

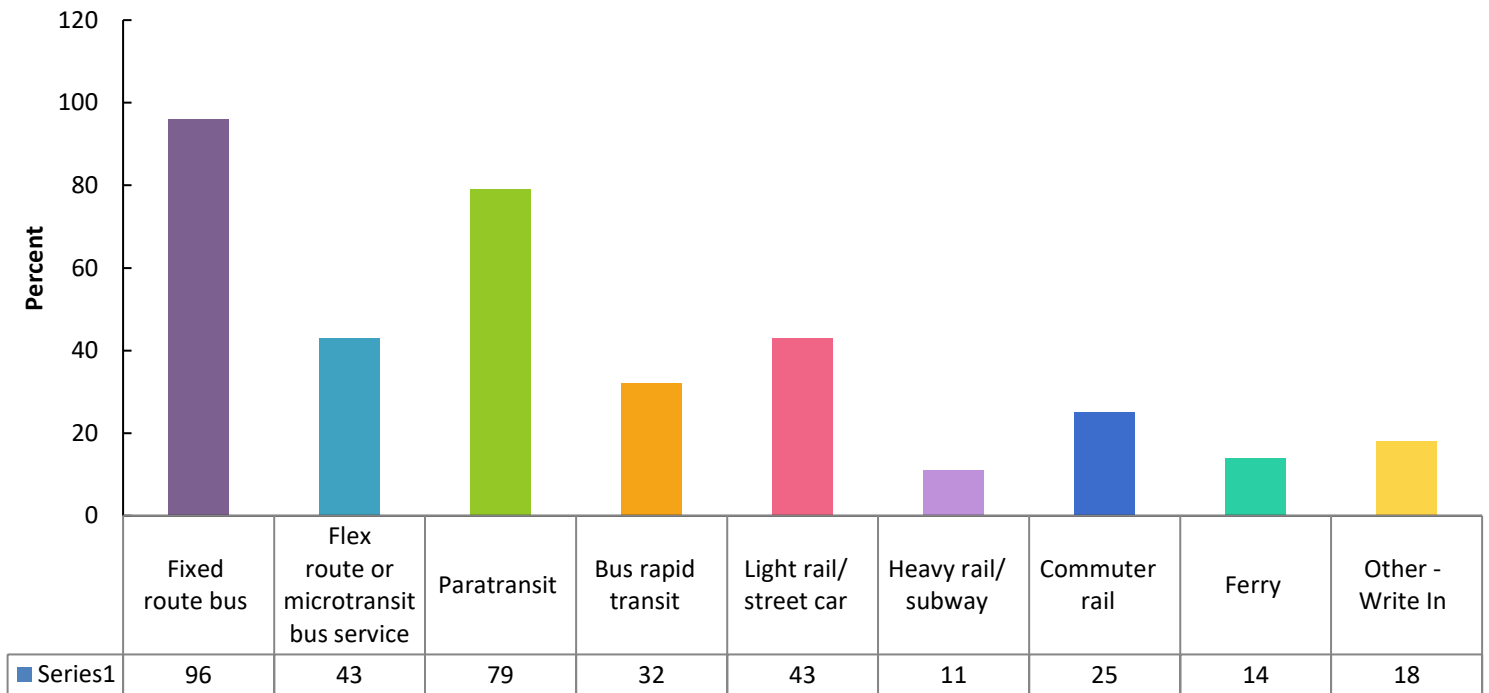


APPENDIX B

Survey Results

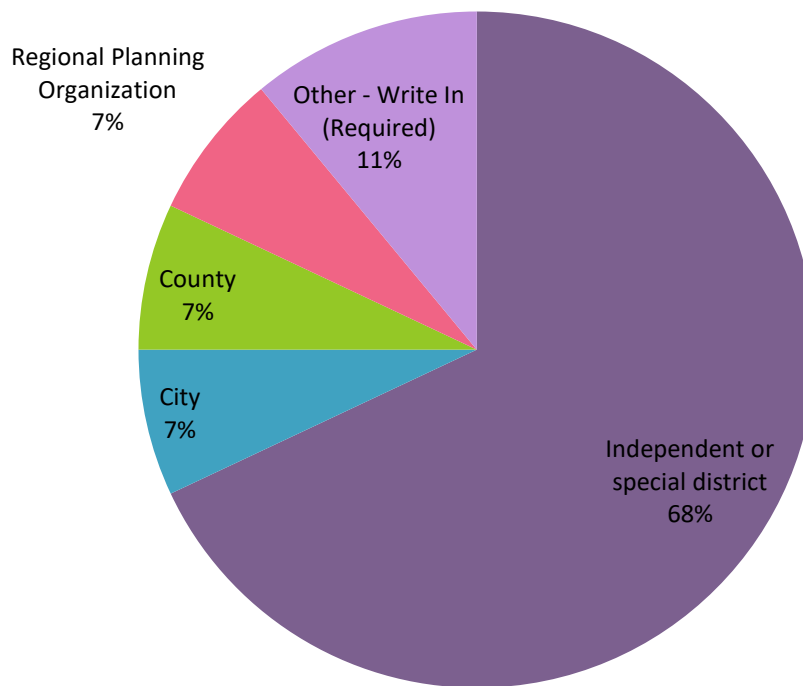
This appendix contains the questions and responses to the survey for The Transit Analyst Toolbox. Questions 7 through 62 are included in this section. Questions 1 through 6 requested information on respondents' contact information. To that end, responses were removed from the report to preserve participant's privacy. In addition, Question 24 was left blank from the survey sent to participants. The questionnaire was set up with dependencies based on previous responses or because they targeted specific modes.

7. What modes are provided by your organization? (select all that apply)



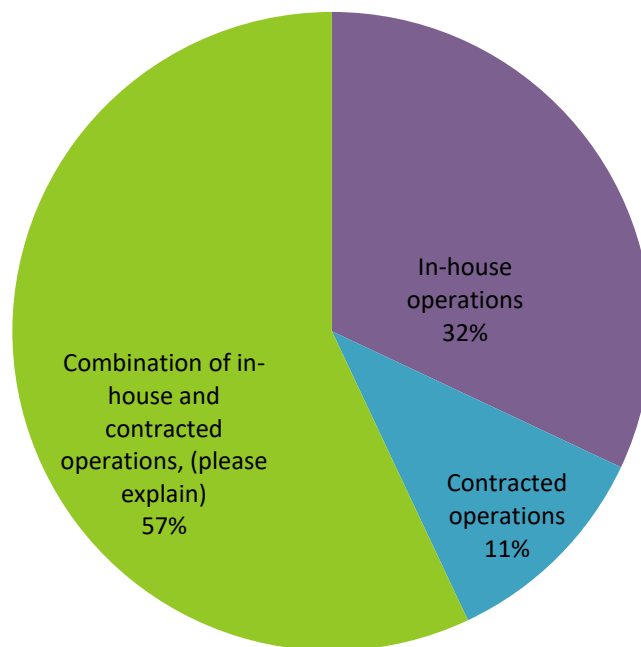
Value	Percent	Count
Fixed route bus	96%	27
Flex route or microtransit bus service	43%	12
Paratransit	79%	22
Bus rapid transit	32%	9
Light rail / street car	43%	12
Heavy rail / subway	11%	3
Commuter rail	25%	7
Ferry	14%	4
Other - Write In	18%	5

8. Select the institutional structure of your organization:



Value	Percent	Count
Independent or special district	68%	19
City	7%	2
County	7%	2
Regional Planning Organization	7%	2
Other - Write In (Required)	11%	3
<ul style="list-style-type: none"> District Joint Powers Authority Regional Transportation Authority 		
	Totals	28

9. Select the operational structure of your organization:



Value	Percent	Count
In-house operations	32%	9
Contracted operations	11%	3
Combination of in-house and contracted operations, (please explain)	57%	16
	Totals	28

