PLANNING FOR FEEDER BUS SERVICES USING VISUM: A CASE STUDY OF MUMBAI, INDIA

Authors:
Bipin R Muley
Uday Chander
Prof. C.S.R.K. Prasad

Presenter:
Bipin R Muley
NIT Warangal
Contents

1. Introduction
2. Study Area and Data Collection
3. Modelling feeder network in VISUM
4. Analysis and Results
5. Conclusions
Introduction

Present Urban Transport Problems:
• Urbanization in India: 31% in 2014 to 50% in 2030.

• Increasing dependence on private transport.

• Inability for mass transit to provide door-to-door connectivity.

• Not every metro corridor with phpdt greater than 15,000 for at least 5km continuous length.
Introduction

Solutions:

- Making public transport attractive to commuters.
- Increasing catchment area of mass transit stations.

Feeder Service
Introduction

Legend

- Transit line
- Transit station
- Origin/Destination
Design Elements

- Objective function: Minimize user’s and operator’s cost
- Demand Pattern: Many-to-one
- Decision variables: Journey time and cost coverage
- Constraints:
  - $0.8 < \text{Load Factor} < 1.2$
  - Total capacity of bus $\leq 30$
  - Stop spacing and connector $\leq 500m$
  - 5mins. $\leq \text{Headways} \leq 10\text{mins.}$
- Network approach with simulation solution.
Selection of Study Area

- Based on following criteria:
  1. Total patronage at each metro station
  2. Land use pattern
  3. Presence of bus stops or bus depots
  4. Location of metro station
  5. Type of IPT’s serving around metro station
  6. Inter-station distance
Metro (Line 1)

Metro station under study

Metro (Line 1)

Monorail
Data Collection

Primary Data
- Passenger interview surveys
- Arrival and dispersal pattern
- Ingress and egress time, distance, cost and mode
- Willingness to use and pay for feeder service

Secondary Data
- Total patronage
- Road network
- BEST bus network
- Location of other mass transit station
- Feeder bus characteristics
- Operating Cost data
Primary Data Collection Location
### Demand Matrix

<table>
<thead>
<tr>
<th>Zone No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>849826</td>
<td>1242053</td>
<td>270399</td>
<td>196073</td>
<td>168648</td>
<td>392227</td>
<td>522970</td>
<td>261485</td>
<td>65371</td>
<td>0</td>
<td>130742</td>
<td>196113</td>
<td>196113</td>
<td>196113</td>
<td>130742</td>
</tr>
<tr>
<td>2</td>
<td>346568</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>506522</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>110272</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>79961</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>68777</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>159954</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>213272</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>106636</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>26659</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>53318</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>79978</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>79978</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>79978</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>53318</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Annual Weekday Demand = 67,66,310 p.**
## Temporal Distribution of Demand

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Versova</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:30 am – 8:00 am</td>
<td>7%</td>
</tr>
<tr>
<td>8:00 am – 11:00 am</td>
<td>23%</td>
</tr>
<tr>
<td>11:00am – 5:00 pm</td>
<td>31%</td>
</tr>
<tr>
<td>5:00 pm – 8:00 pm</td>
<td>27%</td>
</tr>
<tr>
<td>8:00 pm – 11:30 pm</td>
<td>12%</td>
</tr>
</tbody>
</table>
Modeling Feeder Network in VISUM

- Classified into three parts:
  1. Demand modeling
  2. Network modeling
  3. Impact model (User and Operator)

- Assumptions:
  1. The feeder bus service is modeled from 8am to 8pm only.
  2. The effect of Intermediate Public Transport on feeder services is not considered.
  3. Commuters have no information on departure times of feeder bus.
  4. Operating speed of feeder bus and auto-rickshaw in the network are assumed to be 15 kmph and 20 kmph respectively.
Network Modeling

- Steps involved:
  1. Incorporation of network map and marking Points of Interest
  2. Creation of zones
  3. Creating new transport system (feeder & auto)
  4. Creating stop locations for feeder bus
  5. Creating feeder line route
  6. Creating connectors
  7. Creating vehicle journeys
  8. Creating demand matrix with temporal distribution
Incorporation of network map and marking POI
Creation of zones
A1  Focused on stops. They should generally be sufficiently small for it to be realistic to expect people to walk from anywhere in the zone to the nearest public transport stop. This distance can be assumed to be less than a one kilometre radius in urban areas. Generally, there should be one zone of this kind for each stop or station.
Admin, 22-06-2015

