Design approach for
Kampala BRT pilot project

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INTRODUCTION

Arup, with ROM (Israel), is undertaking a World Bank funded project (for the Ministry of Works and Transport in Uganda) to develop a detailed design of a pilot Bus Rapid Transit (BRT) system in Kampala, the capital city of Uganda. The BRT in Kampala will be operated with articulated buses on exclusive on-street bus lanes. This article outlines an approach in which the design of each system component responds to the operational concepts and design philosophy, recognising that each component has a significant impact on the business case and the financial sustainability of the system (Figure 1).

OPERATIONAL CONCEPT

The pilot BRT system's Y-shaped network will, from the opening, create a true network effect, with passengers able to make a variety of radial and cross-city journeys. At the outset of the project an 'operational concept' was agreed with the client and

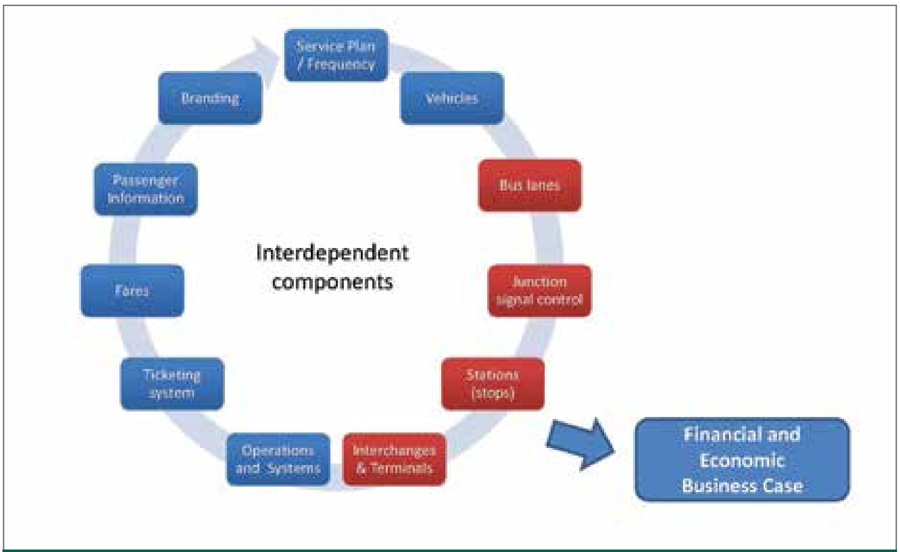

Figure 1: System components impacting on the business case

other stakeholders. In summary, this concept incorporates the following:

- **Reliable and fast journey times:** Full segregation of BRT movements from general traffic along the whole corridor length will result in journey speeds of over 20 km per hour, with guaranteed journey times for travellers.
- **Frequency:** The BRT will operate at 60 buses per hour in peak periods (operating in platoons of two vehicles per two minutes to correspond with junction signal timings).
- **Enforcement:** It is essential for the smooth and efficient operation of the network that no parking, loading/unloading or unauthorised use of the BRT lanes will be allowed during operational hours.
- **Distinctive branding:** The Kampala BRT system will have its own distinctive brand identity, which will be displayed in the vehicle livery, the design of stations and in all marketing material (Figure 2).
- **Attractive vehicles:** The BRT buses will be articulated 18 m long high-passenger capacity, modern low-floor vehicles (Figure 3).
- **Quality stations:** The BRT stations will be comfortable, well-equipped, safe and secure, with level boarding access to the vehicles, located 800 m apart. Stations will have capacity to accommodate two BRT vehicles and will thus be 40 m in length.
- **Off-vehicle ticketing:** All tickets for the BRT system will be purchased before entering the station platform, thus speeding up the boarding process.
- **Short dwell times:** As a result of off-board ticketing, and vehicles with multiple doors, boarding and alighting will be efficient, with short dwell times of 20 seconds, minimising the journey time.
- **Lane priority:** BRT priority measures may reduce road capacity for general traffic and may impose increased delays on non-public transport modes. Priority for BRT over general traffic is part of the 'trade-off' of providing an enhanced public transport system that is designed to achieve desired and sustainable mode share targets. The BRT priority measures are thus based on a whole-length corridor approach. The on-street exclusive BRT lanes will be used by BRT and designated vehicles such as emergency vehicles. The hours of operation of BRT lanes will be 24-hours in order to maximise the perception of the BRT route as a 'fixed' link, to avoid driver confusion, and to emphasise compliance.