Combination of in-house and contracted operations, (please explain)	Count
90% of our service is operated in-house through 9 garages. 10% of our service is contracted out through 5 providers.	1
All services are in house except paratransit.	1
Bus and Rail in house. Paratransit and Ferry outsourced.	1
Bus and Para In-House Commuter Rail: contracted.	1
Commuter Rail is operated by an outside firm.	1
Contract part of paratransit service.	1
Contracted Paratransit service.	1
Fixed Route and BRT are in house; Vanpool, Flex Route, and Paratransit are contracted.	1

Fixed Route is operated in house; paratransit is contracted.	1
In-house fixed route, contracted paratransit and flex areas.	1
Metro provides in-house operations, contracts out service, and serves as contractor for other services.	1
Paratransit and fixed route of < 40' vehicles is contracted.	1
Paratransit contracted.	1
Rail = in house; Bus = both; Paratransit = contracted.	1
Selected bus routes operation is contracted out.	1
Vanpool service is administered in house; fixed-route, complementary paratransit, premium paratransit/taxi, and maintenance are all contracted.	1
Totals	16

10. Please select all Advanced Technologies and Tools used by your agency to collect or generate service data. (select all that apply)

	Fixed route bus	Fixed route bus	Flex or Microtransit	Flex or Microtransit	Paratransit	Paratransit
	#	%	#	%	#	%
Scheduling software	26	96%	8	67%	18	82%
Computer Aided Dispatch (CAD)	25	93%	9	75%	16	73%
Operations monitoring	24	89%	7	58%	14	64%
Headway monitoring	17	63%	3	25%	5	23%
Service delays	20	74%	9	75%	10	45%
Alerts / incidents	26	96%	6	50%	10	45%
Special event management	14	52%	1	8%	2	9%
Automated Vehicle Location (AVL) Vehicle tracking (raw location / time)	26	96%	8	67%	16	73%
Arrival-departure events (arrive-depart at stop, open/close door)	24	89%	4	33%	7	32%
Service events (travel speed, travel time between stops, TSP request)	20	74%	4	33%	5	23%
Automated passenger counter (APC) in field or on-board	23	85%	2	17%	1	5%
Paratransit reservations and dispatch	1	4%	3	25%	18	82%
Customer trip planning and status (web site)	24	89%	5	42%	6	27%
Customer trip planning and status (mobile app)	20	74%	6	50%	3	14%
Open data portal with static schedules (GTFS)	26	96%	2	17%	3	14%
Open data portal with real time information (e.g., GTFS-real time or SIRI)	19	70%	2	17%	2	9%
Open data portal with performance measures (e.g., ridership, on-time performance)	13	48%	2	17%	3	14%
Automated Fare Collection (AFC) - Ticket / pass sales channels	18	67%	6	50%	7	32%
AFC - Farebox	23	85%	2	17%	4	18%
AFC - Validators at farebox, turnstile/gate, field, inspector (smart card, electronic ticket, mobile ticket, paper ticket)	18	67%	3	25%	5	23%

AFC - Flash pass or ticket	11	41%	1	8%	2	9%
Crowd-source apps / social media (e.g., for reporting incidents / disruptions)	10	37%	2	17%	5	23%
Other emerging technologies/sensors that produce service information (please specify in "Enter another option")	1	4%	0	0%	0	0%
Bus stop & LR signs: Please select all Advanced Technologies and Tools used by your agency to collect or generate service data (select all that apply)	1	4%	0	0%	0	0%
Vehicle customer wi-fi: Please select all Advanced Technologies and Tools used by your agency to collect or generate service data (select all that apply)	1	4%	0	0%	1	5%

