

Roundabouts vs. Intersections: The Tale of Three UAE Cities.

A review of historic developments and current practice with an aerial photographic documentation

Bassem Younes, Ph.D

The United Arab Emirates is one of the Gulf cooperation Council member States in the Middle East. It comprises seven federated Emirates namely Abu Dhabi (the capital), Dubai, Sharjah, Ajman, Um Al Qaiwain, Ras Al-Khaimah, and Al Fujairah^a. The three largest urban concentrations are Abu Dhabi, Dubai, and Sharjah^b. Since its independence in December 2nd 1971, the UAE has experienced phenomenal growth and development fuelled by the production of oil and the prominence of some locations as key trading crossroads. The UAE acts as a service provider and a major import/re-export center for a catchment area of some 1.5 billion people.

The rapid economic growth and fast growing economy resulted in an ever changing urban scene and setting. Whilst this has been evident in the three main urban centers, the remaining emirates home also experienced major changes, even if on a lesser scale. The transportation system that links the different regions, as well as the internal or inter-state system is road borne. Traffic has experienced phenomenal growth on city streets with travel demand and vehicle ownership experiencing significant increases. Unfortunately, the only records available are from the city of Dubai and to a lesser extent from Abu Dhabi. The rate at which the economy grew has meant that other issues (e.g. Building the necessary infrastructure to keep up with the increasing demand for movement) took priority over the systematic monitoring of the traffic behavior and the changing transportation landscape.

Background:

In the early days, the number of vehicles was very small. The rough and sandy terrain of the area made it only possible for a certain type of vehicles to use the then available tracks. The British authorities that then had administrative control over the whole area had developed the roadway network in accordance with British engineering standards and codes. It was therefore natural that the roundabout figured as almost the only type of intersection in the roadway network. This was in line with the acceptable practice where priority central is used to achieve the control is used to achieve the control of traffic movements at intersections where traffic flows are small.

Examining visual data obtained from an extensive database^c has turned out some fascinating record of the history of such developments. These are presented as a main part of this paper.

In order to better understand the local situation some thirty years ago and the present conditions, it is important to highlight some of the basic rules and regulations that govern the planning aspects in the UAE.

The seven different emirates each have a municipal authority that oversees the planning, design and implementation of transportation facilities. This is usually carried out through the assistance of international consultants who have been involved in this for many years. The different departments within a municipality undertake the relevant parts of the process accordingly. For example, the planning development would be responsible for the overall structure and strategic planning for the city. The roads department, usually within the same municipality, has its own road planning section that is responsible for the actual planning of roads. Thereafter the design and construction sections within the same department handle the plans.

In the early days, land requirements were readily available. As such, even where the land required for a large island roundabout is greater than that needed for the traffic signal control (specially where flows on one pair of arms are low) the preference for a roundabout would still be accommodated. The fact that most land was and largely is still owned by the state facilitated such decisions.

At present, the extensive built-up situation evident in the urban centers mentioned, and the growth in population and vehicle ownership has warranted considerable changes to the old approach and practice.

The conventional roundabouts (the UAE has never really implemented mini-roundabouts) have difficulty in dealing with unbalanced flows, especially during peak hours when the traffic entering on an arm is considerably greater than the traffic leaving by it. In such situations, there is frequently a shortage of gaps in the circulating stream and as such, delays may become excessive.

As in many other parts of the world, roundabouts have been commonly used in central city areas where traditionally they were used to resolve traffic and pedestrian conflicts in the large open squares that existed in the early 50's and 60's. The central island frequently covered a large area of the square and was utilized for ornamental flowerbeds or statues whilst traffic circulated around the surrounding carriageway.

Increasing traffic demand, and the pressure to allow pedestrians to cross the carriageway at grade, has resulted in many of these roundabouts being connected to signal control, so that more positive control over traffic movements on an area wide basis may be exercised. At first part-time signals were introduced but the continued growth in demand resulted in most of these becoming full-time signals at all the key locations in the city.

In suburban areas roundabouts are frequently found at the intersection of radial type roads where they are subjected to peak hour traffic demands due to commuter flows. Roundabouts were also used on rural roads or inter city links where traffic flows or the road type did not justify the provision of a grade-separated intersection. In such situations, speeds are usually high on the approaches to roundabouts and safety is an important consideration.