Figure 2: Distinctive branding incorporated in BRT stations; also note cycle lane


Figure 3: BRT buses will be articulated low-floor vehicles, and the stations will be safe and secure, with level boarding access

KEY PRINCIPLES FOR INFRASTRUCTURE DESIGN

After the establishment of an operational concept, a design philosophy was developed in order to clarify and guide design choices. The Terms of Reference for the project emphasised the need to put in place a high-quality public transport system as a pre-requisite of effectively addressing the current and future travel needs of Kampala. It further indicated that "… the Kampala Metropolitan Area was moving rapidly towards total gridlock. Concerted, rapid and effective measures are needed to avoid this. Scarce urban transport space must be used most effectively to enhance mobility of people (not autos) by providing space for pedestrians, bicycles and mass transit." (Photo 1)

A key principle of the approach taken was to ensure that the BRT system can be implemented over the short term, which in particular led to an approach where significant impacts on private land will be avoided, and where there is no reliance on implementation of other transport projects (such as road-building or road-widening schemes). Thus, the general principles in respect of developing an initial preliminary design were:

- BRT infrastructure will generally be within the road reserve.
- Existing buildings with an apparent legal status will generally be preserved.
- Illegal encroachment of the road reserve and illegal constructions will not be considered as a constraint.

TRANSPORT CORRIDOR FOR ALL ROAD USERS

The design approach sought to provide an improved quality and level of service for all road users, i.e. to provide more than just 'priority BRT lanes'. Thus, insertion of BRT lanes and stations would be accompanied and supported by the following elements:

- Clearly demarcated and well surfaced general traffic lanes
- Protected parking places (in laybys)
- Sidewalks on both sides of the corridor

- Pedestrian crossing islands
- Kerbed entrances
- Cycle lanes on the BRT corridor where space exists and where impacts on legal or illegal buildings are minimised.
- Cycle parking facilities provided at BRT stops along the corridor.

Provision for the above elements would create a step-change for road users in Kampala, especially for pedestrians, since there are presently limited sidewalks and pedestrian crossings.

BRT LANE DESIGN

The existing road conditions and traffic management are poor, with illegal and unruly parking resulting in inefficient use of traffic lanes. Vehicles often stop in traffic lanes to pick up or drop off, while pedestrians interact with traffic, and parking on the road verge worsens the situation.

Major modification to the existing road space allocation to provide effective priority for BRT services (over general traffic) is essential to deliver speed and journey time reliability. The philosophy of establishing a running way for BRT in Kampala acknowledges that BRT priority measures will limit road capacity for general traffic and will generally give priority to BRT so as to minimise delays to BRT movement over non-public transport modes. The key characteristics for the design of BRT lanes in Kampala are:

- Provision of BRT lanes is generally based on a whole-length corridor approach (i.e. not intermittent, except at intersections).
- BRT lanes consist of on-street exclusive lanes.
- BRT lane width is 3.5 m, except at 'instantaneous' pinch points where widths of 3.0 m are acceptable, provided that the vehicle path can be accommodated safely.
- BRT lanes will generally be discontinuous across major intersections to allow for turning traffic.
- Introduction of the BRT lanes will not impede traffic from legal accesses. However, for certain movements, accessing a minor side road, or other accesses, may require a different route choice for entry and/or exit journeys.
- Priority measures will be designed to be self-enforcing as far as possible – such that drivers are able to easily comprehend the legality, or not, of turning manoeuvres.
- Existing on-street parking provision will be maintained where practicable or relocated to an alternative location. Access to parking will not, however, obstruct the operation of BRT services.