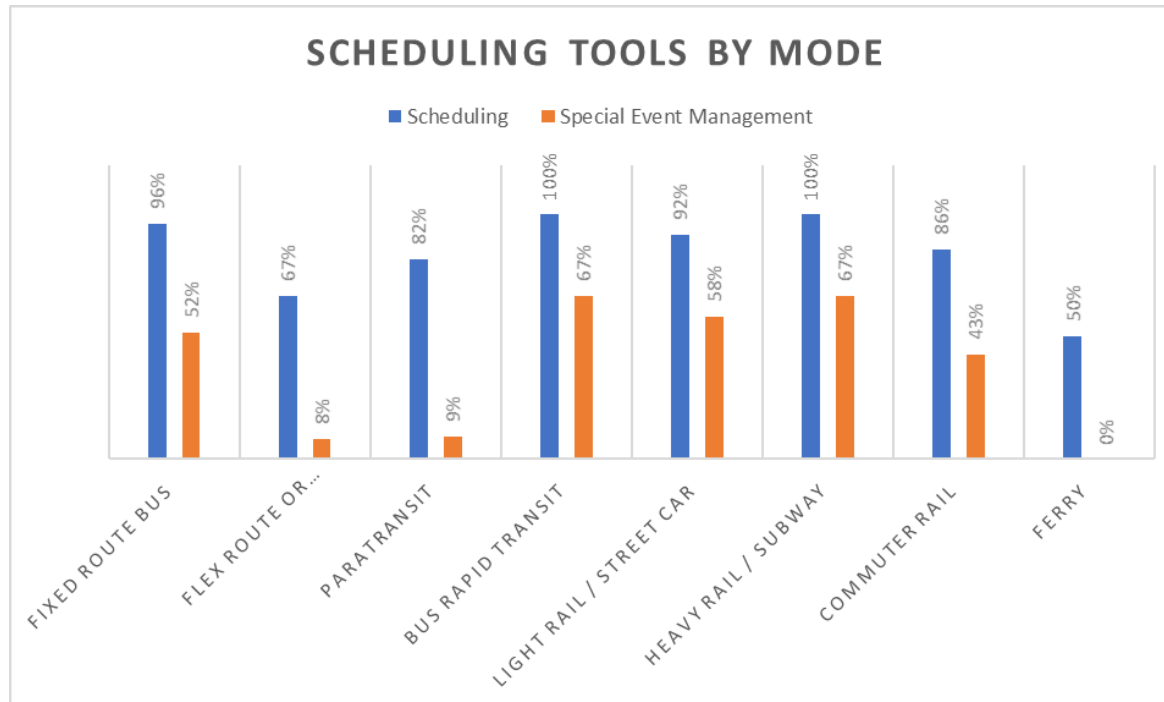
Part Two

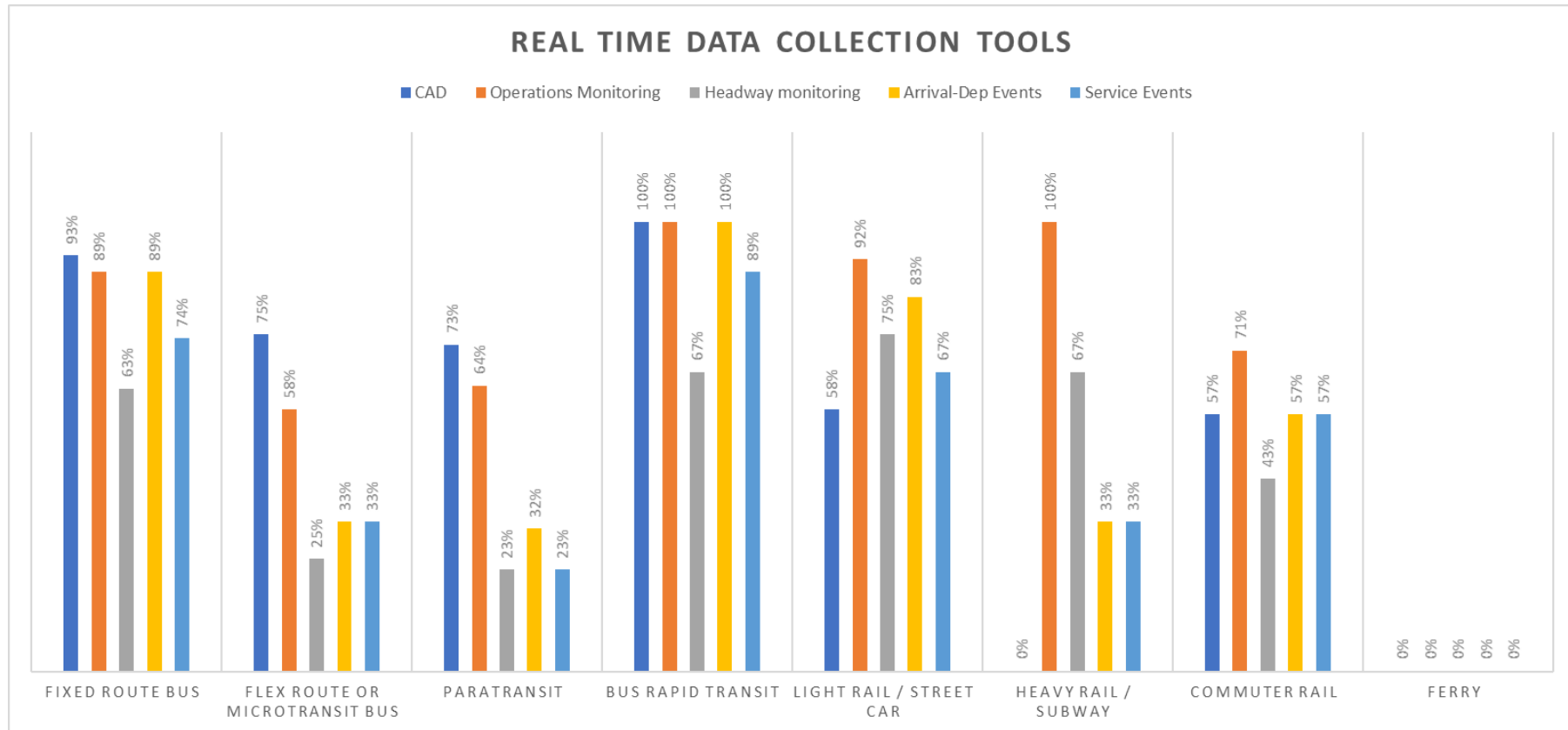
	BRT	BRT	LR	LR	HR	HR	CR	CR	Ferry	Ferry	Other	
	#	%	#	%	#	%	#	%	#	%	#	%
Scheduling software	9	100%	11	92%	3	100%	6	86%	2	50%	3	60%
Computer Aided Dispatch (CAD)	9	100%	7	58%	0	0%	4	57%	0	0%	2	40%
Operations monitoring	9	100%	11	92%	3	100%	5	71%	0	0%	2	40%
Headway monitoring	6	67%	9	75%	2	67%	3	43%	0	0%	2	40%
Service delays	6	67%	10	83%	3	100%	5	71%	2	50%	1	20%
Alerts / incidents	8	89%	12	100%	3	100%	7	100%	3	75%	2	40%
Special event management	6	67%	7	58%	2	67%	3	43%	0	0%	1	20%
Automated Vehicle Location (AVL) Vehicle tracking (raw location / time)	9	100%	10	83%	1	33%	7	100%	2	50%	2	40%
Arrival-departure events (arrive-depart at stop, open/close door)	9	100%	10	83%	1	33%	4	57%	0	0%	2	40%
Service events (travel speed, travel time between stops, TSP request)	8	89%	8	67%	1	33%	4	57%	0	0%	1	20%
Automated passenger counter (APC) in field or on-board	8	89%	10	83%	0	0%	4	57%	0	0%	1	20%
Paratransit reservations and dispatch	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%
Customer trip planning and status (web site)	9	100%	10	83%	3	100%	6	86%	2	50%	2	40%

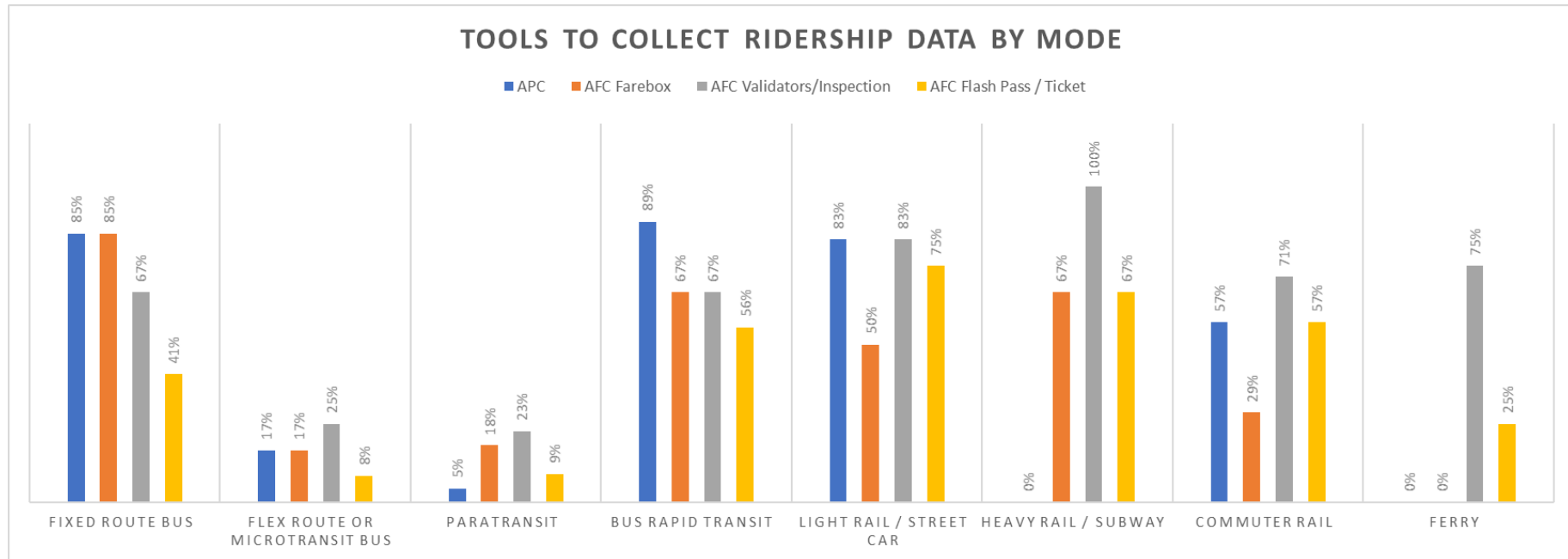
Customer trip planning and status (mobile app)	9	100%	9	75%	3	100%	5	71%	2	50%	0	0%
Open data portal with static schedules (GTFS)	8	89%	12	100%	3	100%	6	86%	2	50%	2	40%
Open data portal with real time information (e.g., GTFS-real time or SIRI)	5	56%	11	92%	1	33%	5	71%	1	25%	1	20%
Open data portal with performance measures (e.g., ridership, on-time performance)	5	56%	8	67%	2	67%	3	43%	2	50%	1	20%
Automated Fare Collection (AFC) - Ticket / pass sales channels	6	67%	11	92%	3	100%	5	71%	1	25%	3	60%
AFC - Farebox	6	67%	6	50%	2	67%	2	29%	0	0%	2	40%
AFC - Validators at farebox, turnstile/gate, field, inspector (smart card, electronic ticket, mobile ticket, paper ticket)	6	67%	10	83%	3	100%	5	71%	3	75%	2	40%
AFC - Flash pass or ticket	5	56%	9	75%	2	67%	4	57%	1	25%	2	40%
Crowd-source apps / social media (e.g., for reporting incidents / disruptions)	3	33%	5	42%	1	33%	4	57%	1	25%	0	0%
Other emerging technologies/sensors that produce service information (please specify in "Enter another option")	1	11%	0	0%	1	33%	0	0%	0	0%	0	0%
Bus stop & LR signs: Please select all Advanced Technologies and Tools used by your agency to collect or generate service data (select all that apply)	1	11%	1	8%	0	0%	0	0%	0	0%	0	0%
Vehicle customer wi-fi: Please select all Advanced Technologies and Tools used by your agency to collect or generate service data (select all that apply)	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%

