BRT Day to Day Operation

Adapting Service Plan to Real Demand Conditions
Thank you to the Transforming Urban Mobility Initiative (TUMI)
- mobilizing investment,
- building capacity, and
- supporting innovative approaches on the ground
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 min</td>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td></td>
<td>Fast overview of operational design and service plan basic concepts</td>
</tr>
<tr>
<td>45 min</td>
<td><strong>Group Exercise</strong></td>
</tr>
<tr>
<td></td>
<td>Two different problems related to service planning of a BRT in operation</td>
</tr>
<tr>
<td>30 min</td>
<td><strong>Presentation of Group Exercise Results</strong></td>
</tr>
<tr>
<td></td>
<td>Each Group: 5 min - Presentation</td>
</tr>
<tr>
<td></td>
<td>5 min - Q&amp;A</td>
</tr>
</tbody>
</table>
Service Planning Before Implementation

Based on the original system data and modeling: field studies and modeling to replicate existing conditions

High degree of uncertainty: the impact of a new system is analyzed through modeling
Dar es Salaam Service Planning Before Implementation
Service Planning After Implementation

A continuous job

More certainty on demand

Set infrastructure - no major changes can be made

Set fleet – difficult to make changes in the short term
Dar es Salaam BRT - DART operational
Purpose of the Service Plan

Before Implementation:

• To understand demand and how to meet that most efficiently
• To define infrastructure characteristics – using peak hour service plan
• To provide inputs to a financial model
• To start operation
DART trunk-feeder terminal
Purpose of the Service Plan

After Implementation:

- To optimize operations, while reducing travel time for passengers
- To attend users’ needs and better meet demand as it changes
What are we going to do today?

We are going to talk about different concepts related to service planning.

We will play a game: suppose we are the technical team of a BRT Agency – operations’ engineers

• Set infrastructure – we cannot easily change it
• Set fleet – contracts’ restrictions: we cannot get more buses without renegotiating contracts with the private operator

We are faced with two different problems that we need to solve under the above restrictions.
Basic Concepts

Trunk and feeder, Direct services

Express, limited, early return and dead headway services
Trunk-and-feeder services
Travel patterns vary according to time of the day
A sound functional design might have different services during the day
Service design can save fleet, be more cost effective, and better meet demand

Example of flexible services in Mexibus III
Basic Concepts

• Peak hour ridership

• Critical volume in the critical link

• Load factor = planned occupancy of bus

• Frequency = # of buses per hour

• Headways = number of minutes between buses

• Cycle time = time for bus to complete the entire route – both directions

• Fleet size = number of buses to meet demand
Critical volume in the critical link

Max Load: 3516 pphpd

Example of boardings and alightings per station/stop and total load (volume) in one direction of a transit route
Frequency and Fleet Size

\[
Freq = \frac{MaxLoad}{V_{size} \times LoadFactor}
\]

Where:

- **Freq**: Service frequency; the number of times a specific service is offered during a given time interval;
- **MaxLoad**: Maximum hourly load on the critical link;
- **\( V_{size} \)**: Vehicle capacity;
- **LoadFactor**: Percentage of a vehicle’s total capacity that is actually occupied.

\[
Fleet Size = Freq \times Cycle Time
\]
Basic Concepts

**Dwell Time:** time that a station or bus stop is occupied by a bus loading and unloading passengers

**Station saturation:** proportion of time that a station or bus stop is occupied by a bus loading and unloading passengers
Dwell Time: time that a station or bus stop is occupied by a bus loading and unloading passengers

\[ T_d = T_0 + T_b + T_a \]

Or

\[ T_d = T_0 + t_b \times P_b + t_a \times P_a \]

Where:

- \( T_d \): Total dwell time;
- \( T_0 \): Fixed dwell time (or “dead time”);
- \( T_b \): Total boarding time per vehicle (given by \( t_b \times P_b \));
- \( t_b \): Boarding time per customer;
- \( P_b \): Number of boarding customers;
- \( T_a \): Total alighting time per vehicle (given by \( t_a \times P_a \));
- \( t_a \): Alighting time per customer;
- \( P_a \): Number of alighting customers.
Saturation Factor, \( X \): proportion of time that a station or bus stop is occupied by a bus loading and unloading passengers

\[
X = \frac{Freq \times T_0 + P_b \times t_b + P_a \times t_a}{3600}
\]

Where:

- \( T_d \): Total dwell time;
- \( T_0 \): Fixed dwell time (or “dead time”);
- \( T_b \): Total boarding time per vehicle (given by \( t_b \times P_b \));
- \( t_b \): Boarding time per customer;
- \( P_b \): Number of boarding customers;
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- \( t_a \): Alighting time per customer;
- \( P_a \): Number of alighting customers.
Basic Concepts

Renovation Factor

Irregularity

Travel Time and Waiting Time
Case

DART’s original service plan for the peak hour

<table>
<thead>
<tr>
<th>Line</th>
<th>from</th>
<th>to</th>
<th>Headway</th>
<th>Length, one direction</th>
<th>fleet</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR001</td>
<td>Ubungo</td>
<td>Kariakoo</td>
<td>4</td>
<td>8.9</td>
<td>13</td>
</tr>
<tr>
<td>DR002 - E</td>
<td>Kimara</td>
<td>Kariakoo</td>
<td>3</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>DR003</td>
<td>Kimara</td>
<td>Kivukoni</td>
<td>3</td>
<td>15.4</td>
<td>28</td>
</tr>
<tr>
<td>DR004</td>
<td>Morocco</td>
<td>Kariakoo</td>
<td>4</td>
<td>7.1</td>
<td>10</td>
</tr>
<tr>
<td>DR005</td>
<td>Morocco</td>
<td>Ubungo</td>
<td>3</td>
<td>8.8</td>
<td>16</td>
</tr>
<tr>
<td>DR006</td>
<td>Morocco</td>
<td>Kivukoni</td>
<td>4</td>
<td>8.5</td>
<td>12</td>
</tr>
<tr>
<td>DR007 - E</td>
<td>Ubungo</td>
<td>Kivukoni</td>
<td>4</td>
<td>10.3</td>
<td>12</td>
</tr>
</tbody>
</table>

Express Services Speed: 28 kph
Local Services Speed: 22 kph

Operational: 111
Reserve: 11
Total: 122
Facts after implementation

• The service plan was determined based on the existing transit conditions (the dala dala system) and through transportation modelling, so there was a high degree of uncertainty about the accuracy of the design.

• Besides, by the time DART was implemented, the service plan was outdated, because the city had doubled in population and travel patterns might have changed.

• In fact, during the first months of implementation, most of the proposed 7 lines were very saturated, while in other buses would run empty.

• The ITS equipment installed in buses and stations provided the DART agency with accurate demand data for the weekday peak hour.
Problem One: Propose New Frequencies

• You, as the operation engineers of DART, must revise the service plan and propose new frequencies for the system. Beware that you will not be able to acquire new fleet in the short term: contracts must be revised and bus procurement takes time (about a year in the best case) and a short term solution is urgent.

Bus Fleet Size - BRT Planning Guide - Chp. 6.4
Problem Two: Solving for the critical link

- The implementation of the revised service plan alleviated the saturation of the system at the most of the stations. However, in the corridor, the segment between Manseze Tip Top and Fire Stations is very congested, with the buses arriving full in many cases. Because of this, some passengers are unable to board buses and have to wait for several buses before being able to enter. As the operation engineers of DART, you must design a strategy – functional service plan - to alleviate this situation.
Tips

• Identify Maximum Load for each service

• Calculate new frequencies and headways (use a load factor of 0.90)

• Calculate needed fleet: do we have enough buses? if not, what can we do?

• Take a look at passenger loads at stations: can we come out with a different service? Can we not stop at certain stations? What impacts can we expect?
Exercise

• Problem One: Propose new frequencies

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Asante! Kufanya kazi!!

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