much more concentrated for the last two, 'finals' days (Table 4 and figure 9). The tennis matches were scheduled to start at 15.00 hours, and the surveys showed that most people arrived just before the start of the matches. The number of vehicles departing peaked at different times. On the last two days there were two peaks (Table 5 and Fig. 10) for vehicles departing, probably corresponding to the end of the most important matches. As with the Squash Tournament, most traffic to the Tennis Tournament arrived by the Khalifa Road access and left by the Markhiya Road

Table 4: Tennis Tournament: highest number of vehicle-arrivals in a continuous hour

| | | | |
|----------|------|-------------------------|-----------------------|
| Thursday | 863 | between 14.30 and 15.30 | 27% of total arrivals |
| Friday | 830 | between 14.30 and 15.30 | 27% of total arrivals |
| Saturday | 1577 | between 14.30 and 15.30 | 47% of total arrivals |
| Sunday | 1626 | between 14.15 and 15.15 | 47% of total arrivals |

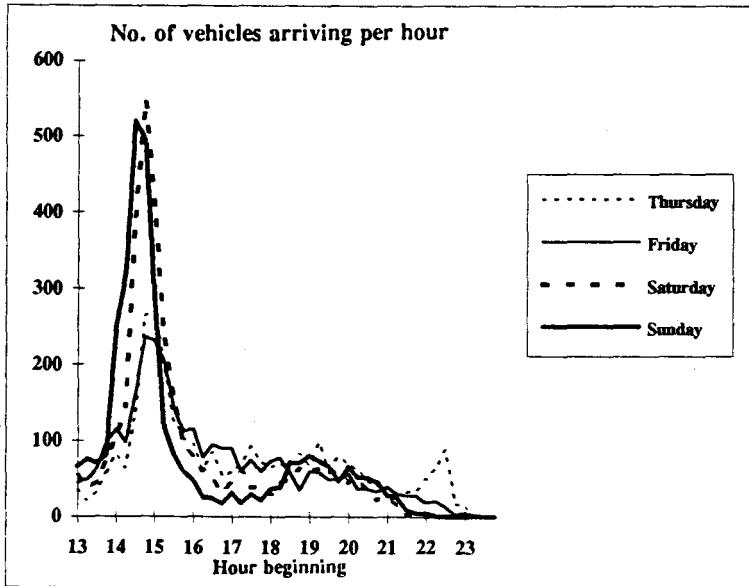


Figure 9: Tennis tournament, arrivals (veh/hour)

Table 5: Tennis Tournament: highest number of vehicle - departures in a continuous hour

| | | | |
|----------|------|----------------|--|
| Thursday | 1026 | 21.45 to 22.45 | 32% of total departures |
| Friday | 969 | 19.00 to 20.00 | 32% of total departures with a smaller peak of 470 veh/hr between 21.30 and 22.30 |
| Saturday | 914 | 19.30 to 20.30 | 27% of total departures and an almost contiguous second peak of 774 vehicles between 18.15 and 19.15 hours |
| Sunday | 1025 | 20.15 to 22.15 | 30% of total departures and 896 vehicles between 18.15 and 19.15 hours |

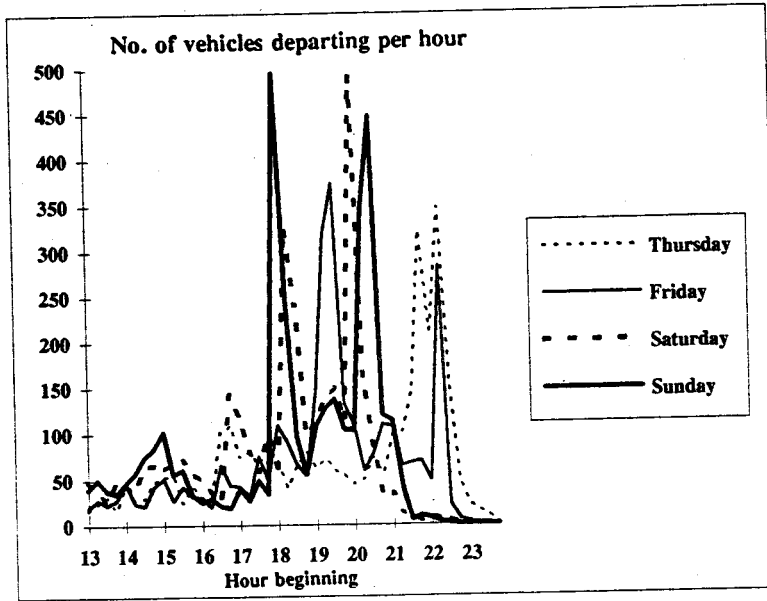


Figure 10: Tennis tournament, departures (veh/hour)

access (Table 6). Only 10% of the total traffic used the VIP access compared with 14% of the Squash Tournament traffic, but of course non-VIP traffic flows were higher.

