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SHARJAH BUS RAPID TRANSIT STUDY (BRT)

Mohsin Ali Balwan, Anurag Thakur, Thomas Varghes, Smitha Nadeera
Sharjah Roads and Transport Authority, Sharjah, UAE

Abstract

Sharjah Emirate, the second largest Emirate of United Arab Emirates, has conducted a feasibility study for providing a Bus Rapid Transit (BRT) System. This paper will provide suggestions and considerations made during the formation of the BRT Master Plan network within Sharjah Emirate. Public transit system with the focus on BRT will contribute to the livability of Sharjah to reduce traffic congestion, energy consumption, and automobile emissions. Sustainable modes of transportation by moving away from car usage which has higher energy consumption and emissions are necessary in this developing world. This study aimed to improve accessibility to the major activities centers within Sharjah with an integrated public transport system which will reduce the car usage and will increase the visitors to the activity centers. A BRT System will introduce a reliable mass rapid transit within Sharjah and extending to other Emirates aimed to reduce congestion on the existing roads, provide a sustainable transportation mode and to promote the use of public transport. Based on the study, BRT technology to support the function of a high quality and passenger capacity, fast, comfortable and cost-effective mobility service is identified and suggested for use in Sharjah.

Keywords: Index Terms - mass transportation, planning, transit system

1 Introduction

Sharjah has grown quickly in population and employment and has now reached a population density that rivals its neighboring Emirates to the south, Dubai. At the same time, Sharjah is seeking to significantly enhance its own internal public bus network system so that a proper cohesive plan provides the correct amount of connectivity in both the existing and future planned developments of this rapidly growing city. This includes the establishment of new bus transfer centers in various locations across the city and additional bus-only roadways that cross the Dubai/Sharjah border to provide relief from other traffic clogged arteries, Figure 1. This paper serves as the blueprint for the master plan of the Bus Rapid Transit (BRT) as the core public transit system for Sharjah along with the necessary supporting stations, stops, and feeder bus and local bus networks.
Dubai and Sharjah Emirates have significant cross-border traffic exchange as many Sharjah residents work in Dubai and cross using only a few key corridors.

Figure 1 Traffic Congestion between Sharjah – Dubai Corridor

2 Data collection and assessment

Data to establish the underlying basis for BRT project were collected from various sources and authorities. It included the information for the existing services and data, which enabled to map the future conditions:

- Site visits and reconnaissance were conducted to obtain additional information for this project as required.
- Reconnaissance Surveys / Site Visits – From the site visits made for the study indicated that the major corridors in Sharjah are congested and completely occupied by slow moving vehicles which has severely hamper the movements of public buses that do offer an option from car-based travel.
- Traffic Survey – Extensive traffic count surveys has been undertaken at the major corridors of Dubai-Sharjah border.
- Sharjah Public Transit Data - Data with respect to the current bus networks serving the Sharjah Emirate was collected from both Sharjah and Dubai authorities. There are eight bus terminals within the Sharjah Emirate.
- Sharjah Existing Bus Network - Existing bus network in Sharjah consists of intercity (to other Emirates) and intracity (within Sharjah (Figure 2)) buses. Ridership information has been collected and highest daily ridership is observed on two bus routes 8 and 88 with 4, 561 and 4, 066 passengers respectively, which totals to 45 % of total intracity ridership.
- Fare - The minimum fare for intra-city buses is 8 AED if purchased from within the bus. Sharjah Emirate's electronic ticketing system known as "Sayer" card can be used in most of the buses with a discounted fare.

Figure 2 Sharjah Intra-city Bus Routes

3 Need for the Study

A better public transportation is one of the crucial requirements of an evolving city, which can support the growing needs and create a better place to live. The needs assessment is aimed to understand the gaps between the current public transport conditions and the desired conditions to improve the performance or fill-in the deficiencies:

- The current mobility is limited to private car and very minor percentage by bus.Therefore, one of the requirements is to develop a public transportation system with effective mobility for inter and intra –emirate.
- Limitation of right of way to develop more roads and related infrastructure.
- Increasing demand for the mobility specially in relation with Dubai Emirate.
- Need for a public transportation system which enhances the economic, social, and environmental fabric of the area, using resources wisely while minimizing adverse impacts.
- Sharjah residents spend considerable amount of time to commute between Sharjah and Dubai.
- Need for a transportation system that is financially feasible and has broad support.