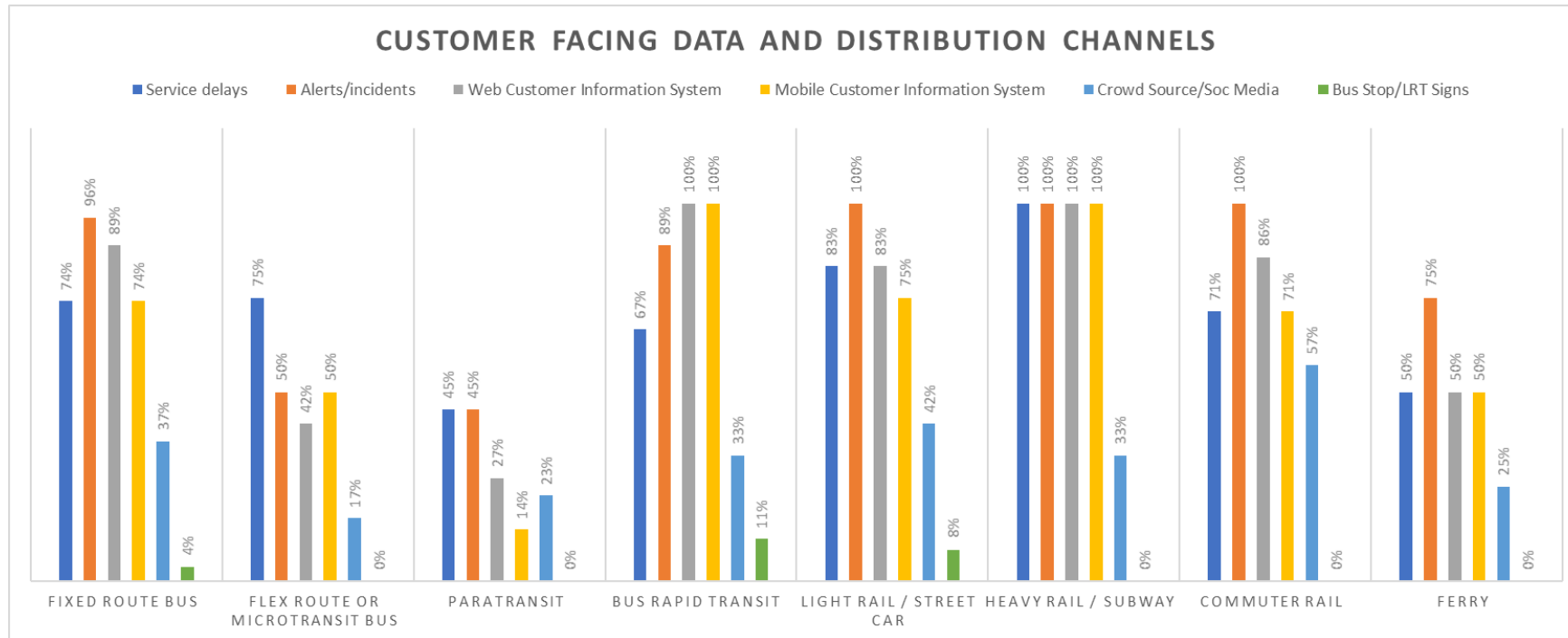
The following tables and graphics are based on the number of agencies with mode that responded. These are captured as follows.

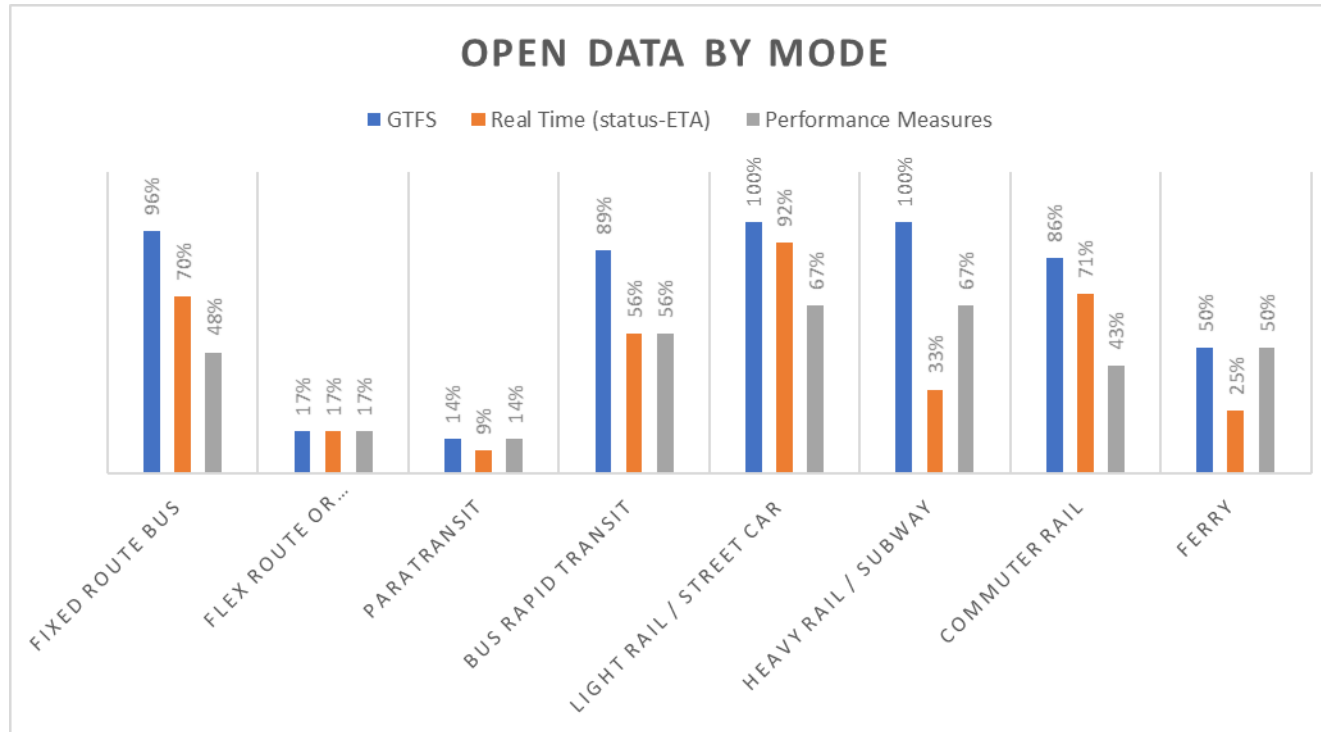
Fixed route bus	96.40%	27
Flex route or microtransit bus service	42.90%	12
Paratransit	78.60%	22
Bus rapid transit	32.10%	9
Light rail / street car	42.90%	12
Heavy rail / subway	10.70%	3
Commuter rail	25.00%	7
Ferry	14.30%	4
Other - Write In	17.90%	5