In addition to the resolution of traffic conflicts, roundabouts were employed where there was a significant change in road type, a change from rural to urban conditions, or when a significant change in road direction was required. It was actually believed that roundabouts deal more efficiently than signal control with traffic movements where there are three arms and well-balanced flows (in real life this cannot be easily arranged). For example, when the number of arms exceeds four, then driver guidance through direction signing becomes difficult. Moreover, with many approach arms the diameter of the roundabout increases, leading to possible higher circulating speeds and consequent safety problems.

In the prevailing UAE practice, there are two basic types of roundabouts:

1) *Normal or conventional roundabout*

One which has a one-way circulatory carriageway around a kerbed central island 4 m or more in diameter and usually with flared approaches to allow multiple vehicle entry. There have, however, been a number of variations to this definition evident in many cases and to some extent appearing to be influenced by certain practice or preference at times. Variations of this type include ring junctions; grade separated roundabouts and signalized roundabouts.

2) Double-roundabouts

A double roundabout is defined as an individual function with two normal or mini roundabouts either contiguous or connected by a central link road or kerbed island. It is considered that this type of function will have advantages in certain circumstances (e.g. joining two parallel routes separated by a river railway or motorway, junctions with more than four entries, improving an existing staggered junction avoiding the need to realign one of the approach roads).

Double roundabouts in the form of two bridge roundabouts and dumb-bell roundabouts are utilized in grade-separated intersections. This form of roundabout control is visible along some of the Sheikh Zayed road interchanges.

The roundabout design has certain limitations. It is usual to add at least one additional lane at the entry of the approach roads to the circulating area with a maximum addition of two lanes, and a maximum entry width of four lanes. However, in cases of predicted low future flows, widening may not be considered necessary. Nevertheless, a minimum of two lanes in an entry is desirable. Moreover, the angle at which vehicles enter the circulating area is of considerable importance in the operation of a roundabout as it carries serious safety implications especially in non-signalized roundabouts.

Over the years, which experienced a rapid growth in urbanization and, therefore increased demand for mobility and accessibility, the UAE urban centers have experienced similar problems and challenges. However, the response to these issues has been anything but similar. The product visible today in some centers appears to be the objective of recent developments in centers still lagging behind.

A Brief History of Developments

First, there were roundabouts almost everywhere. These were designed and implemented as per the specific requirements of different locations. The size^d of these varied from one junction to another, and at times appeared to be a hasty and rushed arrangement. In other cases however, especially in the mid 70's and thereafter, designs were being based on identified needs and forecasted demands.

The Abu Dhabi Experience

Photographic and historical observation and documentation clearly show the prevailing conditions (at the start of the urban explosion witnessed in Abu Dhabi over the last quarter of a century or more) with roundabout dominance on the infrastructure plan.

The city of Abu Dhabi appointed Deleuw Cather, a USA engineering consultancy firm to carry out a planning and transportation study in the early 70's. The same consultants continued to be involved even to date, with results clearly influenced by American design standards. It is worth noting that all new junction control designed in the city has been in the form of signalized intersections. This will be the subject of a more detailed research project currently planned within the Civil Engineering Department at UOS.

The following aerial images show these historic developments over time.

The Dubai Experience

Dubai, the second and most prominent urban center in the UAE has witnessed rapid and systematic developments of the transportation infrastructure. From a similar situation to that of Abu Dhabi during the early period, Dubai experienced a phenomenal growth in population, vehicle ownership, and the demands for mobility and accessibility that have resulted in significant changes and developments over time.

However, Dubai's approach was somewhat different. Being more of a cosmopolitan center, the local authorities were open to different approaches and hence varying international design standards and practice. At times, the local needs and environment had resulted in interesting solutions and sometimes the combination of varying strategies, or techniques in one location. (This too, is the subject of planned research at UOS.)

The Dubai roundabouts have been more resistant to change than those of Abu Dhabi. This meant that all measures leading to improving roundabout capacities would be utilized and even exhausted before converting to the other type. Smaller roundabouts would grow larger at times by means of added circulating lanes in this case. (Wherever land availability permitted), additional lanes added wherever possible, or at least flared approaches widened etc.

