The State of Light Rail Transit in America

2018 APTA Rail Conference Presentation

June 2018
Presentation Agenda

- **Who are we:**
  - Imperial College/Railway & Transport Strategy Centre
  - GOAL, the Benchmarking Group of North American Light Rail Systems

- **An Overview of the Characteristics of Light Rail in North America**

- **Impacts of Characteristics on Operational Performance**
Introduction to the Railway and Transport Strategy Centre
# International Benchmarking: Eight Public Transit Groups – Benefits Drive Continued Participation

<table>
<thead>
<tr>
<th>Group of Metros</th>
<th>Founded</th>
<th>Members</th>
<th>Included Cities</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoMET</td>
<td>1994</td>
<td>18</td>
<td>New York, London, Hong Kong</td>
</tr>
<tr>
<td>Nova</td>
<td>1998</td>
<td>20</td>
<td>Rio, Toronto, Barcelona</td>
</tr>
<tr>
<td>IBBG</td>
<td>2004</td>
<td>15</td>
<td>Dublin, Montreal, Paris, Singapore</td>
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<tr>
<td>ISBERG</td>
<td>2010</td>
<td>14</td>
<td>Munich, Tokyo, Sydney</td>
</tr>
<tr>
<td>ABBG</td>
<td>2011</td>
<td>22</td>
<td>Austin, Cleveland, Rhode Island</td>
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<tr>
<td>GOAL</td>
<td>2016</td>
<td>6</td>
<td>Norway, Belgium, Netherlands, Australia</td>
</tr>
<tr>
<td>Railway Infrastructure</td>
<td>2016</td>
<td>4</td>
<td>members, initially in Australia</td>
</tr>
</tbody>
</table>
Benchmarking is the Search for Best Practices That Lead to Superior Performance

Benchmarking Is:

A systematic process of continuously measuring, comparing and understanding performance and changes in performance

Of a diversity of key business processes

Against comparable peers

To help the participants improve their performance

(Adapted from the definition by Lema and Price)

Benchmarking Provides:

- **Perspective through Data:**
  - How do we compare to our peers?
  - What are our strengths?
  - What are our weaknesses?
  - Quantitative Backing for “rules of thumb”

- **Best Practices through Discussion:**
  - What are others doing to improve?
  - What works/what doesn’t?
  - How to implement best practices.

“Rarely is there a challenge that someone else hasn’t faced...”
Benchmarking Methodology – Normalization Options Adjust for Different Contexts, Including ‘Extreme’ Data Differences

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Total Ton Miles</th>
<th>Total Vehicle Capacity Miles</th>
<th>Total Vehicle Hours</th>
<th>Revenue Vehicle Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicle Weight</strong></td>
<td>40 Tons</td>
<td>70 Tons</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Layover &amp; Deadhead Percentage</strong></td>
<td>11 percent</td>
<td>33 percent</td>
<td></td>
<td>Revenue Vehicle Capacity Miles</td>
<td></td>
<td>Revenue Vehicle Miles</td>
</tr>
<tr>
<td><strong>Vehicle Planning Capacity</strong></td>
<td>104 People</td>
<td>181 People</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Average Commercial Speed</strong></td>
<td>7.6 MPH</td>
<td>22 MPH</td>
<td>Revenue Vehicle Miles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Passenger Trip Length</strong></td>
<td>1.5 Miles</td>
<td>8 Miles</td>
<td>Passenger Boardings</td>
<td>Passenger Miles</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Train Length</strong></td>
<td>1 vehicle / 50 Feet</td>
<td>5 vehicles / 400 Feet</td>
<td>Vehicle Miles</td>
<td>Train Miles</td>
<td>Train Hours</td>
<td>Vehicle Hours</td>
</tr>
</tbody>
</table>
## GOAL Key Performance Indicator System

### Growth & Learning
- **G1** Passenger Boardings, Car Miles & Hours *(5-yr % change)*
- **G2** Passengers per Revenue Mile & Hour *(car & train)*
- **G3** Staff Training *(by staff category)*

### Customer
- **C1** On-Time Performance *(% of departures, 0 <> +5 min)*
- **C2** Headway Regularity *(to come)*
- **C3** Delay Minutes *(passenger & train)*
- **C4** Passenger Miles per Revenue Capacity Mile *(seat & planning)*
- **C5** Capacity Miles per Route Mile
- **C6** Percent of Trips Operated

### Internal Processes
- **P1** Peak Fleet Availability & Utilization *(not used by cause)*
- **P2** Staff Productivity *(train or car miles or hours / labor hr)*
- **P3** Staff Absenteeism Rate *(by staff category)*
- **P4** Mean Distance Between Technical Failures
- **P5** Mean Distance Between Incidents *(>5 min delay)*
- **P6** Lost Vehicle Miles *(internal & external causes)*
- **P7** Percent On-Time Pull-outs *(% of departures, later than 4:59)*

### Financial
- **F1** Total Operating Cost per Total Mile & Hour *(car/train)*
- **F2** Total Operating Cost per Passenger Boarding & Mile *(service operation, maintenance, admin)*
- **F5** Total Operating Cost per Passenger Boarding & Mile *(passenger & train)*
- **F6** Operating Cost Recovery *(fare & other commercial revenue per operating cost)*
- **F7** Revenue per Passenger Boarding & Mile *(categories)*
- **F8** Investment Rate *(5yr rolling avg per operating cost)*

