Minutes Matter – Bus Service Reliability

April 13, 2021
Learning Objectives

1. Define and measure reliability

2. Develop and apply an overall agency reliability improvement program

3. Identify effective strategies to address different reliability problems

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Minutes Matter:
A Guide to Bus Transit Service Reliability

April 13, 2021
1:00 EDT

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Kari Watkins, PhD PE | Georgia Institute of Technology Atlanta GA
Webinar Agenda

- Introduction and overview of research
- Addressing bus service reliability
- Setting the program up for success
- Reliability diagnostic assessment
- Agency case studies
- Reliability improvement tools: review of key treatments
- Wrap up
- Q & A
Guidebook: Addressing Bus Transit Reliability

Why Does Reliability Matter?

Reliability Points of View

Developing an Effective Reliability Improvement Program
Why is Reliability Important: Travel Time Budget

—If a trip normally takes 20 minutes, but takes 30 minutes once a week — a very typical situation for bus riders — then the customer must budget 30 minutes

—By reducing trip length variability, an agency can save customers time, without speeding up buses!
Overview of Research

Transit Cooperative Research Program (TCRP) Project A-42 was a comprehensive assessment of fixed-route bus service reliability, Research focused on identifying:

— How to define and measure reliability
— Factors impacting fixed-route bus service reliability
— Measures to quantify unreliability
— Diagnostic tools to assess extent of reliability problems,
— Potential treatments
— How to achieve agency consensus to implement an overall Reliability Improvement Program
Research Process

— Culminated in **Guidebook on Bus Service Reliability (TCRP Report 215)** – A user guide for identifying, evaluating and solving reliability problems on fixed-route bus systems

— The Guidebook is supplemented by a Final Report (Web-Only Document 72)
  — Research Summary
  — Literature Review
  — Transit Agency Survey
  — Case Study Summary
  — Implementation Plan
Literature Review

The number of times each of these measures was cited in the literature review

![Bar chart showing the number of documents reviewed that included each measure.]

- On-time performance: 38
- Schedule adherence: 20
- Wait times: 18
- Delay: 15
- Travel times: 15
- Travel time variance: 13
- Schedule deviation: 12
- Travel time coefficient of variation: 11
- Excess wait time: 10
- Headway regularity: 10
- Buffer time: 9
- Running time variance: 9
- Headway adherence: 8
- Headway variance: 8
- Running times: 7
Transit Agency Survey

— Survey sent to over 400 fixed-route bus operators in the U.S. and Canada, and a handful of agencies overseas

— 44 questions
  — Agency Characteristics
  — Definitions and Measures
  — Improvement Strategies
  — Before-After Studies
  — Implementation
  — Case Study Participation

— 86 agencies responded from North America and two from the U.K.
Which measures do agencies use to evaluate and report reliability at the system level?

- On-Time Performance: 83%
- Missed Trips: 56%
- Number of Accidents: 40%
- Distance Between Vehicle Breakdowns: 35%
- Pull-Out Performance: 29%
- Driver Attendance: 28%
- Missed Pullouts/Missed Driver Runs: 28%
- Missed or Unfulfilled Scheduled Hours: 28%
- Headway Adherence: 24%
- Recovery Time: 16%
- Time Between Vehicle Breakdowns: 16%
- Added Trips: 14%
- Maintenance Personnel Attendance: 14%
- Distance Without Service Interruption: 13%
- Travel Time Variability: 9%
- Excess Wait Time: 6%
- Average Wait Time: 2%
- Wait Assessment: 2%
Guidebook: Addressing Bus Transit Reliability

- Declines in Travel Time Reliability
  - Customer Point of View
    - Current Customer Behavior
      - Budgeting extra time for trip
      - Health and safety impacts (comfort)
      - Monetary impacts
        (other modes of last-minute transportation)
    - Future Customer Behavior
      - Choice riders turn to other modes
      - Decreased desire to use transit
  - Agency Point of View
    - Route Cycle Time
      - Increases time
      - Increases variability
    - Route Operating Cost
      - Increased labor costs
      - Add buses to a route
  - Operator Point of View
    - Operator Health
      - Stress
      - Fatigue
      - Lack of personal recovery time
    - Operator and Passenger Safety
      - Potential for crashes
      - Negative interactions with passengers
  - Decreased Satisfaction and Ridership
  - Lower Transit Agency Reputation
  - Issues with Morale and Retention

