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TRANSPORTATION RESEARCH BOARD

Minutes Matter – Bus Service Reliability

April 13, 2021

@NASEMTRB
#TRBwebinar

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

#TRBwebinar

AICP Credits

- This webinar is eligible for 1.5 AICP credits
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Minutes Matter:
A Guide to Bus Transit Service Reliability

April 13, 2021
1:00 EDT

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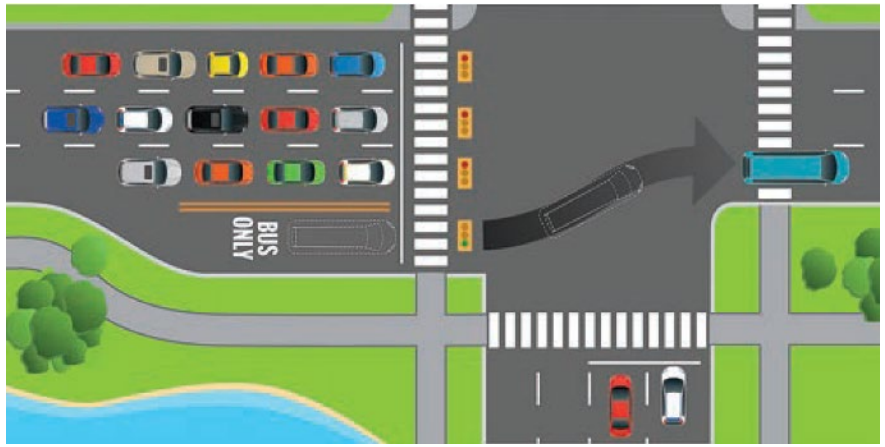
Webinar Agenda

- 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



Kari E Watkins

Guidebook: Addressing Bus Transit Reliability

Why Does Reliability Matter?

Reliability Points of View

Developing an Effective Reliability Improvement Program

Kari E Watkins

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!

Kari E Watkins

Overview of Research

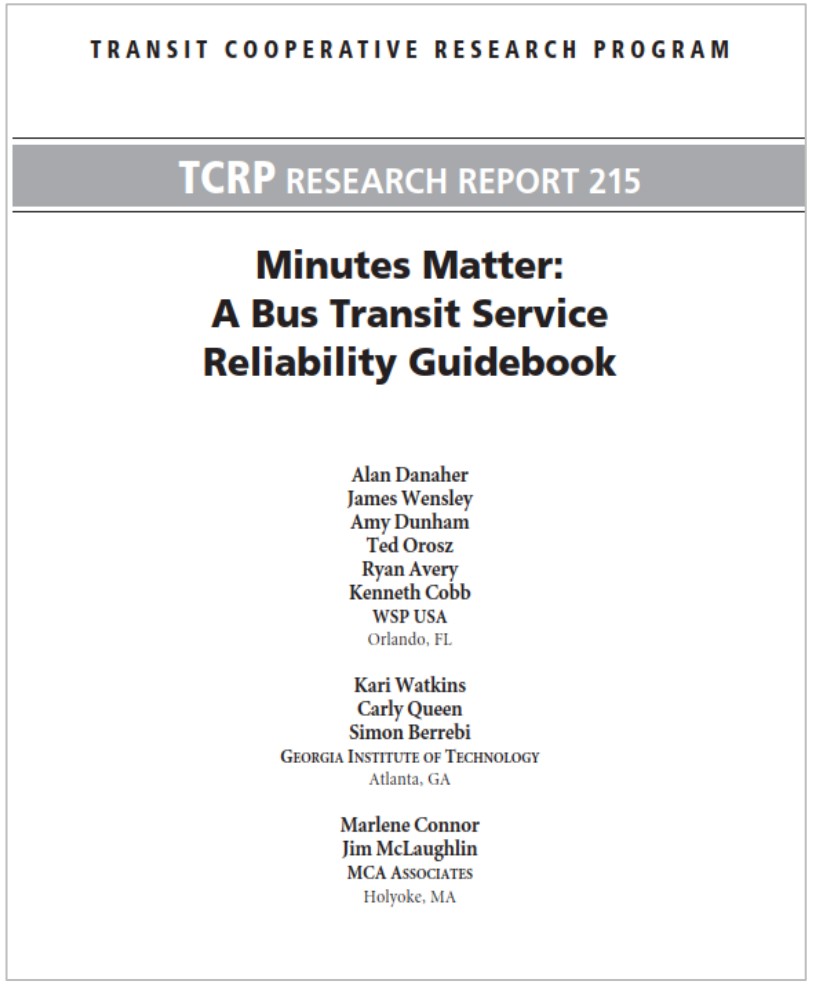
Transit Cooperative Research Program (TCRP) Project A-42 was a comprehensive assessment of fixed-route bus service reliability, Research focused on identifying:

- 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

Kari E Watkins

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


TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP RESEARCH REPORT 215

Minutes Matter: A Bus Transit Service Reliability Guidebook

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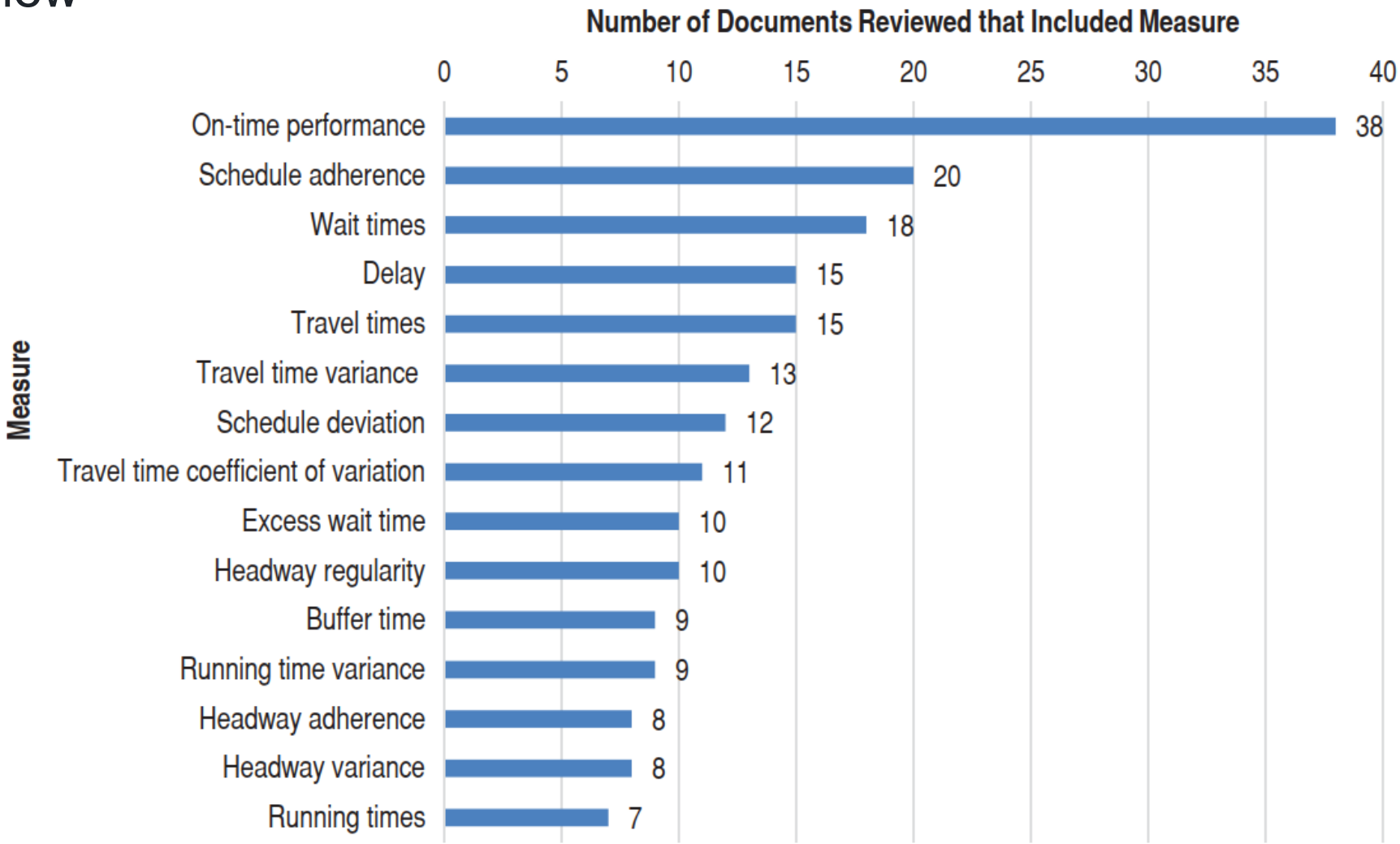
Kari E Watkins

Literature Review

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



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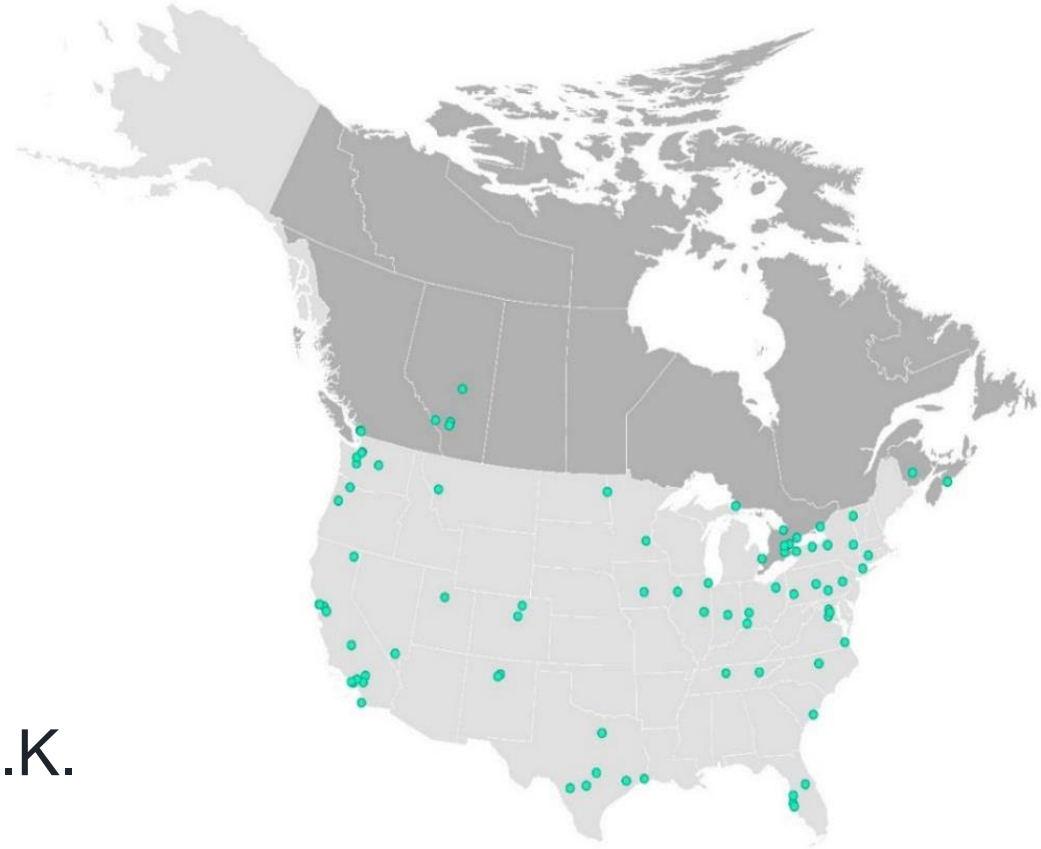
Transit Agency Survey

- 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.