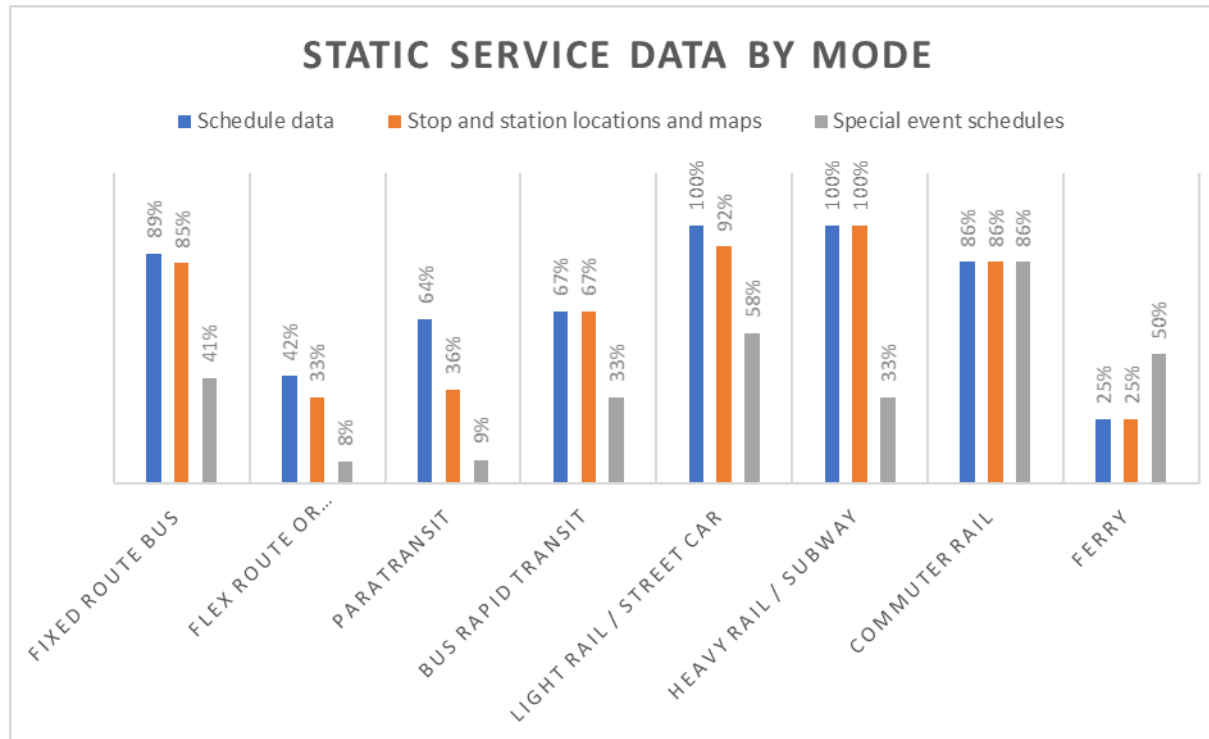


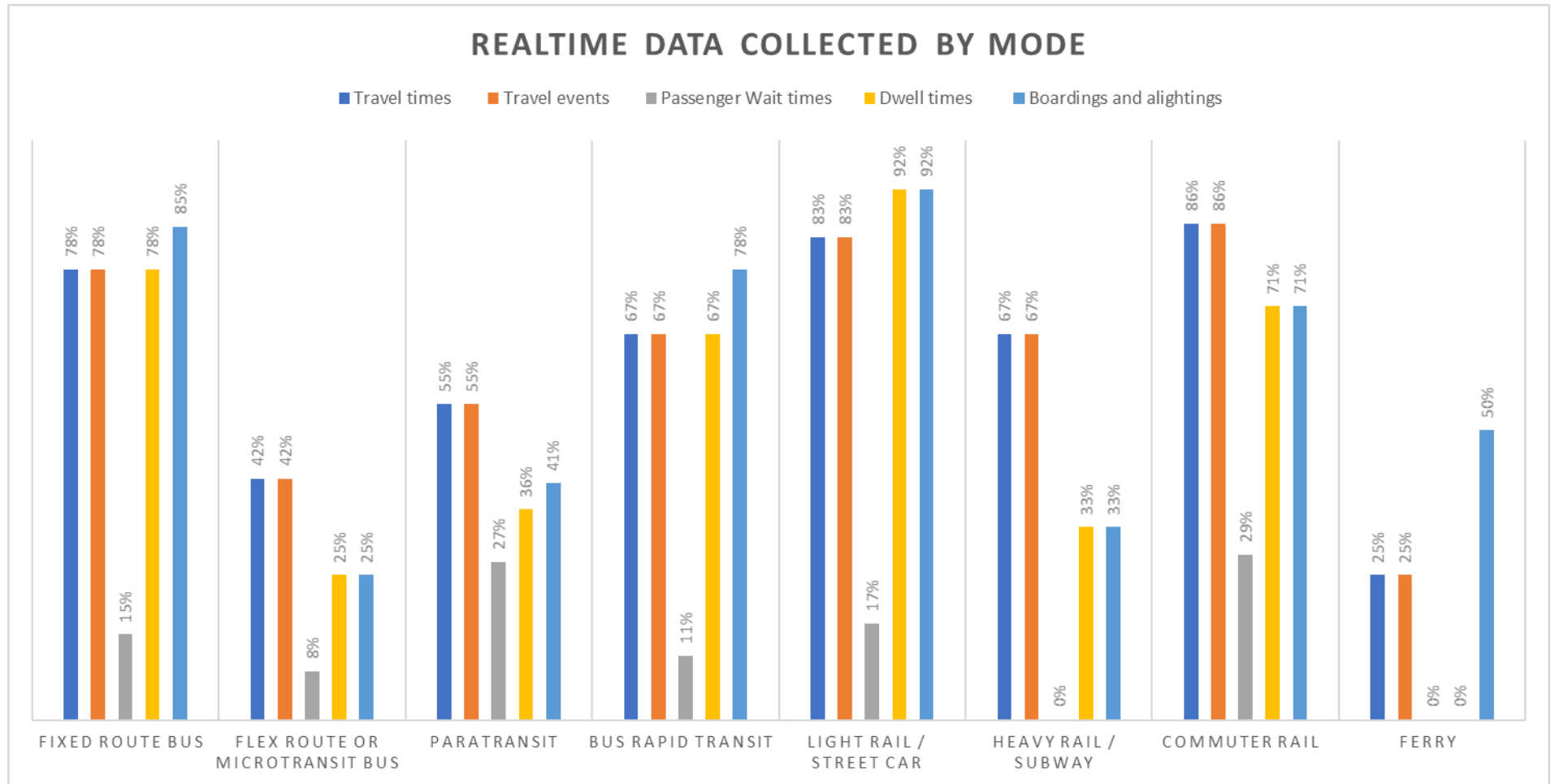
11. What raw service or third-party data are collected, stored and/or processed (by mode)?

	Fixed	Fixed	Flex/Micro	Flex/Micro	Paratransit	Paratransit	BRT	BRT
	#	%	#	%	#	%	#	%
Schedule data	24	89%	5	42%	14	64%	6	67%
Stop and station locations and maps	23	85%	4	33%	8	36%	6	67%
Special event schedules	11	41%	1	8%	2	9%	3	33%
Travel times (origin-destination for each trip/line)	21	78%	5	42%	12	55%	6	67%
Travel events (arrival-departure events for each trip/line)	21	78%	5	42%	12	55%	6	67%
(Passenger) Wait times (at stops)	4	15%	1	8%	6	27%	1	11%
Dwell times	21	78%	3	25%	8	36%	6	67%
Boardings and alightings at each stop by trip	23	85%	3	25%	9	41%	7	78%
Third-party traffic data (travel time, traffic incidents, weather, work zones, etc.)	3	11%	1	8%	2	9%	1	11%
Signal priority requests	1	4%	0	0%	0	0%	0	0%