- Addressing and Improving Reliability
  - Continuous Performance Monitoring
    - Diagnose Underlying Causes of Unreliability
    - Select and Implement Strategies for Improvement
  - Improvements in Travel Time Reliability

TCRP A-42: Minutes
Matter:
A Guide to Bus Transit Service Reliability

Kari E Watkins
The Guidebook develops a framework for a transit agency to develop a bus service reliability improvement program.
Guidebook: Defining Goals and Objectives

— Inclusive of agency- and customer-centric goals

— Understand the analysis capabilities of different systems to be used in monitoring standards

— Surveys, focus groups, and advisory committees can be used to further refine the measures
Guidebook: Selecting Measurements, Standards, and Monitoring Data

—Comprehensive list of measures

—The metrics selected must inform standards or targets to measure goals being accomplished

<table>
<thead>
<tr>
<th>Aspect of Reliability</th>
<th>Data Needed</th>
<th>Reliability Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punctuality</td>
<td>Arrival and departure times</td>
<td>On-time performance/schedule adherence</td>
</tr>
<tr>
<td></td>
<td>Trip start and end times</td>
<td>Running time</td>
</tr>
<tr>
<td></td>
<td>Dwell time at stops</td>
<td>Dwell time</td>
</tr>
<tr>
<td></td>
<td>Customer travel times</td>
<td>Travel time</td>
</tr>
<tr>
<td></td>
<td>Time between buses</td>
<td>Headways</td>
</tr>
<tr>
<td></td>
<td>Customer wait times</td>
<td>Wait times</td>
</tr>
<tr>
<td>Variability</td>
<td>Records of missed service</td>
<td>Pullouts missed</td>
</tr>
<tr>
<td></td>
<td>Counts of service disruptions</td>
<td>Missed hours of service</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scheduled trips cancelled</td>
</tr>
<tr>
<td>Non-operation</td>
<td>Multiple</td>
<td>Number of crashes</td>
</tr>
<tr>
<td></td>
<td>Customer surveys</td>
<td>Mean distance between failures</td>
</tr>
</tbody>
</table>

Guidebook: Selecting Measurements, Standards, and Monitoring Data

Aspect of Reliability | Data Needed | Reliability Measure
--- | --- | ---
Punctuality | Arrival and departure times | On-time performance/schedule adherence
| Trip start and end times | Running time |
| Dwell time at stops | Dwell time |
| Customer travel times | Travel time |
| Time between buses | Headways |
| Customer wait times | Wait times |
| Variability | Records of missed service | Pullouts missed |
| Non-operation | Counts of service disruptions | Missed hours of service |
| Multiple | Customer surveys | Number of crashes |
|           |                  | Mean distance between failures |

Kari E Watkins
Survey: How Agencies Define LATE

Number of Minutes After Scheduled Time

- 0 minutes: 2%
- 1 minute: 2%
- 2 minutes: 3%
- 3 minutes: 6%
- 4 minutes: 6%
- 5 minutes: 67%
- 6 to 10 minutes: 10%
- Not Displayed: 3%

Percent of Responding Agencies
Survey: How Agencies Define EARLY

Kari E Watkins

Percent of Responding Agencies

Number of Minutes Before Scheduled Time

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

0 1 2 3 4 5 6 to 10 Not Displayed

47% 31% 10% 5% 1% 3% 1% 3%
The Guidebook develops a framework for a transit agency to develop a bus service reliability improvement program

1. Define Goals and Objectives
2. Select Reliability Measures
3. Select Reliability Standards
4. Implement the Program/Monitor Performance
5. Review and Update
6. Implement and Monitor Treatments
7. Identify Treatments
8. Diagnostic Assessment
For each element of poor reliability, the framework identifies the customer-facing measures affected.