3.1 Existing bus service conditions/quality

The current transit and its coverage is used as an indicator of public transit accessibility. Figure 3 presents the Sharjah public transit coverage considering 500m walking distance. As shown, the western part of Sharjah, around Arouba Street and Al Wahda Street, have better accessibility to public transport and in other areas close to major corridors are accessible to public transit. It shows that the penetration index of public transit is very low.

Figure 3 Current Sharjah Transit Line and Catchment area

3.1.1 Public transit travel time

Currently public transit operate shared with other vehicles and they do not provide any travel time advantage over the later. The public transit travel time is considerably longer due to the multiple stops, low running speed and additional waiting time. The average headway in the current transit system is 15-20 minutes with average stop distance of one kilometre and an average speed of 30 km/hr. The overall performance of the public transit system only supports the captive passengers who are not able to afford travelling in any other modes. Such performance does not encourage transit-oriented mobility and encourages more private vehicle trips and aggravates traffic congestion.

3.1.2 Comfort

A way to improve perception of public transport and even attract some new passengers is by making the ride more comfortable. There is a certain element of comfort expected in each

component of a bus ride such as clear route information, accurate timing information, desirable connectivity, comfortable waiting areas, boarding and getting off easiness, cleanliness etc. Overcrowded buses and unprotected bus stops may have more influence on a potential passenger than more technical characteristics, such as catchment area or average speed. The passengers have to board a small island located between the bus bays and the travel lane. The lack of designated pedestrian crossings also creates safety hazards for the commuters. Waiting areas with shades and benches will provide the required comfort in case of any delay in the bus arrival.

3.2 Demographic and land use analysis

Demographic profile of the community helps to understand the different types of market segments where a public transit service will need to serve.

3.3 Population and employment

Population and Employment density is often used as an indicator to determine the type of public transit services required within a study area. Figure 4 present the population and employment density for Sharjah in year 2018. The pattern of the non-active population distribution is very similar to the population dispersion mostly in the westside of Sharjah along Al Ittihad Road and Arouba Street. These areas are relatively served better than the rest of Sharjah. Understanding strengths and weaknesses of the current transport system specifically will assist in finding opportunities to improve and enhance the system. The current condition evaluation conducted with the purpose of finding the deficiencies and enhancements to be considered during the course of this study is summarized below:

- High Mobility demand is in the Western Part of Sharjah.Current public transit system covers mainly westside of Sharjah the areas near Arouba Street and Ittihad road.
- Many of the educational areas are not accessible by public transit.
- Low income areas of Sharjah have limited public transit coverage. Low level of car ownership make their mobility difficult.
- Current public transit services are delayed due to the congested roads and do not provide any advantage to attract car-oriented travelers
- Current public transit system does not provide equal opportunity to the areas within Sharjah.
- Prioritizing public transit is one of the solutions to alleviate and overcome the congestion between Dubai and Sharjah.

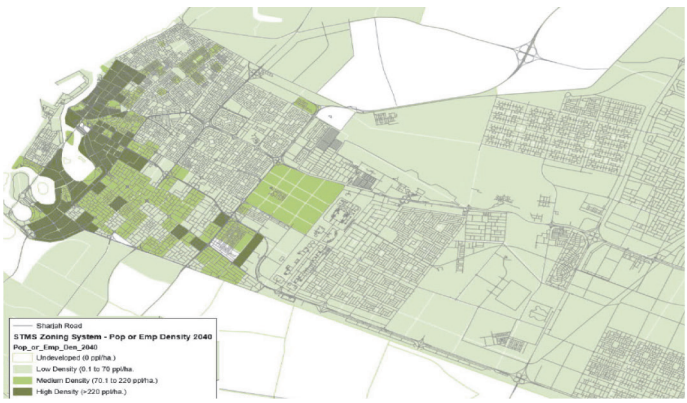

Figure 4 Sharjah Population and Employment Attraction Area

4 Objective of the study

Implementing a BRT system shall address the existing demand and needs while setting objectives and independent system, which had better understanding to caters for the needs of the Emirate and its commuters. The following are the objectives of the study:

- To identify the network that will satisfy existing and future travel demand in terms of coverage, accessibility and optimized travel time;
- Design a network that is easy for the passenger to understand and use, with a clear route hierarchy that has (a) primary trunk routes of BRT and supporting potential feeder services; and, (b) a clear origin-destination pattern (directness to main attractors) and convenient transfer station points;
- Ensure the network is efficient in terms of fleet utilization and can offer the flexibility to adjust services to meet demand while maintaining high load factors;
- Develop a system design within which the service facilities are compatible for both the initial and later stages of the BRT; that is, physical infrastructure should be implemented in such a manner ensuring a seamless transition between current and future designs; and,
- Intermodal opportunities are maximized, both between BRT and other means of conveyance, both motorized (bus, taxi, private car) and non-motorized (walk, bicycle).
- To provide a safe, comfortable and reliable Public transport system, thus reducing the individual car usage.

5 Study area & BRT corridor alternatives

The major corridors in Sharjah are congested and completely occupied by slow moving vehicles, which severely hamper the movements of public buses that do offer an option from car-based travel. Public transit facilities are generally planned along the road corridors and most often by impeding the space used by regular vehicles. Figure 5 presents the study area that covers the whole of Sharjah city and connections with the neighboring Emirates and the identified Potential BRT corridors.

Figure 5 Study Area and Potential BRT Corridors

The following elements have been taken into consideration to select the corridor alternatives for the study:

- Expressway and arterial corridors are most suitable for BRT implementation considering their connectivity and wider right-of-way.
- Surrounding Land Uses and Service Population which includes population and employment density and also identify highly intense developments

- Integration of Activity Centers and Key Generators and Integration of other modes and public transport facilities
- Existing Transit Infrastructure, which includes existing ROW, road width and other constraints.

6 BRT corridor evaluation and selection

The BRT implementation and selection of the corridors shall be planned considering the long-term vision to achieve the best results. The ridership on each corridor under varying degree of parameters were assessed to select the final BRT corridors within Sharjah. BRT corridor selection methodology is embedded within the context of system alternative analysis based on:

- Identify system alternatives.
- Test alternatives using the Sharjah transportation planning model
- Estimate the maximum ridership on each corridor for all the system alternatives
- Select the corridor with maximum ridership
- Enhance the ridership on selected corridors by developing an optimized feeder system
- Select the final BRT network plan.

7 BRT network alternatives

The transit network proposed for Sharjah has to provide all feasible routes and transfers that connect every place on the network with acceptable travel time whether inside the vehicles or out of vehicle time including reasonable number of required route changes. A system-wide assessment has to be conducted to understand the intra- and inter-city passenger movements. Unless a connectivity is provided to benefit the commuters, the public transport will not be utilized to its full capacity.

A system of normal buses with a few dedicated high-capacity lines were proposed to serve the expected demand. The performance of each corridor will vary depending on the system and overall network. Therefore, corridor selection for Sharjah BRT is done within the context of system alternative analysis and to assess function of each corridor under varying conditions, three distinct system alternatives were selected. With these alternatives, the sensitivity of change in ridership on each corridor depending on the system and connectivity studied. The strengths and weaknesses of each corridor based on each system alternative assist in proposing an optimized public transit network with a balanced combination of normal buses and BRT.

7.1 Corridor alternative 1 - no build (existing network)

A No Build network is always an important first step in performing any type of forecast model comparison since it provides a baseline against which all other networks can be assessed. The current network presented in Figure 2 was analyzed using the Sharjah Transport Master Plan model and its effectiveness to serve the forecasted ridership assuming no expansion until year 2030. This will provide better understanding of the shortfalls in the connectivity and capacity of the current lines considering the growth expected in the future.

7.2 Corridor alternative 2 - Arouba model transit system

The second alternative tested is the 2030 original Arouba Model transit network. Dedicated public transit only routes were identified based on the highest transit demand corridors. Figure 6 shows the proposed public transit route developed for year 2030 as part of the Al Arou-

ba Street project.The assumptions and planning considering will be refined and developed as part of this study to improve the accuracy, especially for the inter-city mobility.