Table 6: Tennis Tournament: summary of the arrival and departure patterns by day of the tournament

| Day | Khalifa Road Arrivals | Markhiya Road Departures | Majlis Al Ta'awon |
|----------|-----------------------|--------------------------|-------------------|
| Thursday | 73% | 54% | 10% |
| Friday | 73% | 53% | 8% |
| Saturday | 69% | 52% | 9% |
| Sunday | 71% | 54% | 10% |

NOTE figures show % of total daily traffic arrivals and departures; for Majlis Al Ta'awon, the VIP access, they show % of total daily arrivals plus departures. All the percentages covered total traffic including VIP traffic to Majlis Al-Ta'awon for Sunday.

The traffic surveys provided two estimates of the demand for parking. One is the result of the count made of the number of vehicles parked on the site formally and informally (Table A6) but excluding the VIP area. It showed that

the maximum number of vehicles parked at any one time during the last day of the Tennis tournament was just over 1700 (this figure does not include vehicles simply setting down persons). The second estimate from the access counts covered the VIP access and will also have covered setting down persons. It suggests that only some 370 vehicles parked for more than 3 hours (20% of the maximum observed). A comparison of the profiles of the accumulation of vehicles, using data from the counts at the car parks, shows how the demand for parking increased each day for the last four days of the Tennis tournament (Fig. 11). The maximum accumulation of vehicles only lasted for about 3 hours on the last day of the competition and the profiles of the day to day accumulation show how the accumulation increased over the four days of the Tennis tournament with Thursday, the first day, being the lowest with around 1000 parked vehicles from about 17.00 to 22.00 hours. This was about 55% of the peak on Sunday, the last day of the tournament.

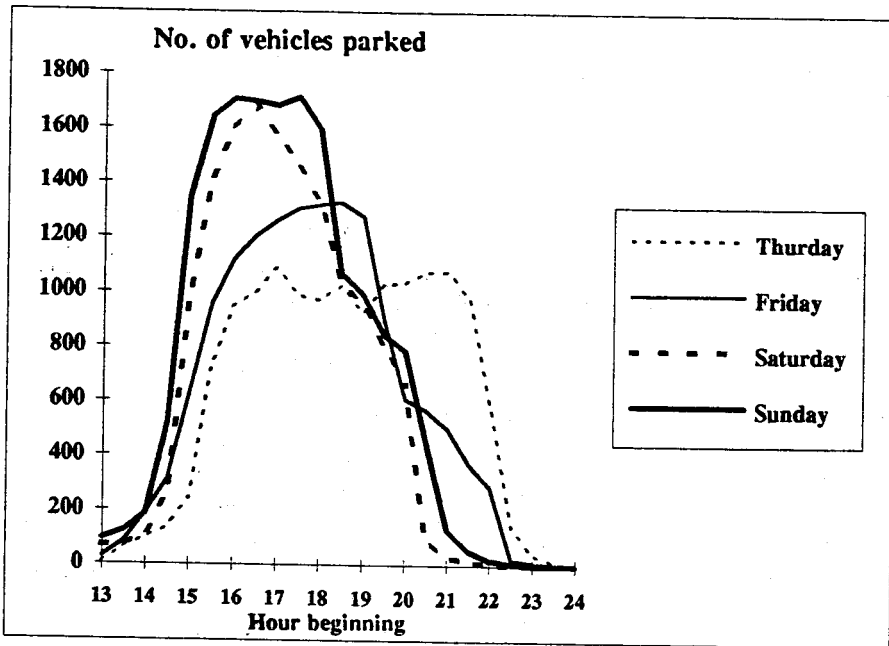


Figure 11: Tennis tournament, vehicle accumulation

Comparison of observed and forecast values

The observed peak - hour flows and the maximum demand for parking are similar to the forecast values (Table 7 excludes VIP traffic using the Majlis Al-

Ta'awon Access). As with the Squash Tournament, we expected most traffic to arrive and leave the site by the Khalifa (south) access. Most arrived by the Khalifa access (79% observed, 60% predicted) whilst most traffic left by the Markhiya access (60% observed, 40% predicted).