<table>
<thead>
<tr>
<th>Measure with Poor Results</th>
<th>Element of Unreliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal departure times</td>
<td>Non-Operation</td>
</tr>
<tr>
<td>Arrival times</td>
<td></td>
</tr>
<tr>
<td>Bus running times</td>
<td></td>
</tr>
<tr>
<td>Dwell times</td>
<td></td>
</tr>
<tr>
<td>Customer travel time</td>
<td></td>
</tr>
<tr>
<td>Buffer time</td>
<td></td>
</tr>
<tr>
<td>Headways (terminal departure)</td>
<td></td>
</tr>
<tr>
<td>Headways (mid-route)</td>
<td></td>
</tr>
<tr>
<td>Customer wait times</td>
<td></td>
</tr>
<tr>
<td>Missed service</td>
<td></td>
</tr>
<tr>
<td>Service disruptions</td>
<td></td>
</tr>
<tr>
<td>Customer survey data</td>
<td></td>
</tr>
</tbody>
</table>
Guidebook: Reliability Diagnostic Assessment

Assessment of factors causing unreliability should be based on a hierarchy of these four questions:

1. Are there enough buses and bus operators available to provide the scheduled service?
2. Are vehicles and bus operators available to start each trip on time?
3. Are bus operators starting each trip on time?
4. Are bus operators able to meet scheduled timepoints?
Guidebook: Reliability Diagnostic Assessment

— The Framework identifies possible causal factors influencing each characteristic of poor reliability

<table>
<thead>
<tr>
<th>Factors</th>
<th>Non-Operation</th>
<th>Early/Late Start</th>
<th>Variable Travel Speed</th>
<th>Variable Dwell Times</th>
<th>Inconsistent Transfer Times</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operator availability</td>
<td>Insufficient recovery time</td>
<td>Insufficient/excess sched. time</td>
<td>Too many stops/poorly located</td>
<td>Insufficient recovery time</td>
</tr>
<tr>
<td></td>
<td>Vehicle availability</td>
<td>Operator restroom breaks</td>
<td>Too few/too many timepoints</td>
<td>Poor transfer connections</td>
<td>Poor schedule coordination</td>
</tr>
<tr>
<td></td>
<td>Breakdowns</td>
<td>Holds for late connections</td>
<td>Overly long route</td>
<td>Uneven loading</td>
<td>Poor route connectivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor operational control</td>
<td>Lack of timepoint adherence</td>
<td>Demand in excess of capacity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mechanical issue</td>
<td>Operator skill/behavior</td>
<td>Variable passenger demand</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Delays merging into traffic</td>
<td>Fare payment delays</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Incidents, events, construction</td>
<td>Access for cyclists</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Traffic congestion</td>
<td>Access for mobility impaired</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Signal delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Weather</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Guidebook: Reliability Diagnostic Assessment framework identifies possible causal factors influencing each characteristic of poor reliability.
The Guidebook develops a framework for a transit agency to develop a bus service reliability improvement program.
Guidebook Use Example #1: Creating a new reliability improvement program

**STEP 1** Define Goals and Objectives

**STEP 2** Reliability Measures
- Punctuality = on-time performance (route-level, time-point-level)
- Variability = travel time variability (route-level)
- Non-operation = pullouts missed & number of crashes (trip-level)
- Passenger ratings of reliability

**STEP 3** Select Reliability Standards
Benchmarks set using 10 peer agencies

**STEP 4** Implement the Program and Monitor Performance
Process using data flow from the CAD/AVL system to the operations, archived each night, analyzed monthly
Guidebook Use Example #2: Revision of reliability improvement program with new CAD/AVL system

STEP 2 Select Reliability Measures
New CAD/AVL system with APC allows vastly more in depth analysis of vehicle location data, including signal delays, dwell times, and stop-level boardings and alightings.

STEP 3 Select Reliability Standards
Dwell time variability at using stop-level data to identify worst 10% of routes.

STEP 4 Implement the Program and Monitor Performance
CAD/AVL system more in depth into why speeds are inconsistent using components of travel time.

STEP 5 Diagnostic Assessment
- Dwell time analysis using CAD/AVL + APCs = variable passenger demand
- Assess possible treatments for inconsistent dwell times = ex. standby buses, right-sizing bus stops, increase fleet size, etc.
Guidebook Use Example #3: Reliability Issue Identified = Variable Travel Speeds

**STEP 5** Diagnostic Assessment
Worst variability occurring in two corridors due to delays merging

**STEP 6** Identify Reliability Treatments
- Inconsistent travel speeds = right-sizing bus stops & transit signal priority
- Approach municipality to reconstruct areas close to stops
- Approach municipality to advance Transit Signal Priority

**STEP 7** Implement and Monitor Reliability Treatments
Plan to phase in the treatments one before the other with data collection program to compare measures before and after the implementation
Case Studies: Goals

Better understand critical aspects of measurement and improvement:

1. **Measures** – both traditional and non-traditional.