Figure 6 Corridor Alternative 2 - Arouba Model Transit System

7.3 Corridor alternative 3 - BRT only network

An alternative with extensive BRT network only on all major corridors was considered as shown in Figure 5. The network focused on maximizing the opportunity for Sharjah residents to utilize BRT. The ridership on each corridor is expected to increase due to the additional benefits offered by the BRT system compared to regular buses. The results helped to indicate non-feasibility of BRT along certain corridors due to the low ridership although the best possible public transport alternative was provided along it.

7.4 Alternatives comparison

The analysis has been undertaken for all three alternatives, their performance and sensitivity of the ridership along the corridors with regards to the system has been compared and is summarized in Figure 7

It shall be noted that none of the three alternatives are considered to be optimal and the objective of the comparison is to select corridors based on the ridership.

The results indicate that Alternative 2 achieved the highest transit share and ridership due to its public transit network that is considered to be robust with various transit modes including dedicated high-capacity lines, feeder and normal bus systems. However, the estimated fleet size is high compared to other alternatives. Alternative 3 has considerable ridership and transit share with smaller fleet size and improved speed due to limited interaction with other PrT modes. The results for Alternative 1 on the other hand, indicate that the existing PuT network is inefficient to capture the potential public transit demand, and need improvements to the PuT system. The strengths and weaknesses of each alternative tested will be considered in the development of a BRT network for Sharjah.

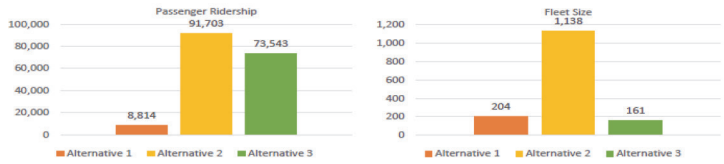

Figure 7 Ridership and Fleet Size Comparison for 3 Alternatives

8 Network development

Network design is fundamental to meeting passenger needs, as its efficiency will influence ridership, revenue and manage costs efficiently. It was aimed for the Sharjah BRT network to offer:

- Strong origin/destination pattern connecting major and popular destinations;
- Proper spacing of stations to ensure an optimum balance between frequency of stops and overall commercial speed;
- Suitable transfer points to provide connectivity with other modes; and,
- Suitability of service given road geometry dictated by on going and pending road improvement projects within the corridor.

The proposed BRT network was supported with optimized feeder services from various locations within Sharjah. The dedicated system is capable of attracting more public transport commuters including inter-Emirate commuters, as it will provide short and comfortable journeys. The Sharjah proposed BRT network is presented in Figure 9.
The ridership estimates for the BRT network was arrived using the Sharjah Transportation Master Plan model (STMP). The maximum overall transit share expected with the proposed BRT and feeder bus network is 12.3 % in year 2030. Stations were placed along the line at locations where it was physically accommodatable. Figure 8 summarizes and depicts the ridership along the final BRT corridors considering the maximum loadings along these corridors for the three peak hours i.e. AM, LT and PM.

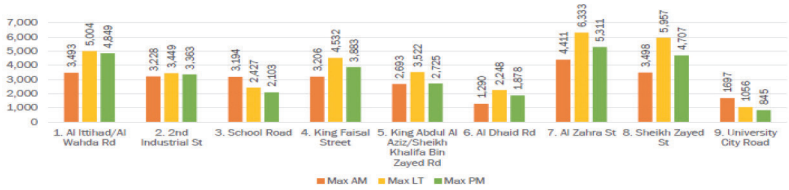

Figure 8 Figure 8. 9. Impact Assessment

The changes to the highway network to accommodate the BRT system could impact the existing traffic operations. Impacts to the existing road capacities were assessed to quantify the reduction in lane and/or prioritization of BRT through the at-grade junctions. Capacity reduction in the range of 20 %-60 % is estimated with the proposed measures assuming no shift of traffic to public transport. The impacts to the junctions was studied and optimized to reduce the impacts.