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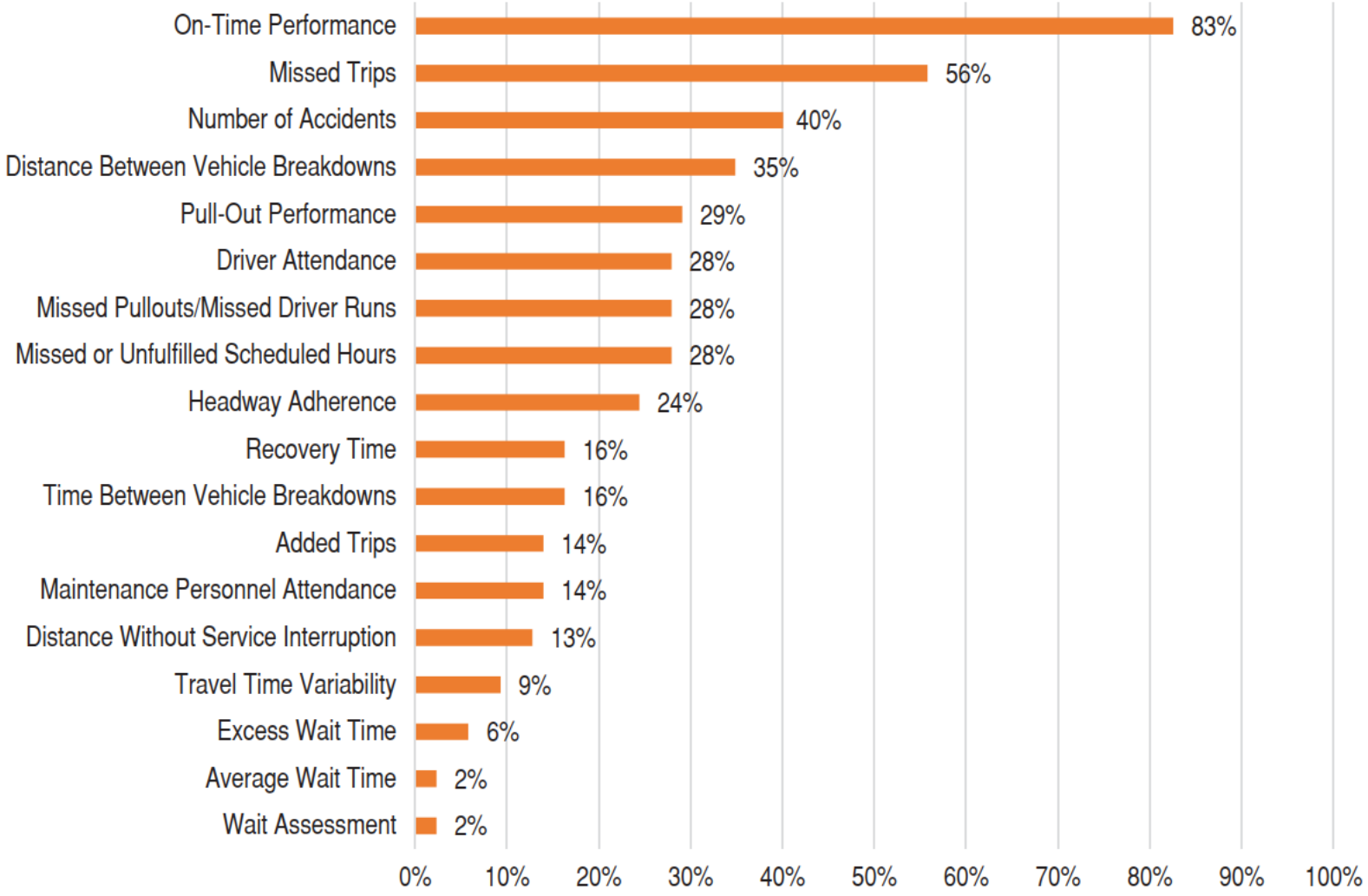
Survey: Systemwide Reliability Measurement Tools

Which measures do agencies use to evaluate and report reliability at the system level?



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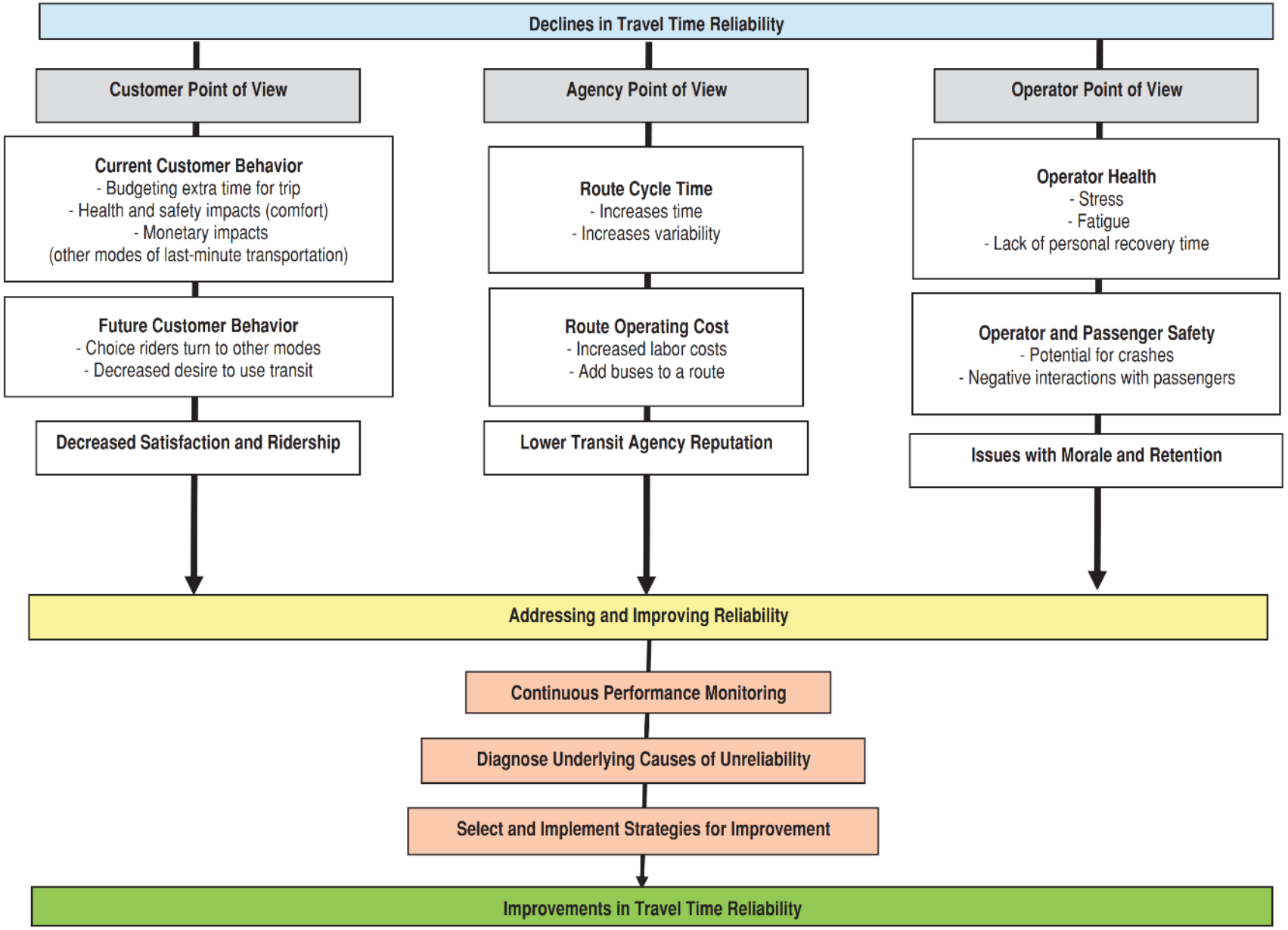