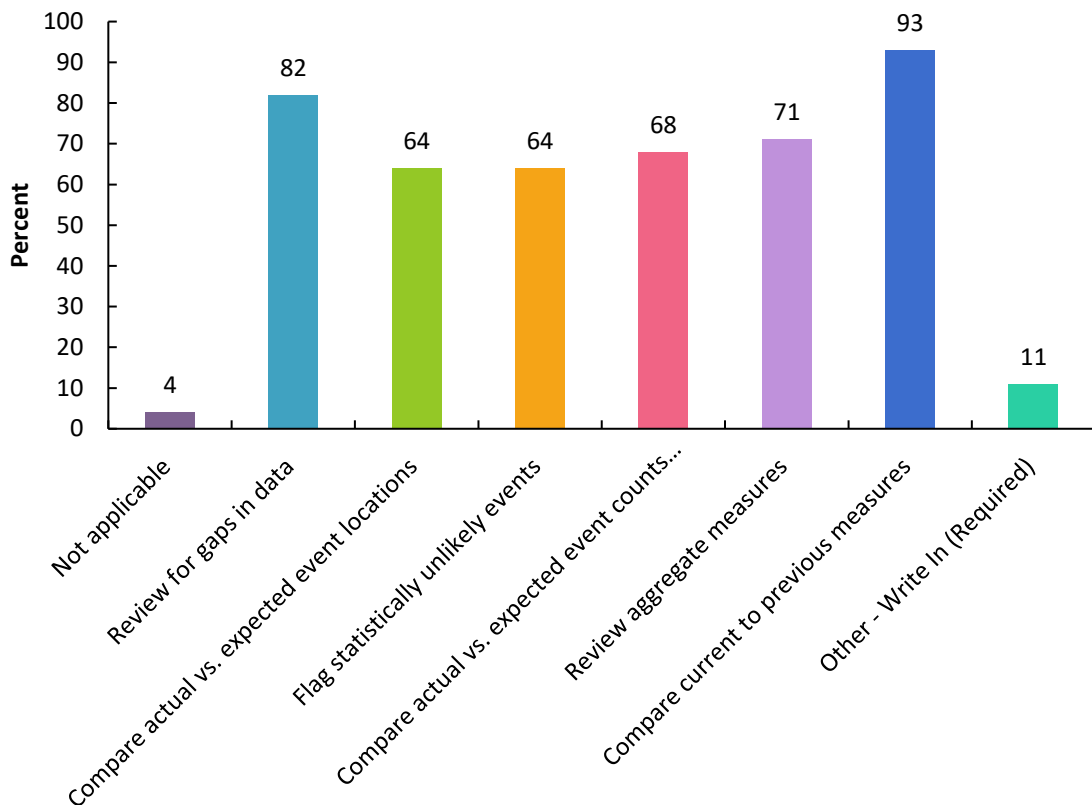
Table 2

	LR	LR	HR	HR	CR	CR	Ferry	Ferry
	#	%	#	%	#	%	#	%
Schedule data	12	100%	3	100%	6	86%	1	25%
Stop and station locations and maps	11	92%	3	100%	6	86%	1	25%
Special event schedules	7	58%	1	33%	6	86%	2	50%
Travel times (origin-destination for each trip/line)	10	83%	2	67%	6	86%	1	25%
Travel events (arrival-departure events for each trip/line)	10	83%	2	67%	6	86%	1	25%
(Passenger) Wait times (at stops)	2	17%	0	0%	2	29%	0	0%
Dwell times	11	92%	1	33%	5	71%	0	0%
Boardings and alightings at each stop by trip	11	92%	1	33%	5	71%	2	50%
Third-party traffic data (travel time, traffic incidents, weather, work zones, etc.)	2	17%	1	33%	1	14%	0	0%
Signal priority requests	0	0%	0	0%	0	0%	0	0%





12. To measure quality (i.e., completeness, accuracy and reliability) of the data, our agency does the following. (select all that apply)



Value	Percent	Count
Not applicable	4%	1
Review for gaps in data	82%	23
Compare actual vs. expected event locations	64%	18
Flag statistically unlikely events	64%	18
Compare actual vs. expected event counts (e.g., against schedules, bus capacity, other data sources)	68%	19
Review aggregate measures	71%	20
Compare current to previous measures	93%	26
Other - Write In (Required) <ul style="list-style-type: none"> Compare different sources of Data, such as Schedule Adherence, APC, and Fare System, since they all have a common backbone in the scheduling system Validate farebox boardings against HASTUS daily schedule data N/A 	11%	3

13. Please attach any additional information on your data quality procedures, if applicable.

1 File Uploaded

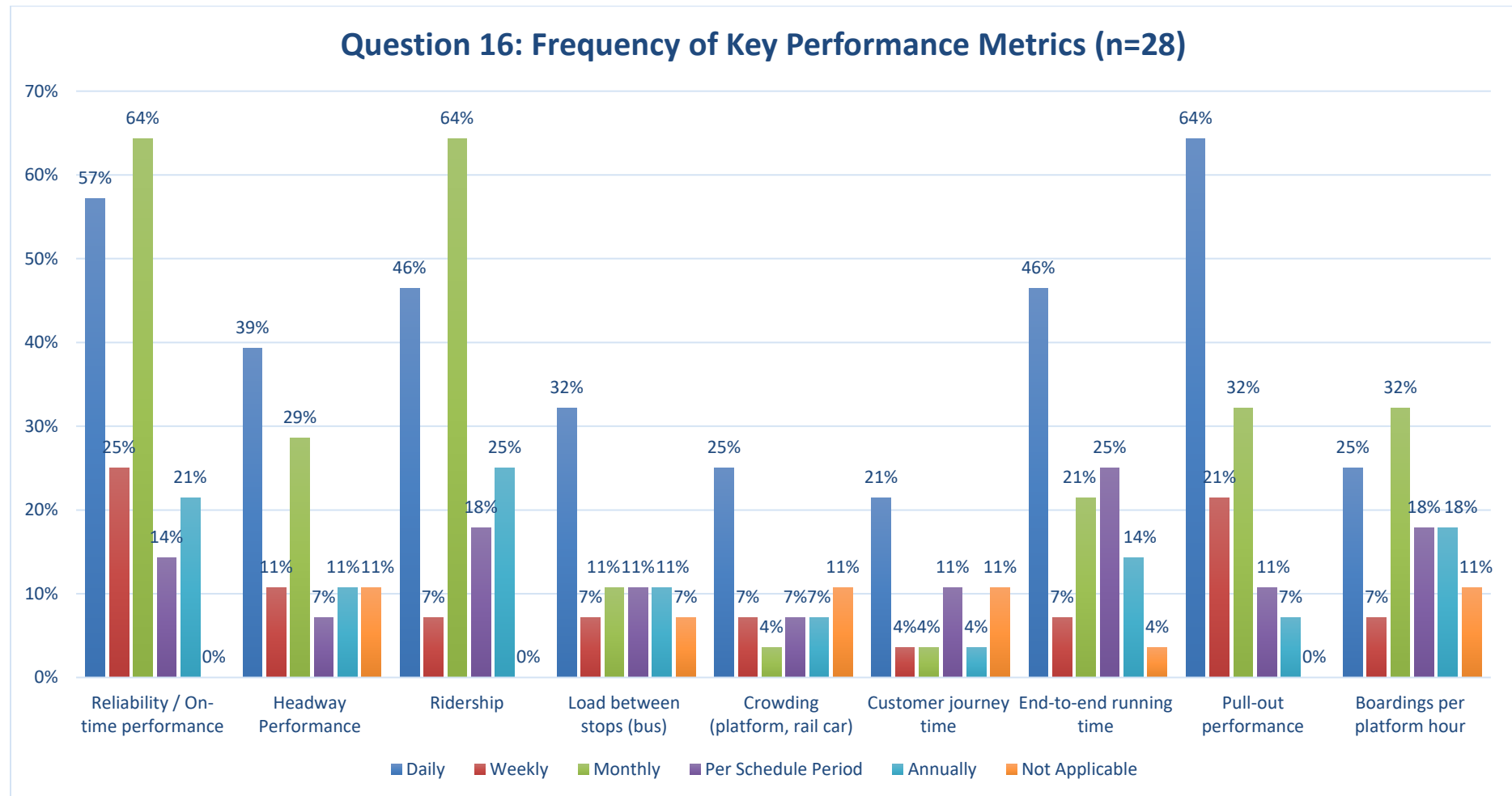
14. What performance metrics do you produce from the data? (or attach list to next question) and 15. Alternatively, attach a list of performance metrics you produce (by mode if available).