2. **Standards** – assessing and communicating performance.

3. **Data collection/diagnostic tools** – determining causes of unreliability.

4. **Improvement treatments** – how chosen.

5. **Evaluation** – how to measure success.
## Case Study Agencies

### Small (< 100 buses)
- Manatee County Area Transit (MCAT)
- Kingston, CA Transit

### Medium (100 - 300 buses)
- Pierce Transit (WA)
- Southwest Ohio Regional Transit Agency (SORTA)

### Large (> 300 buses)
- Chicago Transit Authority (CTA)
- Denver RTD
- LA Metro
- New York City Transit
- Transport for London
- VIA Transit (San Antonio)
### Case Studies: Reliability Measures and Standards

<table>
<thead>
<tr>
<th>Agency</th>
<th>Size of Fixed-Route Bus Fleet</th>
<th>On-Time Definition</th>
<th>Acceptable Headway Definition</th>
<th>Bus Reliability Target</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large Transit Agencies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New York City Transit</td>
<td>3,286 buses</td>
<td>-1 minutes to +5 minutes</td>
<td>1.5 x headway OR +3 minutes (peak) +5 minutes (off-peak)</td>
<td>60%</td>
</tr>
<tr>
<td>Chicago Transit Authority</td>
<td>1,572 buses</td>
<td>-1 minutes to +5 minutes</td>
<td>&gt; 60 seconds &lt; 15 minutes OR &lt; 2 x headway &lt; 4% gap headway &lt; 3% bunched</td>
<td>80% on-time</td>
</tr>
<tr>
<td>VIA Metropolitan Transit</td>
<td>378 buses</td>
<td>-30 seconds to +5 minutes</td>
<td>+ 5 minutes</td>
<td>80%</td>
</tr>
<tr>
<td>Regional Transportation District</td>
<td>873 buses</td>
<td>-1 minutes to +5 minutes</td>
<td>N/A</td>
<td>88% in 2017 86% in 2018</td>
</tr>
<tr>
<td>Los Angeles Metro</td>
<td>1,902 buses</td>
<td>-1 minutes to +5 minutes</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Transport for London</td>
<td>7,300 buses</td>
<td>-2 minutes to +5 minutes</td>
<td>uses EWT goal, varies by route</td>
<td>varies by route</td>
</tr>
<tr>
<td><strong>Medium Transit Agencies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southwest Ohio Regional Transportation Authority</td>
<td>299 buses</td>
<td>- 59 seconds to + 5 minutes, 29 seconds</td>
<td>N/A</td>
<td>86% target 85% minimum</td>
</tr>
<tr>
<td>Pierce Transit</td>
<td>118 buses</td>
<td>-1 minutes to +4 minutes</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>Small Transit Agencies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kingston Transit</td>
<td>69 buses</td>
<td>0 minutes</td>
<td>N/A</td>
<td>no target</td>
</tr>
<tr>
<td>Manatee County Area Transit</td>
<td>23 buses</td>
<td>-1 minutes to +5 minutes</td>
<td>N/A</td>
<td>60%</td>
</tr>
</tbody>
</table>
Case Studies: Discussion Items

– Organizational structure and departmental integration.
– Agency measures and standards process.
– System use – data collection, analysis and reporting.
– Analysis process – diagnosing and addressing issues.
– Overall program evaluation.
Case Studies and Reliability: Background

- Reliability is a system performance measure for many agencies.
  - Typically employs technology to inform staff, stakeholders, and customers.
- Measures have generally not changed, but technology has affected:
  - Volume and availability of real time data.
  - Expectations of riders.
- As a result, agencies are creating hybrid organization systems to effectively communicate actions, adjustments and results.
Case Studies: General Agency Communications

- Agencies were focused on reliability from standpoint of improving their overall services.
- Many agencies were incorporating next generation technology processes to measure reliability, either in lieu of, or in concert with, field observations.
- Typically, the above resulted in additional coordination and communication between department programs and processes.
- Similarly, interactions with technology programs and field personnel operations were important to blend immediate operational occurrences with system goals.
Partnering and communication are critical:

**Street, traffic signals, curb space is usually controlled by others.**

Almost all agencies cited the need for good working relationships with the Departments of Transportation/Public Works as well as Police Departments:

**Understanding planned activities and reacting to unplanned events.**
Case Studies: Pierce Transit—On-Time Performance for Top Seven Routes
Case Studies: Take-Aways

Given all the complexities, it was great to hear agencies describe:

– Working collaboratively and proactively to make service better
– Both for their communities and all agencies and riders.