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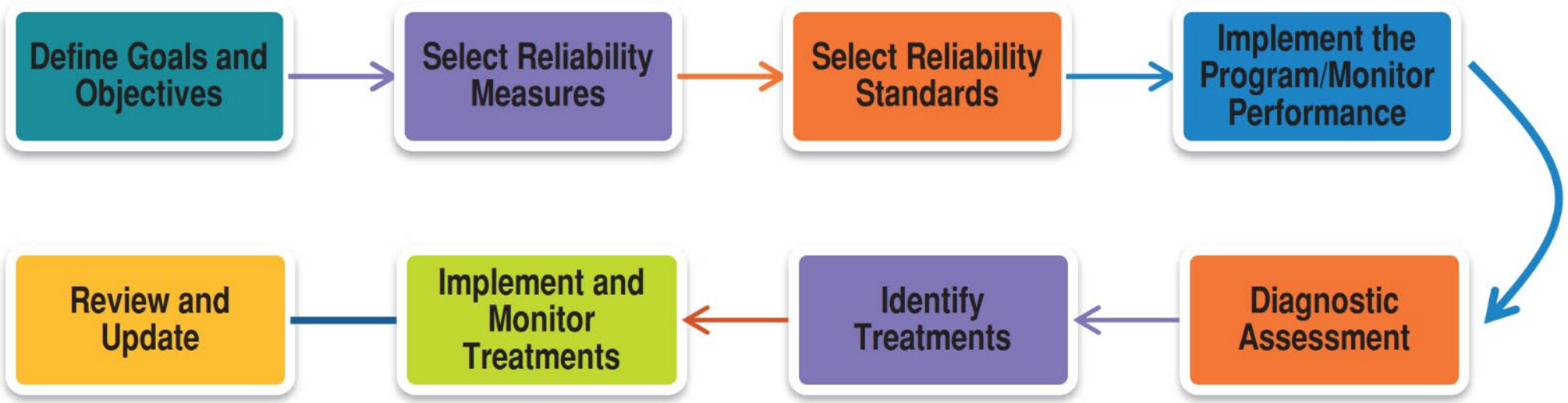
Guidebook: Developing a Bus Service Reliability Improvement Program

The Guidebook develops a framework for a transit agency to develop a bus service reliability improvement program



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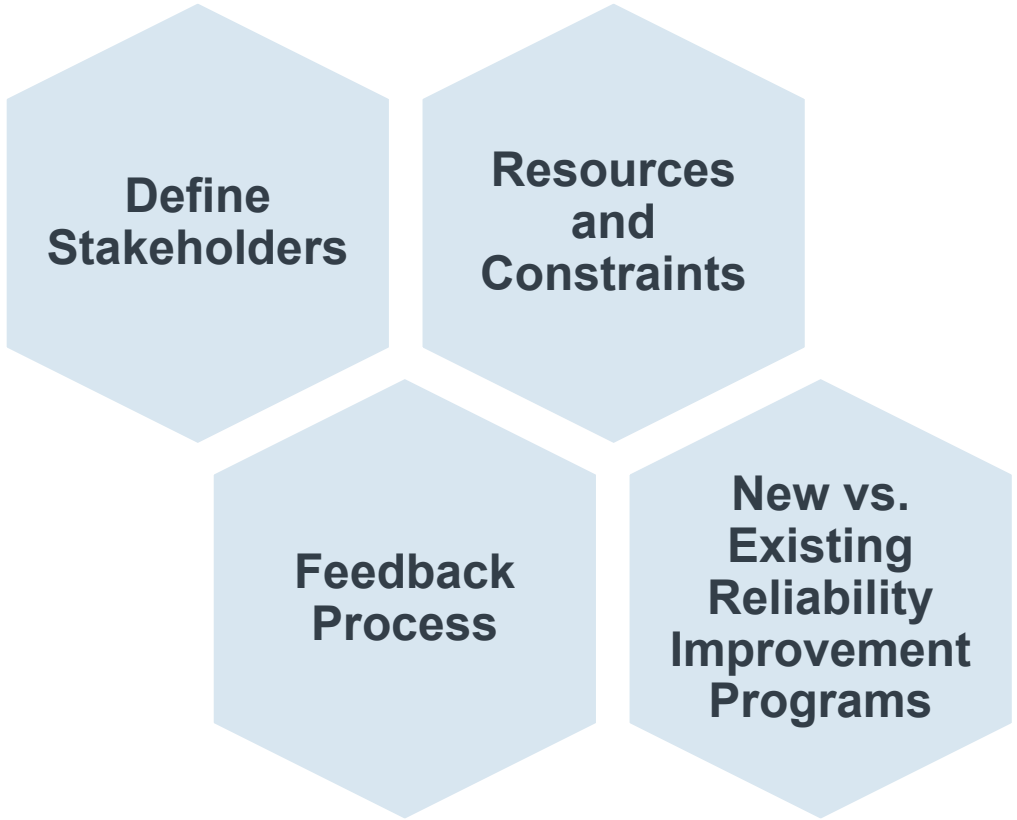
Guidebook: Defining Goals and Objectives