### Safety & Security
- **S1** Train Collisions per Train Mile & Hour *(preventable, non-preventable)*
- **S2** Staff Injuries per Staff Work Hours
- **S3** Staff Lost Time from Accidents per Staff Work Hours
- **S4** Passenger Injuries per Boarding & Pax Mile
- **S5** Incidences of Crime per Boarding *(including station & on-board)*
- **S6** Signal Violations
- **S7** Derailments *(non revenue, revenue)*

### Environmental
- **E1** Energy Consumption *(Traction and Non-Traction)* *(per total car mile, pax mile, and capacity mile)*
- **E2** CO2 Emissions per Total Car Mile & Pax Mile
Introduction to GOAL
GOAL: 11 Member Light Rail Systems Across North America –
A Diverse Mixture of System Ages and Characteristics
GOAL Covers Wide-Range of Light Rail Systems, from Smallest (Hampton Roads) to Largest Toronto

2016 Light Rail and Streetcar Ridership and Directional Route Miles (GOAL Members Shown with Hashed Bars)

Largely streetcar operations
Example KPI – Boardings per Vehicle / Train Hour: Range of Density, with Typical Light Rail Train Equal to a Metro Car

207 Light rail boardings/train hour similar to metro average (per car) of 209 boardings/vehicle hour

86 Light rail boardings/vehicle hour is higher than 30 bus boardings/vehicle hour
Context - Ridership: Wide Range, but Normalization Allows for Direct Comparison of Different Sized Agencies

Dallas/Seattle: Long trip lengths impact system/vehicle design

Buffalo/Toronto, short trip lengths – closer to streetcar
Context: Network by Type – Broad Comparability Across the Group with Primarily At-Grade Segregated Running

Track Miles by Type (2016)

- Bf: 10.7%
- UT: 22.5%
- SD: 20.3%
- ST: 20.1%
- Ed: 18.4%
- Ch: 22.0%
- Po: 20.8%
- Da: 18.1%
- HR: 13.1%
- To: 7.6%
- Ca: 19.4%

- Underground Track Miles
- Elevated Track Miles
- At-Grade Segregated Track Miles with Crossings
- At-Grade Mixed Traffic Track Miles
- At-Grade Segregated Track Miles with Fewer or No Crossings

Average Speed: XX.X
KPI Example: Collisions per Revenue Train Miles – Impacts Safety, Vehicle Availability, Cost

Collisions per Million Revenue Train Miles (2016)

- **A**: Highest number of grade crossings in the group
- **B**: Lowest number of grade crossings in the group
- **B**: Large amount of mixed running
- Impacted by ROW Type, Number of Crossings
  - Combines aspects of bus and metro operations/benchmarking

Train Collisions per Million Revenue Train Miles

**Collisions**

<table>
<thead>
<tr>
<th>Letter</th>
<th>Collisions</th>
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<tbody>
<tr>
<td>A</td>
<td>50.05</td>
</tr>
<tr>
<td>B</td>
<td>20</td>
</tr>
<tr>
<td>C</td>
<td>18</td>
</tr>
<tr>
<td>D</td>
<td>16</td>
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<tr>
<td>E</td>
<td>14</td>
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<td>F</td>
<td>12</td>
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<td>G</td>
<td>10</td>
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<tr>
<td>H</td>
<td>8</td>
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<tr>
<td>I</td>
<td>6</td>
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<tr>
<td>J</td>
<td>4</td>
</tr>
<tr>
<td>K</td>
<td>2</td>
</tr>
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<td>0</td>
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</table>
KPI Example: Fleet Required for Peak Service – Reflects Service Levels, Fleet Availability, Age

GOAL Vehicles Required for Peak Service per Total Number of LRVs in Fleet

- Expansion comes on-line
- International Metro Avg: 80%
- Retirement of older, less reliable fleet
- Additional Vehicles Purchased for Expansion

BENCHMARKING GROUP OF NORTH AMERICAN LIGHT RAIL SYSTEMS
KPI Example: Influence of Infrastructure Complexity on Maintenance Costs

US 2016$

$200,000

$0

Infrastructure Maintenance Cost per Track Mile (2016)

- Large number of switches/special track-work
- Large amount of underground running
- Relatively simple at grade systems
KPI Example: Indexed and Anonymized KPI – CO2 Emissions for Light Rail vs Personal Automobile

CO2 Emissions per Miles Travelled
(Indexed and Anonymized GOAL Average = 1.0)

More dense systems or systems using more sustainable energy (wind, solar, nuclear)

Single Passenger Auto Average

Light Rail Average
Examples of Benefits Identified Through Benchmarking

- **Member 1: Adjust supervision levels for LRV Operators**
  - Used a small study that looked into supervision levels and practices across the group

- **Member 2: Increase funding/staffing for LRV maintenance**
  - Use KPI data to understand how much comparable members spend on maintenance per vehicle, how many LRV mechanics per vehicle as well as mean-distance between failures

- **Member 3: Identify areas for operational focus**
  - Use dashboards to understand relative performance among members on KPIs and areas of improvement
Thank You! Any Questions?

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