But controlling the data processes requires:

– Balancing the time/energy/resource expenditures
– Compared to the benefit from the amount of data being gathered.

And you still need operators and buses to make all this happen.
Case Studies: Southwest Ohio RTA On-Time Performance by Route

On-Time Performance - Local

On-Time Performance - Express
Guidebook: Reliability Improvement Tools

The Guidebook provides a list of reliability improvement treatments described by several attributes.

It also categorizes treatments by cost and ease of implementation.

- Actions under Direct Agency Control
- Administrative Actions with Some Cost
- Actions with Significant Cost
- Actions that Require Municipal Support

<table>
<thead>
<tr>
<th>Causes of unreliability addressed</th>
<th>Companion treatments</th>
<th>Treatment tradeoffs</th>
<th>Expected effect</th>
<th>Capital cost</th>
<th>Operating cost</th>
<th>Ease of implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower cost</td>
<td>Lower cost</td>
<td>Lower difficult</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher cost</td>
<td>Higher cost</td>
<td>Higher difficult</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Guidebook: Reliability Treatment Menus
Operational

— Introduce standby buses
— Route contingency plans
— Right-sizing bus stops
— Route network adjustments
— Introduce scheduled short-turns
— Divide very long bus routes
— Schedule and headway optimization
— Coordinate schedules at transfer points
— Bus operator training, incentives and monitoring
— Coordinate with other agencies to reduce construction impacts
— Coordinate with traffic and parking enforcement
Guidebook: Reliability Treatment Menus Technology

— More effective use of bus control center
— Fare innovations to reduce dwell time
— Traffic signal optimization
— Transit signal priority
— Real-time information systems
— Improved customer communications
Guidebook: Reliability Treatment Menus

**Physical**

— Encourage roadway agencies to incorporate bus-supportive features
— Far-side stop placement
— Dedicated transitways
— Queue jump lanes
— Level boarding and low-floor buses
— Right-sized terminals and layovers
— Curb extensions at bus stops
— Articulated buses
Guidebook: Reliability Treatment Menus
Policy

— Bus-on-shoulder operation
— Public education
— Yield to bus laws
— Reliability-based fleet maintenance
— Boarding limits
Guidebook: Reported Success of Reliability Treatments

<table>
<thead>
<tr>
<th>Operational Strategy</th>
<th>Overall Adoption</th>
<th>Successful Implementation</th>
<th>Mixed Results</th>
<th>Unsuccessful Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Schedule Changes</td>
<td>92%</td>
<td>65%</td>
<td>30%</td>
<td>2%</td>
</tr>
<tr>
<td>2. Stop Consolidation</td>
<td>47%</td>
<td>55%</td>
<td>24%</td>
<td>21%</td>
</tr>
<tr>
<td>3. Skip Stop Services</td>
<td>27%</td>
<td>52%</td>
<td>48%</td>
<td>0%</td>
</tr>
<tr>
<td>4. Route Realignment</td>
<td>75%</td>
<td>55%</td>
<td>43%</td>
<td>2%</td>
</tr>
<tr>
<td>5. Shortening Route Length</td>
<td>28%</td>
<td>75%</td>
<td>23%</td>
<td>5%</td>
</tr>
<tr>
<td>6. Reducing Number of Route Variations</td>
<td>31%</td>
<td>75%</td>
<td>23%</td>
<td>5%</td>
</tr>
<tr>
<td>7. Adding Time Points</td>
<td>21%</td>
<td>40%</td>
<td>31%</td>
<td>20%</td>
</tr>
<tr>
<td>8. Eliminating Time Points</td>
<td>23%</td>
<td>54%</td>
<td>38%</td>
<td>6%</td>
</tr>
<tr>
<td>9. Real-time Dispatches for Timed Transfers</td>
<td>27%</td>
<td>47%</td>
<td>37%</td>
<td>0%</td>
</tr>
<tr>
<td>10. Using Real-Time Information to Make Ad-Hoc Service Changes</td>
<td>23%</td>
<td>50%</td>
<td>50%</td>
<td>12%</td>
</tr>
</tbody>
</table>
### Guidebook: Reported Success of Reliability Treatments (2)