Then there were signalized roundabouts. Some were signalized only part time, others especially those within the central area had full-time signalization. Later, the increasing demand and the unsuitability of the roundabout design to handle uneven flow balances, warranted the conversion of key locations to signalized intersection operation. This, however, was only carried out after exhausting all signal timing improvement possibilities.

The Sharjah Experience

Sharjah, the cultural center of the UAE accommodates most of the higher educational and cultural institutions. Its proximity to Dubai has resulted in a lot of activity between the two cities.

Starting from similar background to that of Abu Dhabi and Dubai, Sharjah adopted a roundabout orientated city road network. The roundabout implementation continued in all new zones and was introduced with new roadway extensions. The increased demand for urbanisation and the growth in certain zones, especially within the industrial area, warranted the signalization of key locations. In a fashion similar to that used in Dubai, part-time signalization went together with full-time signalization of certain locations. This was not a sufficient measure at certain sites. However, only a couple of locations have been converted so far.

Sharjah, has a number of what could probably be called the world's largest roundabouts. In fact, the term 'round' is not appropriate. The following images illustrate this situation. Ongoing research at UOS is investigating the history of such developments and the circumstances which lead to this particular phenomenon.

Summary and Conclusions

Over the last 30 years the overall transportation picture in the UAE has been shaped by a number of factors.

- Inherited conditions which were the result of certain design practices influenced by the political situation.
- The explosion in urbanization experienced by the UAE's three major urban centers, and the accompanying growth in population and vehicle-ownership warranted increased capacities and improved traffic control means
- The phasing out of roundabouts was carried out by Abu Dhabi where American Consultants and American design practice was involved
- A slower phasing-out process was evident in Dubai and an even slower one Sharjah
- The trend is for a conversion of roundabouts to signalized intersection
Signalized intersections cope better with increased traffic demands and provide a better form of traffic control in urban areas where traffic flows are high
- Roundabouts have gone through a number of modifications and adjustments which at times appear to challenge the basic idea and purpose of a roundabout.

About the Author

Dr. Bassem Younes is an Associate Professor of Civil Engineering at the University of Sharjah. He holds a PhD and a DIC in Transportation Planning and Traffic Engineering from the Imperial College of London where he completed his research in 1991.

He has a BSCE and an MSCE in Civil Engineering from Bradley University in Illinois following which he had academic spells at Purdue and the Georgia Institute of Technology in the USA before joining Imperial College.

Dr. Younes has authored a number of refereed papers, commissioned research and organised and participated in several international conferences and symposiums. His current interests are in Intelligent Transportation Systems (ITS); Traffic Access and Impact Assessments and the wider strategic planning issues.

He is member of several International professional organizations and honor societies.

Emirate	Area (Square Km)	% of total population (1998) *
Abu Dhabi	67,340	86.67
Dubai	3,885	5.0
Sharjah	2,590	3.33
Ras Al-Khaimah	1,688.5	2.17
Fujairah	1165.5	1.5
Umm Al-Qaiwain	777	1
Ajman	259	.33

- ***Estimated***

Source: The Evolution of Planning and Development in the UAE: Stages of Urban Growth in UAE Cities. Directorate of Town Planning & Survey, 1999.

^b The gradual growth of population started in 1963, when the total population reached 95,000. The figure increased to 320,000 in 1972 indicating a four-fold increase within 8 years only.

In 1975, the country's population was 557,887 rising to 1,042,099 in 1980. The 1995 census showed a total population of 2.4 million. 1999 figures indicate a total population of 25 million.

The **Abu Dhabi** population increased from 100,000 in 1970 to 150,000 in 1975 and to 243,257 in 1980. 1998 estimates put the figure at 1,050,000 inhabitants.

Dubai's population was 370,800 in 1985. The 1995 census showed a figure of 674,100. In other words, the population more than doubled in ten years. 1998 estimates put the figure at 783,000.

Sarah's population was a mere 30,000 in 1968. In 1998, the estimates indicate a figure of 460,000 of which some 350,000 live in the city of Sharjah.

^c Source: Maps (UAE), a Geosystems company based in Sharjah since the early seventies.

^d The size of a roundabout is determined by the diameter of the inscribed circle. The inscribed circle is that which approximately touches the outer edges of the circulating area.