—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



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Guidebook: Selecting Measurements, Standards, and Monitoring Data

- Comprehensive list of measures
- The metrics selected must inform standards or targets to measure goals being accomplished

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

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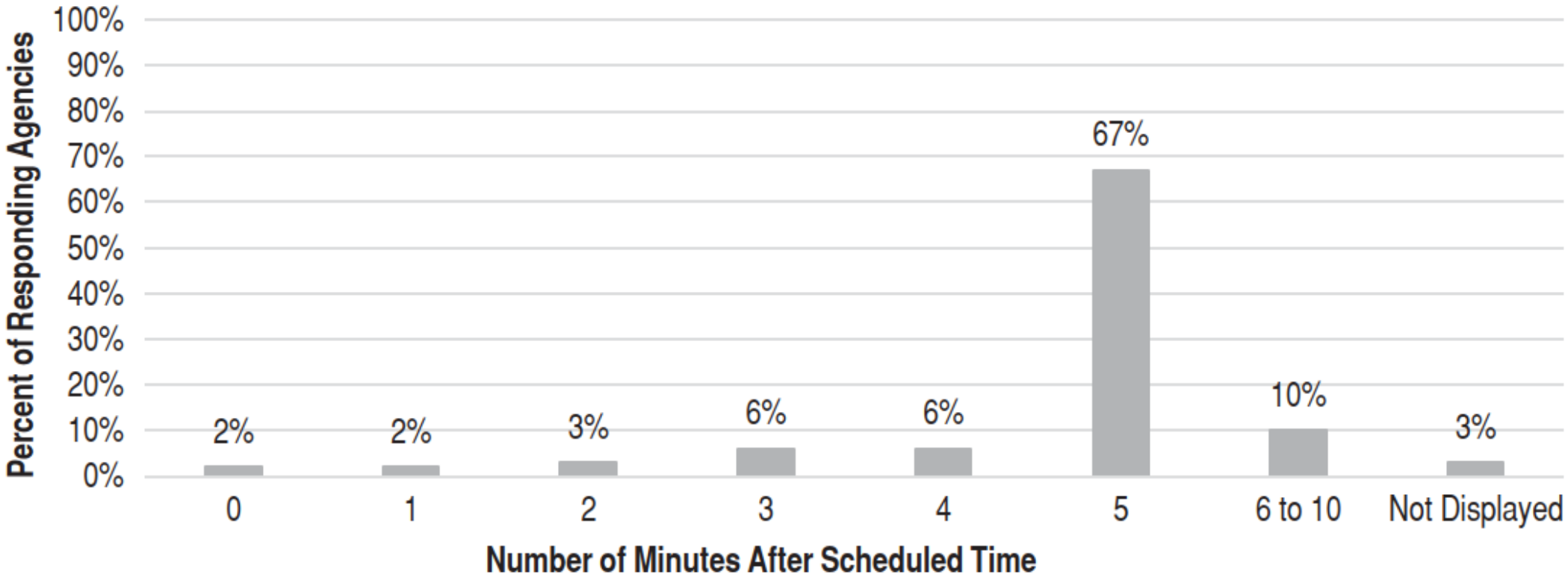
Survey: How Agencies Define LATE



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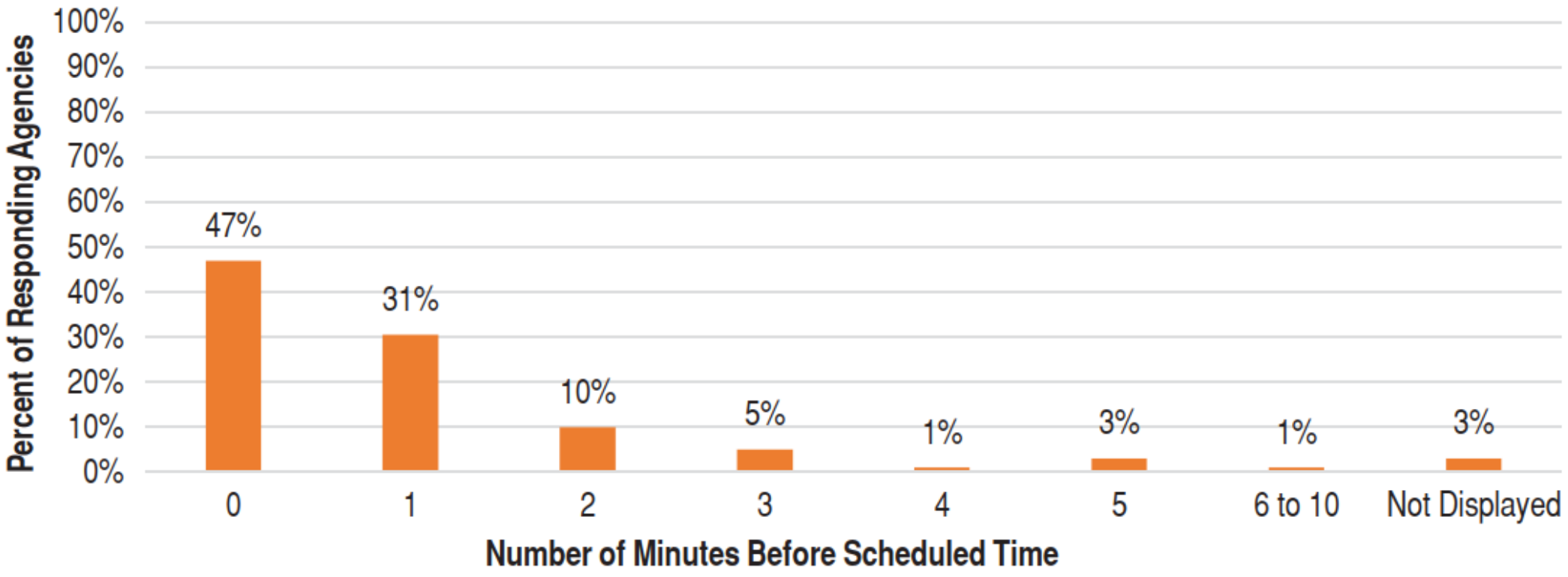
Survey: How Agencies Define EARLY