<table>
<thead>
<tr>
<th>Operational Strategy</th>
<th>Overall Adoption</th>
<th>Successful Implementation</th>
<th>Mixed Results</th>
<th>Unsuccessful Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. Use Real-Time Information to Deploy Run-as-Directed Buses</td>
<td>21%</td>
<td>10%</td>
<td>11%</td>
<td>0%</td>
</tr>
<tr>
<td>12. Pay-on-Exit Fare Collection</td>
<td>3%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>13. Off-Board Fare Collection / All Door Boarding</td>
<td>10%</td>
<td>57%</td>
<td>43%</td>
<td>0%</td>
</tr>
<tr>
<td>14. Accepting Some Fare Evasion for Reliability Improvements</td>
<td>11%</td>
<td>38%</td>
<td>62%</td>
<td>0%</td>
</tr>
<tr>
<td>15. Monitoring Driver Performance / Fatigue</td>
<td>32%</td>
<td>26%</td>
<td>62%</td>
<td>13%</td>
</tr>
<tr>
<td>16. Re-Train Drivers with Poor Reliability Performance</td>
<td>61%</td>
<td>50%</td>
<td>50%</td>
<td>2%</td>
</tr>
<tr>
<td>17. Implementing On-Bus Vehicle Diagnostic Systems</td>
<td>16%</td>
<td>55%</td>
<td>18%</td>
<td>18%</td>
</tr>
</tbody>
</table>
Guidebook: Which Departments are Involved with Reliability Evaluation and Reporting?

<table>
<thead>
<tr>
<th>Collection</th>
<th>Reporting</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation (45%)</td>
<td>Planning (45%)</td>
<td>Planning (52%)</td>
</tr>
<tr>
<td>Planning (30%)</td>
<td>Transportation (38%)</td>
<td>Transportation (33%)</td>
</tr>
<tr>
<td>IT (13%)</td>
<td>Other (17%)</td>
<td>Other (15%)</td>
</tr>
<tr>
<td>Other (11%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ideally the department being evaluated should not be doing the evaluation and reporting.
Improving Reliability is not Easy, but... it need not be Expensive

— Make Reliability The Agency focus
— Departments must work together
— Bus Operators will understand that reliable operation makes their jobs easier
— Reporting must be transparent and believable
Guidebook Hyperlinks

Broad Application of Hyperlinks

- Access to Individual Chapters
- Reliability Selection Menus
  - Measures – related to aspect of reliability
  - Data requirements, analyses, usage
  - Treatments – related to cause of unreliability
- Referrals to Other Research

Table 7.1. Reliability measure menu.

<table>
<thead>
<tr>
<th>Aspect of Reliability</th>
<th>Reliability Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punctuality</td>
<td>On-time performance</td>
</tr>
<tr>
<td></td>
<td>Running time</td>
</tr>
<tr>
<td></td>
<td>Dwell time</td>
</tr>
<tr>
<td>Variability</td>
<td>Travel time</td>
</tr>
<tr>
<td></td>
<td>Buffer time indices</td>
</tr>
<tr>
<td></td>
<td>Headway</td>
</tr>
<tr>
<td></td>
<td>Wait times</td>
</tr>
<tr>
<td>Non-operation</td>
<td>Pullouts missed</td>
</tr>
<tr>
<td></td>
<td>Missed hours of service</td>
</tr>
<tr>
<td></td>
<td>Scheduled trips cancelled</td>
</tr>
<tr>
<td></td>
<td>Number of crashes</td>
</tr>
<tr>
<td></td>
<td>Mean distance between failures</td>
</tr>
<tr>
<td>Multiple</td>
<td>Passenger ratings of reliability</td>
</tr>
</tbody>
</table>
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Questions?

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Kari Watkins, Georgia Institute of Technology

Marlene Connor, Marlene Connor Associates

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