- Reliability / on-time performance
- Headway performance
- Ridership
- Load between stops (crowding on bus)
- Crowding (platform, rail car)
- Customer journey time
- End-to-end running time
- Pull-out performance
- Boardings per platform hours

Others included other types of information such as maintenance, National Transit Database reporting metrics. Specifically, other performance [metrics] included the following:

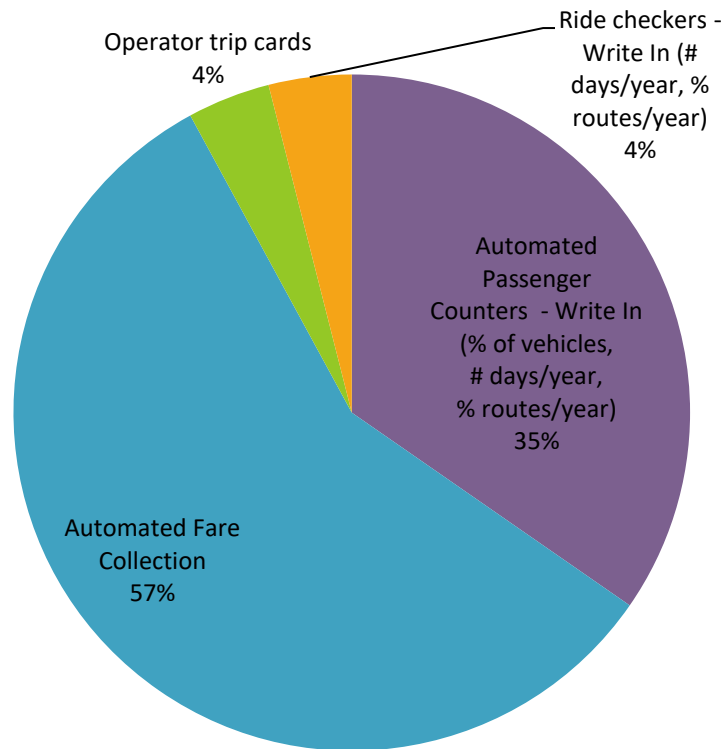
- Operated and Missed Trips
- Safety
- Security
- Quality of Life (passenger/law enforcement)
- Service Failures by category (rolling stock, systems, infrastructure)
- Expense
- Platform Hours
- Total/Hubo Miles
- Cost per Hour
- Cost per Mile
- Subsidy per Rider
- Bus Miles per Voice of the Customer Road Call
- Rail Miles per Service Interruption
- Bus Avoidable Accidents per 100K Miles
- Fare Inspection Rate
- Preventive Inspections

16. How often are these performance measures generated?



FREQUENCY OF USE OF KEY PERFORMANCE METRIC TYPES	Daily	Daily	Weekly	Weekly	Monthly	Monthly	Per Schedule Period	Per Schedule Period	Annually	Annually	Other	Other	Not Applicable	
	count	%	count	%	count	%	count	%	count	%	count	%	count	%
Reliability / On-time performance	16	57%	7	25%	18	64%	4	14%	6	21%	0	0%	0	0%
Headway Performance	11	39%	3	11%	8	29%	2	7%	3	11%	0	0%	3	11%
Ridership	13	46%	2	7%	18	64%	5	18%	7	25%	2	7%	0	0%
Load between stops (bus)	9	32%	2	7%	3	11%	3	11%	3	11%	2	7%	2	7%
Crowding (platform, rail car)	7	25%	2	7%	1	4%	2	7%	2	7%	2	7%	3	11%
Customer journey time	6	21%	1	4%	1	4%	3	11%	1	4%	4	14%	3	11%
End-to-end running time	13	46%	2	7%	6	21%	7	25%	4	14%	1	4%	1	4%
Pull-out performance	18	64%	6	21%	9	32%	3	11%	2	7%	1	4%	0	0%
Boardings per platform hour	7	25%	2	7%	9	32%	5	18%	5	18%	1	4%	3	11%

17. Bus Mode Ridership: What is the primary data source for determining ridership information for bus mode only?



Value	Percent	Count
Automated Passenger Counters - Write In (% of vehicles, # days/year, % routes/year)	35%	9
Automated Fare Collection	58%	15
Operator trip cards	4%	1
Ride checkers - Write In (# days/year, % routes/year)	4%	1
	Totals	26

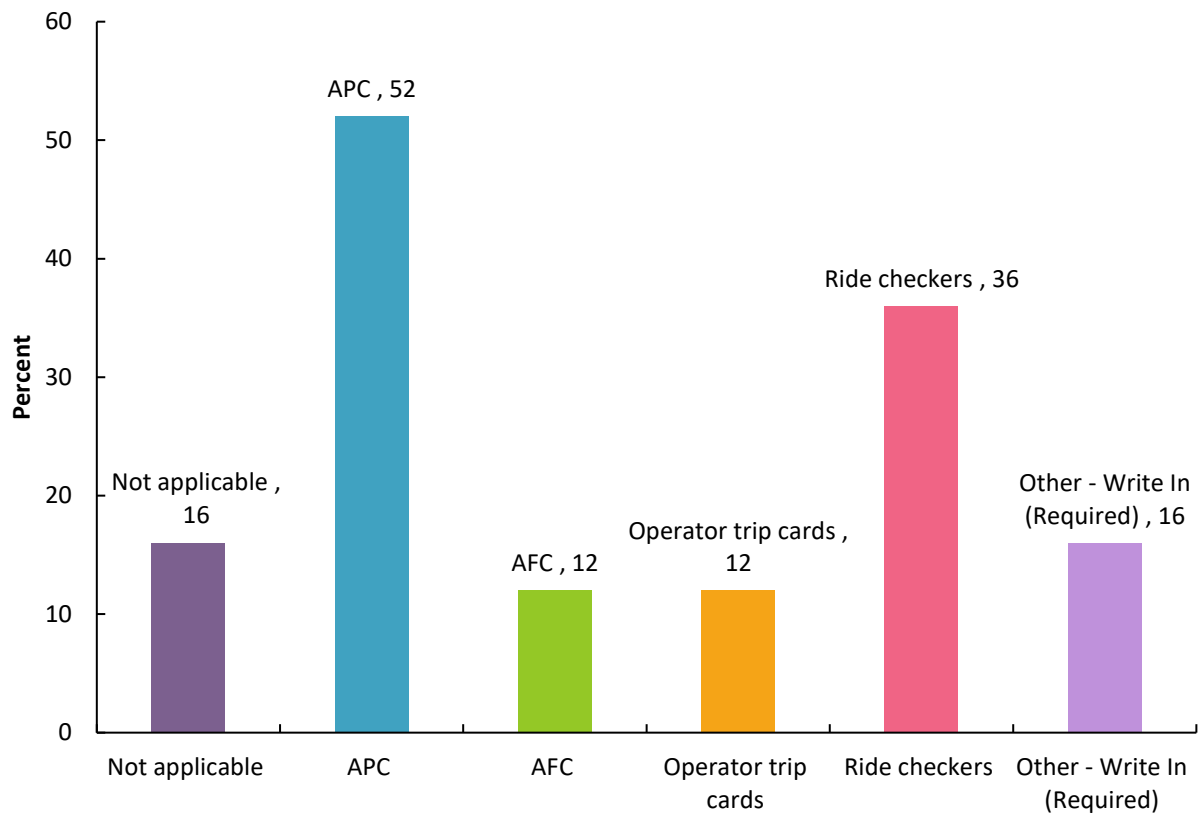
Automated Passenger Counters - Write In (% of vehicles, # days/year, % routes/year)	Count
---	-------