The general principle for placement of BRT lanes in Kampala is:

- **Central lanes**, located in the centre of the carriageway with general traffic lanes located adjacent to the edge of the road reserve (Figure 4).
- **One-way mixed traffic adjacent to two-way BRT lanes**, for specific locations where traffic management or station placement dictates; and where central running is not suitable, a two-way BRT lane is located on one side of the road, with mixed traffic located on the other side of the road (and generally operating as a one-way lane). It is important in this case that pedestrians understand the lane configuration with signage and/or surface treatment.

BRT STATION PLACEMENT

There are 25 stations along the route, approximately 800 m apart. Station platforms will be side platforms, that is, located on the left-hand side of the bus such that the bus passenger doors will be in the conventional position. Since the BRT lane will generally be located centrally within the road carriageway, the station platforms will be constructed as 'islands' between the central BRT lanes and the mixed traffic lanes on the edge of the road (Figure 4).

For Kampala, investigations of station platform arrangements identified a number of advantages of central-side platforms in this case, namely:

- **Segregation:** The central-side station creates a clear physical and visual segregation between BRT and traffic lanes.
- **Width:** Traffic signal poles are located on the station islands and thus do not need additional space (width). The

Photo 1: The Kampala metropolitan area is moving rapidly towards total gridlock

Figure 4: Typical BRT station placement, with lane configurations for central BRT lanes, pedestrian crossings and cycle-securing facilities

ability to offset stations also provides flexibility to minimise impact on adjacent land.

- **Pedestrian crossing safety:** The layout provides high-quality pedestrian crossing facilities for passengers and pedestrians (Figure 4).
- **Bus costs:** The BRT system will be operated with conventional buses with doors on one side and hence does not require higher cost bespoke buses with doors on both sides.
- **Seating capacity:** Buses with doors on one side have significantly more seats than those with doors on both sides.
- **Capability of buses to travel beyond infrastructure:** Conventional buses are able to travel beyond the BRT infrastructure (e.g. to the airport), with no special kerbing needed at additional stops.

NON-MOTORISED TRANSPORT

Pedestrian/walking facilities will be included at **all** locations on the corridor, comprising kerbed sidewalks along the road edge, pedestrian crossings at **all** stations, pedestrian crossings at all signal-controlled intersections, dropped kerbs at pedestrian crossings, access ramps at stations, and new street lighting. Typically a 2 m wide sidewalk will be provided. Adjacent to stations and at busy crossings a wider sidewalk will be provided.

For the provision of **cycling facilities**, the following key principles will apply:

- Cycle parking facilities will be provided at all BRT stations.
- On-road kerbside cycle lanes have been provided along the BRT corridor along a significant proportion of the scheme, and will represent a step change from the current situation where there are no cycling facilities.

Access for people with physical disabilities follows established international best practice design. Facilities include dropped kerbs at road crossings, tactile paving at road crossings, access ramps to stations and wheelchair access through station turnstiles. Low-floor platforms and buses provide convenient access for wheelchairs.

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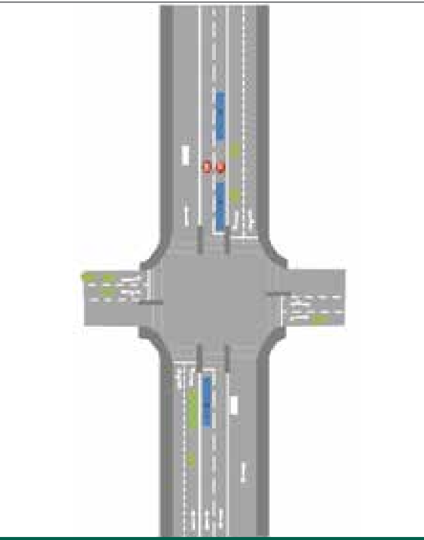