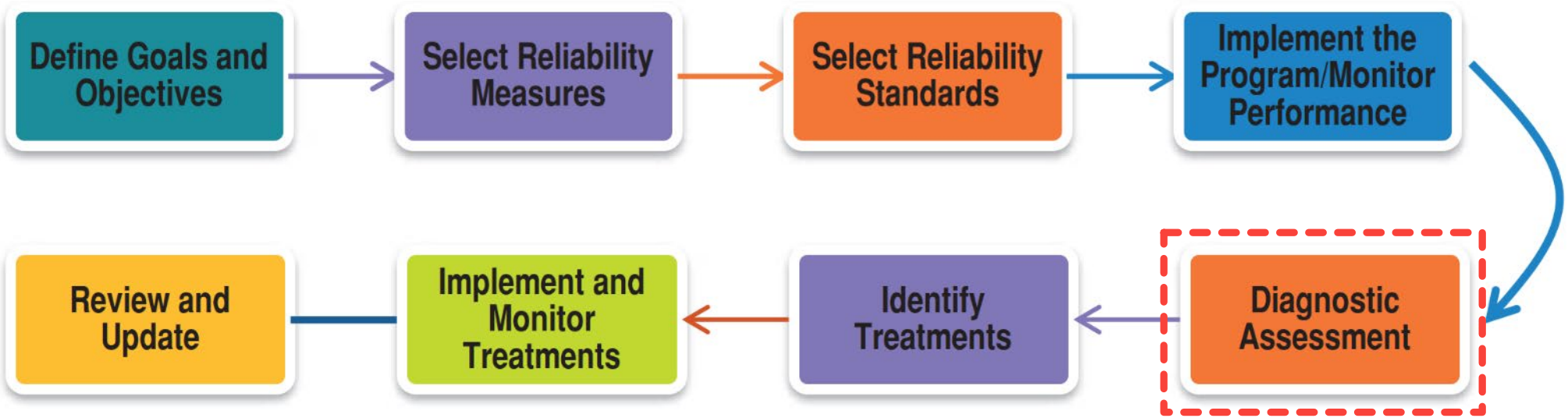


TCRP A-42: Minutes Matter: *A Guide to Bus Transit Service Reliability*

Kari E Watkins

Guidebook: Developing a Bus Service Reliability Improvement Program

The Guidebook develops a framework for a transit agency to develop a bus service reliability improvement program



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Guidebook: Reliability Diagnostic Assessment

For each element of poor reliability, the framework identifies the customer-facing measures affected

Measure with Poor Results	Element of Unreliability				
	Non-Operation	Early/Late Start	Variable Travel Speed	Variable Dwell Time	Inconsistent Transfer Time
Terminal departure times					
Arrival times					
Bus running times					
Dwell times					
Customer travel time					
Buffer time					
Headways (terminal departure)					
Headways (mid-route)					
Customer wait times					
Missed service					
Service disruptions					
Customer survey data					

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Guidebook: Reliability Diagnostic Assessment

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

Are there enough buses and bus operators available to provide the scheduled service?

Are vehicles and bus operators available to start each trip on -time?

Are bus operators starting each trip on -time?

Are bus operators able to meet scheduled timepoints?

Kari E Watkins

Guidebook: Reliability Diagnostic Assessment

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

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

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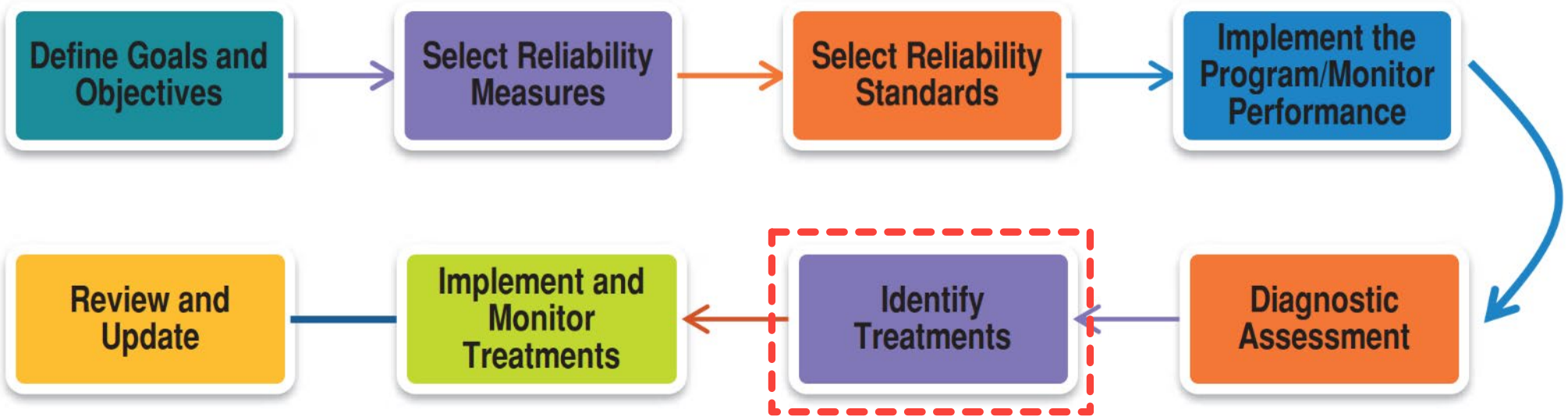
Guidebook: Developing a Bus Service Reliability Improvement Program

The Guidebook develops a framework for a transit agency to develop a bus service reliability improvement program



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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

Kari E Watkins

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.