Table 7: Tennis Tournament --summary of observed and forecast values

| TRAFFIC ELEMENT | | OBSERVED | FORECAST |
|---|------------------|----------|-------------|
| Peak Hour Arrivals, Sunday | total | 1626 | 1160 - 1660 |
| | VIP | 129 | 140 |
| Peak Hour Departures | total | 1025 | 1160 - 1660 |
| | VIP | 89 | 140 |
| Parking Demand, Sunday | | 1840 | 1850 |
| Distribution of Arrivals ¹ | Markhiya (north) | 21% | 40% |
| | Khalifa (south) | 79% | 60% |
| Distribution of Departures ¹ | Markhiya (north) | 60% | 40% |
| | Khalifa (south) | 40% | 60% |

NOTES: ¹ These figures compare usage of the Markhiya and Khalifa accesses only, and so exclude VIP traffic using the Majlis Al Ta'awon access. The quoted survey data is for the Sunday (the last day of the tournament).

DISCUSSION

It is probably a little unusual for pre- and post-construction studies to be made of the same project. One reason is that the consultant who carried out the initial studies will have moved on to other work, and the developer who paid for them, provided no serious traffic problems occurred, is now concerned with other, new projects and is not over-interested in financing research into a completed project. In this study, use of a pragmatic method of assessment was able to produce a good estimate of traffic and parking generation. The MMAA will soon have two, new, state-of-the-art tools to assist in traffic impact assessments. One is a new traffic model, which will be developed as part of a new Physical Development Plan Study for Qatar; the other is the State's GIS System.

Engineering is not an exact science and no traffic survey has 100% accuracy. Manual classified counts have an accuracy of $\pm 10\%$, for 16 hour counts, with 95% confidence limits (1). The accuracy can be less for more detailed surveys (the accuracy of a 16 hour classified count in estimating the flow of different types of goods vehicle is of the order of $\pm 20\%$). In this study, analysis of the survey data at the two tournaments included some 'balancing' of

the results for the accumulation of vehicles. For example, the accumulation shown in Table A3 shows 28 vehicles present at the start of the survey period. This is a slight increase in the number observed, as otherwise they would have been a negative value for the accumulation at 22.45 hours (negative cars do not exist).

Buttke (2) describes three different methods of calculating trip generation: from a graph, from a regression equation, and from average rates. The Trip Generation Manual of the Institute of Transportation Engineers (ITE) of the United States of America (3) is moving towards regression equations. There are three problems with these methods. First, summarizing data in graphs or regression equations hides the raw material, which moves away from the principles of "base data integrity" (4). Second, the average rate can be somewhere inside a very wide range of values; for example, the trip rate of a State Park quoted in the ITE Manual (3) is 0.66 vehicle trip ends per acre, within a range of 0.12 to 26.27 trip ends per acre. The graph of this data shows a similar number of trip ends for Parks ranging in size from one or two acres to almost 5,000 acres. The third problem is that most of the data which form the basis of Buttke's three methods are collected for one particular country, that being the USA in the case of the ITE. Social and behavioral characteristics vary from country to country; in Qatar, Friday morning traffic flows can be very low, whereas in the USA they are typically high weekday flows. Characteristics also vary within the same country; for example, car ownership in the UK decreases with the size of the urban area and this can affect car-based trip rates to similar facilities located in different places. Stover and Koepke (5), refer to other problems, such as the age of the base data, in a wider debate on the matter.

Buttke (2) also refers to the direct survey of an existing development, similar in type to the proposed one which is the subject of the new analysis, but implies that this is a method of last resort. It does produce figures which are implicitly based on local social, behavioral and engineering characteristics. Working from first principles is a step-by-step approach which is a sort of 'micro' application of the basic methods of classical models of traffic. A good, early and widely used example of this in the UK was the Greater London Council user's guide manual (6). It would be very helpful if cities and countries of the GCC region would pool their available data on trip-making characteristics and trip generation, perhaps in setting up a computer data-base on the lines of existing computer databases such as "TRICS, TRAIDS AND GENTL" in the UK (7).

Car parking takes up a large area of the site. At the time of the first tournaments the project had about 550 formal parking spaces on site. The

maximum number of vehicles parked at any one time was about 1840 vehicles, although this peak demand only lasted for around 3 hours. The typical demand for parking during the four days of the Tennis Tournament was over 1,000 spaces, but for most of the time the new Centre operated well. On the last day of the tennis tournament we understand that traffic and parking patterns on the site were often chaotic. Drivers were parking on the verges of Khalifa Road and Markhiya Road, and on any empty space in and off the formal car parks. It is not necessarily cost-effective to provide sufficient parking to meet a demand which, at most, lasts for only a few hours each year. At such times, Traffic Police and temporary traffic wardens will normally be on hand to direct traffic, and traffic not destined for the event can be re-routed. In addition there are other parking facilities nearby which could be brought into use for future international tournaments, and with this in mind the MMAA is considering the development of special pedestrian links between the Tournament Centre and the car parks at the Qatar Sports Club and the main Post Office building near the Corniche.

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