Figure 5: Typical intersection arrangement with BRT

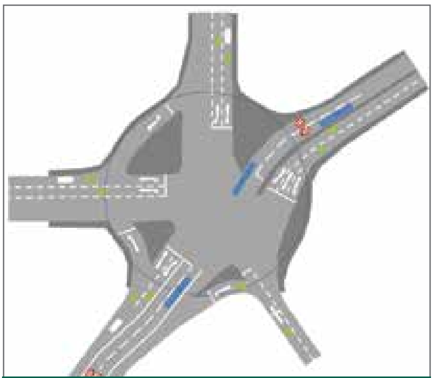

Figure 6: Roundabout converted to signalised BRT intersection

INTERSECTION DESIGN APPROACH

Major intersections

The principles of operating BRT at major intersections are as follows (Figure 5):

- BRT lanes should be signal-controlled through all main intersections on the BRT Route.
- BRT vehicle movements through signalised intersections should have dedicated phases.
- The BRT lanes should extend to the stop line at signalised intersections.
- Signalised intersections should have a dedicated pedestrian crossing phase.
- Signalised intersection should be designed to operate with detection priority for BRT vehicles, and should provide green time extension.

Roundabouts

The principle adopted for roundabouts on the BRT route is to modify the junction to a conventional signalised intersection with the BRT travelling through the centre of the junction without the need to traverse the roundabout lanes (Figure 6). This principle is important in respect of:

- Passenger comfort through the junction
- Providing a tram-like level of service and image
- Maximising and controlling the priority given to the BRT system
- Avoiding the possibility of gridlock on the roundabout gyratory.

Minor intersections and entrances

For minor intersections and private accesses, the arrangements for BRT traffic is as follows:

- All minor intersections and accesses will operate as left-in / left-out accesses.
- Vehicular traffic movement across BRT lanes will not be allowed.

STATION DESIGN APPROACH

General design principles

The station and platform designs were assessed on a location-by-location basis, addressing pedestrian accessibility, impact on intersections and accesses for upstream or downstream platforms, journey time, passenger demand, etc. Approaches to stations were designed to allow for accurate vehicle/platform docking.

Station operation

The station will be surrounded by a fence or barrier. Turnstiles will be located at both ends of the station. Passenger access to/from BRT vehicles will be via gaps in the surrounding fence or barrier.

Figure 7: BRT stations will be surrounded by a barrier, turnstiles will be located at both ends, and passenger access to/from BRT vehicles will be via gaps in the surrounding barrier

Station locations

Stations are located at approximately 800 m intervals along the BRT route, although distances vary locally according to specific needs and constraints, such as proximity to key passenger demand generators and the availability of space.

The BRT stations have level boarding access for low-floor BRT buses, and thus kerb heights will be approximately 300 mm. Stations have the capacity to accommodate two articulated BRT vehicles (approximately 18 m in length) and thus platforms are 40 m in length. Station platforms will have a 5 m width (kerb-to-kerb). The resulting effective platform area will be approximately 1 m less than the station island to accommodate fencing and bus shelter panels. Stations will also comprise 5 m to 10 m long approach ramps with ticketing turnstiles at the beginning of the platform. The whole station island is therefore approximately 60 m in length (Figure 7).

FINANCIAL SUSTAINABILITY AND BRT PRIORITY

A key requirement of the BRT operation is that it should be, as far as possible, financially self-sustainable, i.e. the operating cost should be paid from income generated by fares.

The level of priority given to movement of BRT vehicles along the road corridor, and especially at intersections, is a key determinant of whether the BRT operation is financially self-sustainable. The resulting commercial speed of the BRT vehicles has a direct relationship with the BRT operating costs and income, that is:

- The higher the speed the lesser the number of vehicles needed to operate the required frequency.
- The higher the journey speed the greater the attractiveness of the service to passengers.

PROGRAMME FOR IMPLEMENTATION

The detailed design for the infrastructure is currently being finalised, and operation is planned to start by 2018. □

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