Kari E Watkins

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

Marlene Connor

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.

Marlene Connor

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)

Marlene Connor

Case Studies: Reliability Measures and Standards

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

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

Marlene Connor

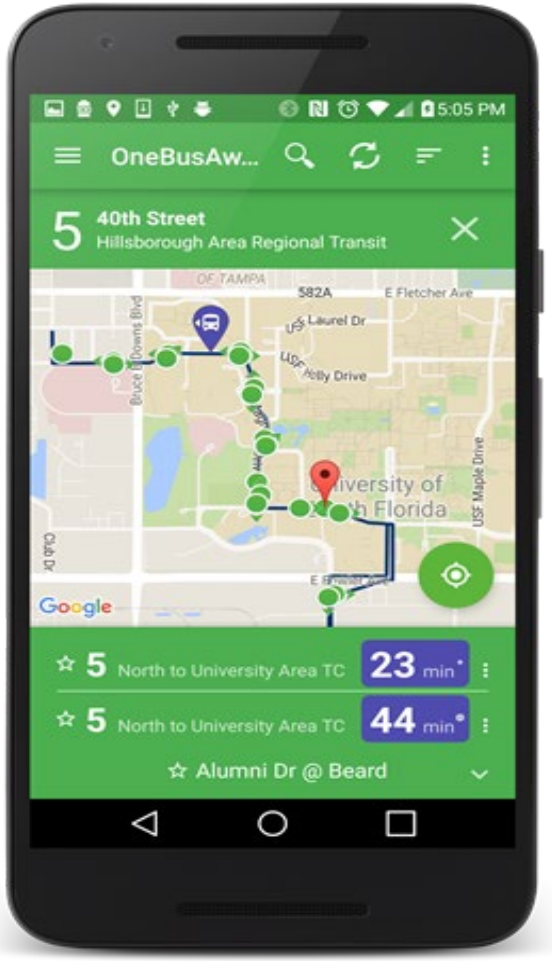
Case Studies: Discussion Items

- 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.

Marlene Connor

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.



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Marlene Connor

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.

Marlene Connor

Case Studies: Working with External Agency Partners

Partnering and communication are critical:

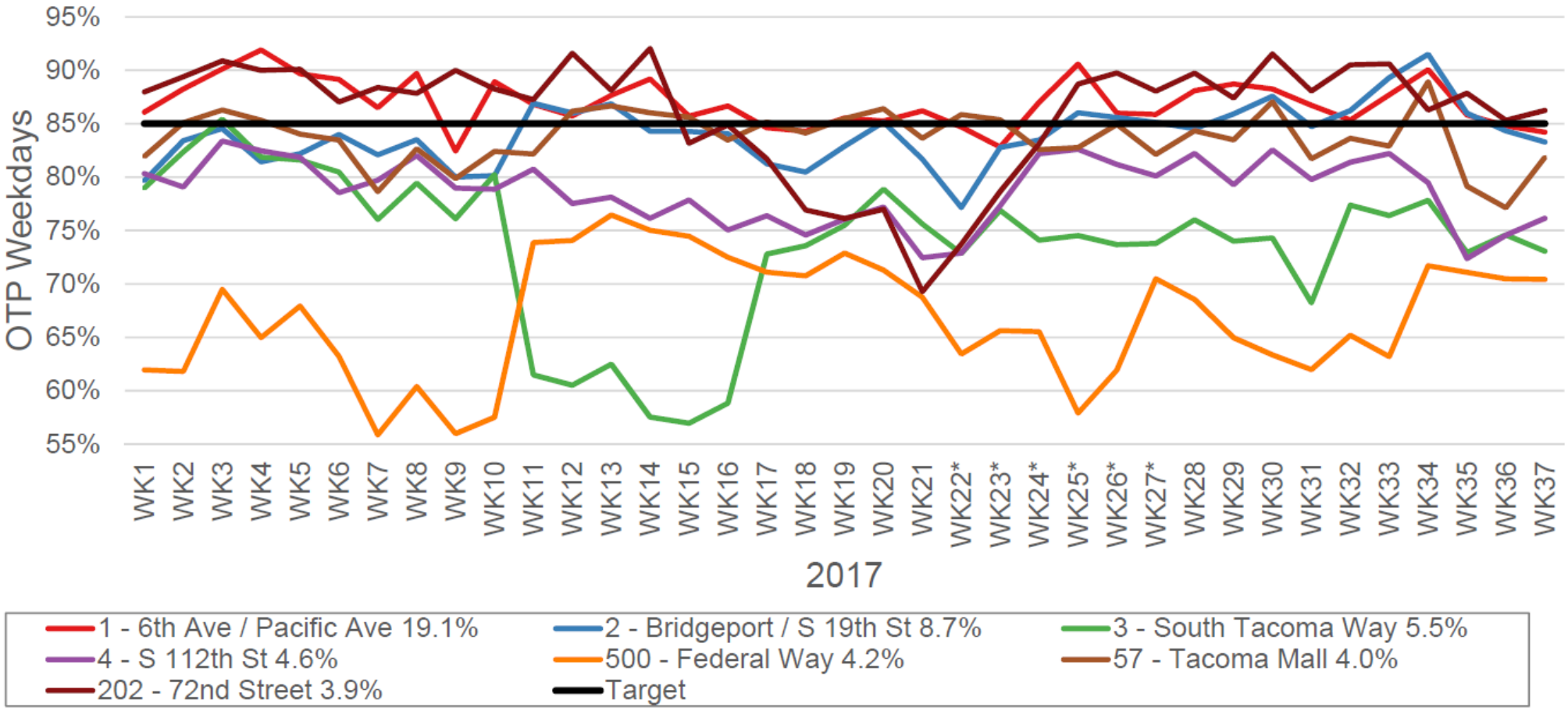
Street, traffic signals, curb space is usually controlled by others.