A2  people would not normally access public transport system by walking. People accessing facilities in these zones are much less likely to use public transport than people in the first category of zone and, as a consequence, the modelling of these zones can be more approximate, that is, the sizes of these zones can be geared to highway modelling which are often larger. Access to public transport in these zones is often likely to be car.
Admin, 22-06-2015
Creating stop locations for feeder
Creating feeder line route
Creating vehicle journeys
Calendar Settings
Public Transport: User model

- Three types of assignment procedures:
  1. Transport system based assignment
  2. Headway based assignment
  3. Timetable based assignment
Headway based assignment
Public Transport: Operator model

- Steps involved:
  1. Calculation of public transport assignment
  2. Creating operator, vehicles and allocating vehicle journeys
  3. Creating fare model
  4. Defining cost model
  5. Calculation of line blocking procedure
  6. Calculation of operating indicators
Creating operator, vehicle and allocating vehicle journeys
Creating fare model
Defining cost model
Procedure Sequence
Scenario Management

<table>
<thead>
<tr>
<th>Count</th>
<th>Code</th>
<th>Description</th>
<th>Procedure parameter set</th>
<th>Modifications</th>
<th>Calculation state</th>
<th>Progress</th>
<th>Last calculation</th>
<th>Passenger trips unlinked PuT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R1</td>
<td>ROUTE 1</td>
<td>1 BASE</td>
<td>...</td>
<td>Calculated</td>
<td>06-06-2015 03:22:19</td>
<td>5974651</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>R2</td>
<td>ROUTE 2</td>
<td>1 BASE</td>
<td>1</td>
<td>Calculated</td>
<td>06-06-2015 03:26:06</td>
<td>5974347</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>R3</td>
<td>ROUTE 3</td>
<td>1 BASE</td>
<td>2</td>
<td>Calculated</td>
<td>06-06-2015 03:28:34</td>
<td>5970935</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>R4</td>
<td>ROUTE 4</td>
<td>1 BASE</td>
<td>3</td>
<td>Calculated</td>
<td>06-06-2015 03:33:29</td>
<td>5494973</td>
<td></td>
</tr>
</tbody>
</table>

[Image of software interface]
Assignment
Analysis and Results

- Based on two perspectives:
  1. Users perspective: comparing journey time of feeder bus with auto-rickshaws and walking.
  2. Operators perspective: various measures of effectiveness (MOE) based on operational characteristics.
Users Perspective

Journey time at Versova (Last mile)

- Reduction in journey time for different zones.
- Comparison between Auto-Feeder and Walk-Feeder modes.

Zone No.: 1 to 16
# Operators Perspective

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Operating indicator</th>
<th>Versova</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Line network</td>
<td>7.6 km</td>
</tr>
<tr>
<td>2.</td>
<td>Vehicles required</td>
<td>10</td>
</tr>
<tr>
<td>3.</td>
<td>Passenger kilometre</td>
<td>70,87,396 km</td>
</tr>
<tr>
<td>4.</td>
<td>Service kilometre</td>
<td>3,32,507 km</td>
</tr>
<tr>
<td>5.</td>
<td>Mean volume trip</td>
<td>26</td>
</tr>
<tr>
<td>6.</td>
<td>Service efficiency</td>
<td>88.3%</td>
</tr>
<tr>
<td>7.</td>
<td>Load factor</td>
<td>0.87</td>
</tr>
<tr>
<td>8.</td>
<td>Total costs</td>
<td>Rs. 2,58,70,088/-</td>
</tr>
<tr>
<td>9.</td>
<td>Total revenue</td>
<td>Rs. 2,95,85,324/-</td>
</tr>
<tr>
<td>10.</td>
<td>Cost coverage</td>
<td>115%</td>
</tr>
</tbody>
</table>
Conclusions

• Optimized result achieved balancing user and operator costs.

• Users Perspective:

<table>
<thead>
<tr>
<th></th>
<th>Versova</th>
<th>First Mile</th>
<th>Last Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto-rickshaw</td>
<td>9%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td>-28%</td>
<td>-27%</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- Operators Perspective:

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Versova</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Efficiency</td>
<td>88.3%</td>
<td>Favorable to both user and operator</td>
</tr>
<tr>
<td>Load Factor</td>
<td>0.87</td>
<td>Favorable to both user and operator</td>
</tr>
<tr>
<td>Cost Coverage %</td>
<td>115%</td>
<td>Services run under profits</td>
</tr>
</tbody>
</table>
Feeder Route (Versova)
References

THANK YOU