9 Integration

A BRT system's success lies in its integration that allows safe and convenient access to all parts of the city. By maximizing the connections via other motorized and non-motorized transportation modes, the proposed BRT system can generate higher ridership and raise customer satisfaction.At the planning stage, Sharjah BRT transport networks was develop to reduce redundancies, share resources and maximize coverage:

1) BRT system is planned along the high mobility corridors in Sharjah, the catchment area of each station includes high-dense residential communities and/or work places with Maximize the coverage area through feeder bus network.

2) To promote car users to shift to the BRT and to facilitate shift between the modes, a few park and ride locations have been proposed adjacent to the BRT corridors and figure is presented in Figure 9.
3) Pedestrian access to the BRT stations located within an arterial street could be served with at-grade signalized pedestrian crossings/bridges. A well-integrated public transport/BRT system using micro mobility options were reviewed which include the users to ride their bicycle from their home to the nearest BRT station.

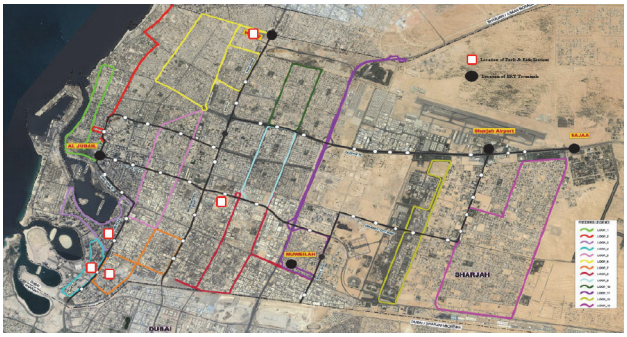

Figure 9 BRT Integration with Feeder Bus Routes and Park-and- Ride Stations

10 Conclusions

Bus Rapid Transit System will introduce a reliable mass rapid transit within Sharjah and extending to other Emirates aimed to reduce congestion on the existing roads, provide a sustainable transportation mode and to promote the use of public transport.
The growth anticipated in the future years in Sharjah will increase the population densities, taking congestion to an alarming level. An immediate cost-effective solution such as a BRT is needed which can make use of the existing infrastructure and provides an alternate mode of transport. The feasibility of a dedicated lane for the BRT within the corridor considering the right of way availability and other physical constraints were studied. The proposed network was divided into five lines which includes Red, Yellow, Blue, Green and Pink Lines. Integration required with other modes of transportation including non-motorized modes were identified and proposed as part of the study. BRT is one of the most cost-effective successful public transportation modes in the world. It allows flexibility for adjustments depending on the ground conditions and to satisfaction of the customers. BRT has the potential to become an iconic public transport mode in Sharjah and in other Emirates.

References

[1] https://brtguide.itdp.org/branch/master/guide/pdf/the-brt-planning-guide.pdf
[2] Sharjah Transport Master Plan, Phase 3 – Development of STMS, AECOM, Sharjah Roads and Transport Authority, May 2015.
[3] BRT, Bus Rapid Transit Service Design Guidelines, VTA Transit Sustainability Policy 2007.
[4] Bus Rapid Transit Stations and Stops, APTA BTS-BRT-RP-002-10, APTA standards Development program, Recommended Practice, American Public Transportation Association 1666 K Street, NW, Washington, DC, 20006-1215
[5] Federal Transit Administration, U.S. Department of Transportation (DOT), https://www.transit.dot.gov/research-innovation/bus-rapid-transit-resources
[6] Abu Dhabi Walking and Cycling Master Plan, Department of Transportation, Abu Dhabi

[7] https://thecityfix.com/blog/how-to-integrate-new-brt-system-existing-transport-modes-josephine-dallant/

[8] BRT Planning Guide, Institute of Transportation and Development Policy (ITDP)

[9] Bus Rapid Transit Service Design, APTA BTS-BRT-RP-004-10, APTA standards Development program, Recommended Practice, American Public Transportation Association 1666 K Street, NW, Washington, DC, 20006-1215

[10] FTA Research (federal Transit Administration), Manual on Pedestrian and Bicycle Connections to Transit, August 2017, FTA Report No: 0111, Transportation Research & Education Centre (TREC) at Poland University

[11] Sharjah Bus Rapid Transit (BRT) - Development of Master plan, Parsons, Sharjah Roads and Transport Authority, May 2019.