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.

Marlene Connor

Case Studies: Pierce Transit—On-Time Performance for Top Seven Routes



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Marlene Connor

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.**

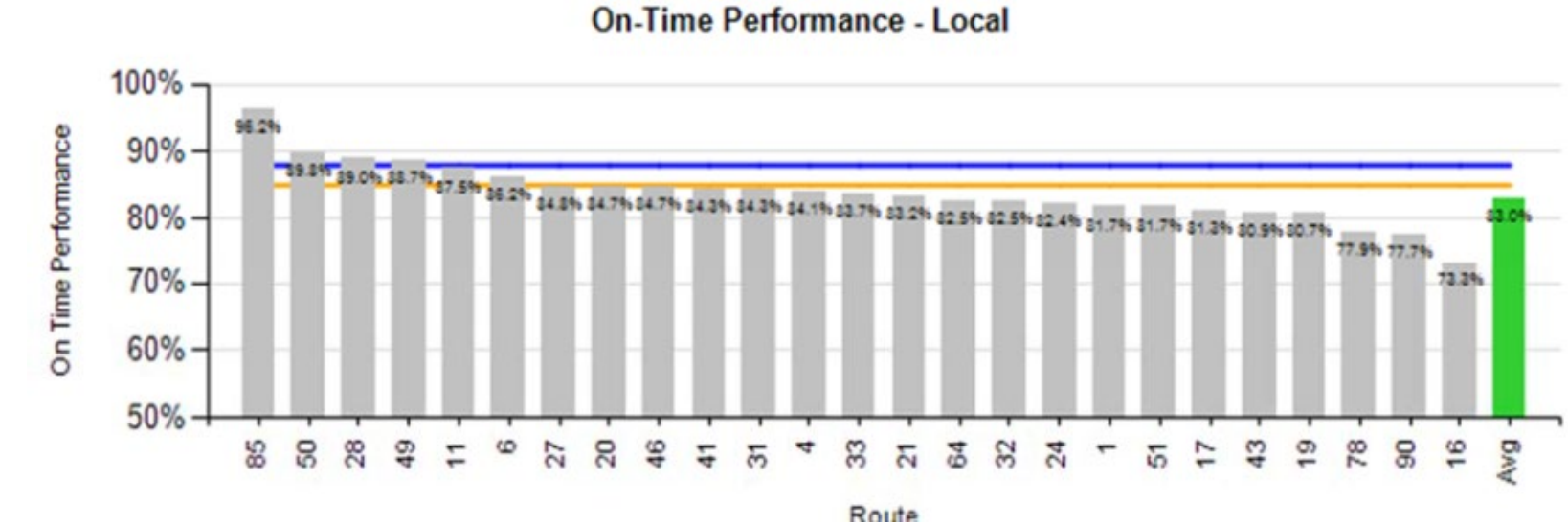
But controlling the data processes requires:

- **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

Marlene Connor



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

Ted Orosz

Guidebook: Reliability Improvement Tools

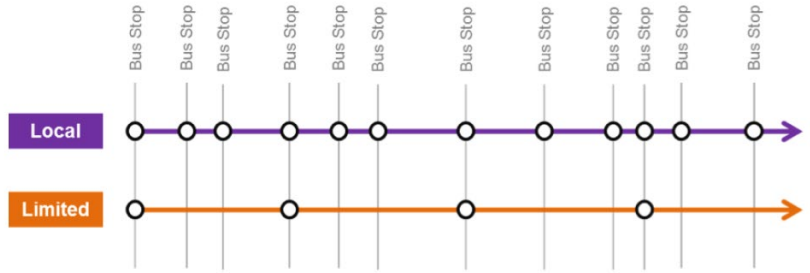
The Guidebook provides a list of reliability improvement treatments described by several attributes

- Causes of unreliability addressed
- Companion treatments
- Treatment tradeoffs
- Expected effect
- Capital cost
- Operating cost
- Ease of implement-ation

It also categorizes treatments by cost and ease of implementation

Ted Orosz

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

Ted Orosz

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

Ted Orosz

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

Ted Orosz

Guidebook: Reliability Treatment Menus
Policy

—Bus-on-shoulder operation

—Public education

—Yield to bus laws

—Reliability-based fleet maintenance

—Boarding limits

Transit Education
Making North Texans DART-smart!

Ted Orosz

Guidebook: Reported Success of Reliability Treatments

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

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

Ted Orosz

Guidebook: Reported Success of Reliability Treatments (2)

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

Ted Orosz

Guidebook: Which Departments are Involved with Reliability Evaluation and Reporting?

Collection	Reporting	Analysis
Transportation (45%)	Planning (45%)	Planning (52%)
Planning (30%)	Transportation (38%)	Transportation (33%)
IT (13%)	Other (17%)	Other (15%)
Other (11%)		

Ideally the department being evaluated should not be doing the evaluation and reporting

Ted Orosz

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

Ted Orosz

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.

Aspect of Reliability	Reliability Measure
Punctuality	On-time performance
Variability	Running time
	Dwell time
	Travel time
	Buffer time indices
	Headway
	Wait times
Non-operation	Pullouts missed
	Missed hours of service
	Scheduled trips cancelled
	Number of crashes
	Mean distance between failures
Multiple	Passenger ratings of reliability

Ted Orosz

Guidebook Access

To view the report, visit:

https://www.nap.edu/read/25727/chapter/1

To download, visit:

http://www.nap.edu/download/25727

Questions?

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Today's Panelists

#TRBWebinar

Moderator: Alan Danaher, *WSP*

Kari Watkins, *Georgia Institute of Technology*

Marlene Connor, *Marlene Connor Associates*

Ted Orosz, *WSP*

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