100%	1
100% of buses	1
100% of vehicles	1
100%, 365/year, 100%	1
100%,365/year,100%	1
62% of vehicles, every day of year, 100% routes/year (~750K sample sets)	1
99%, All service days, 100% of routes/year	1
About 65% of fleet has APCs	1
Currently upgrading from 30% to 100% of vehicles	1
Totals	9

Ride checkers - Write In (# days/year, % routes/year)	Count
104 random ride checks per year	1
Totals	1

Other - Write In (Required)	Count
Totals	0

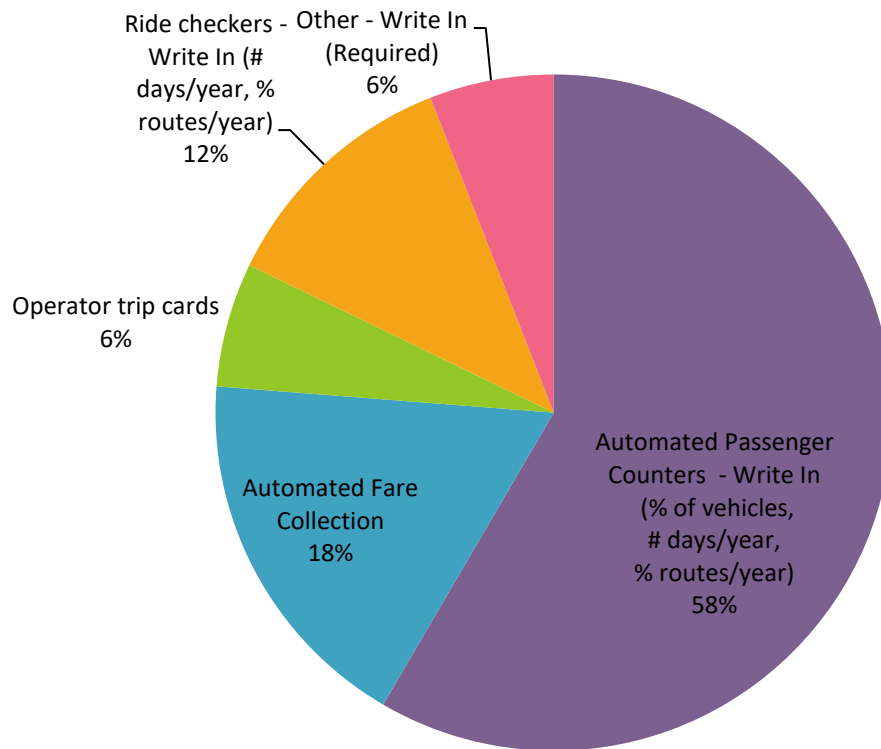
18. Bus Mode Ridership: Do you use additional data sources for determining ridership for bus mode only? Please list all that apply.



Value	Percent	Count
Not applicable	16%	4
APC	52%	13
AFC	12%	3
Operator trip cards	12%	3
Ride checkers	36%	9
Other - Write In (Required)	16%	4

Other - Write In (Required)	Count
Automatic Fare Cards	1
Fare payment and transit app	1
Trip Manifests and Invoices for Flex Route and Paratransit	1
Video of onboard cameras to validate APC counts	1
Totals	4

19. Rail Mode Ridership: What is the primary data source for determining ridership information for rail modes only?



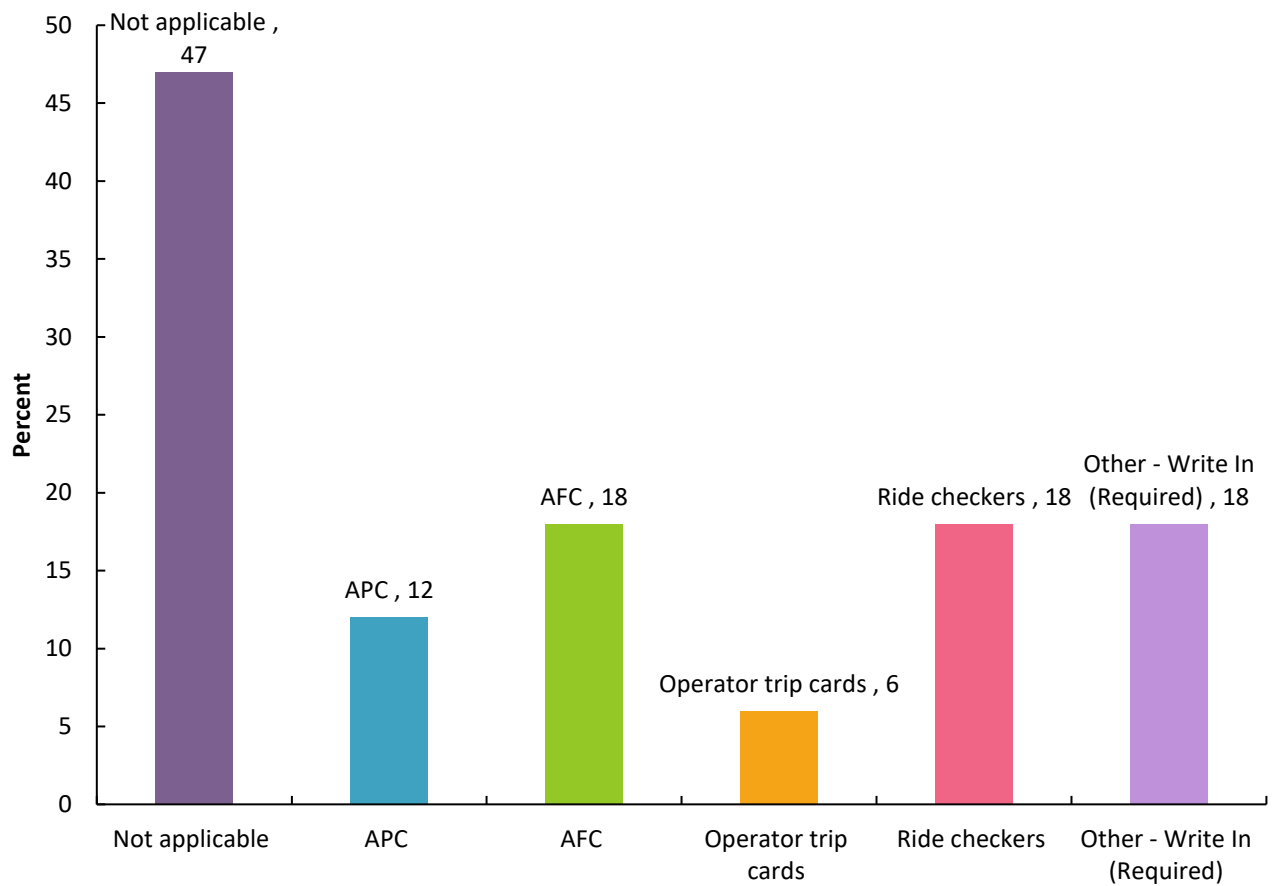
Value	Percent	Count
Automated Passenger Counters - Write In (% of vehicles, # days/year, % routes/year)	59%	10
Automated Fare Collection	18%	3
Operator trip cards	6%	1
Ride checkers - Write In (# days/year, % routes/year)	12%	2
Other - Write In (Required)	6%	1
	Totals	17

Automated Passenger Counters - Write In (% of vehicles, # days/year, % routes/year)	Count
10%	1
100%	1
100% 365, 100%	1
100% of vehicles (9)	1
100%, 365, 100%	1
46,365,100%	1
50%, 365, 50%	1
66% of vehicles, 365 days/year, 100% of routes/year	1
80% rail	1
99%, all service days, 100% of routes/year	1
Totals	10

Ride checkers - Write In (# days/year, % routes/year)	Count
10 routes per year, spring and fall	1
100%/year	1
Totals	2

Other - Write In (Required)	Count
Not applicable	1
Totals	1

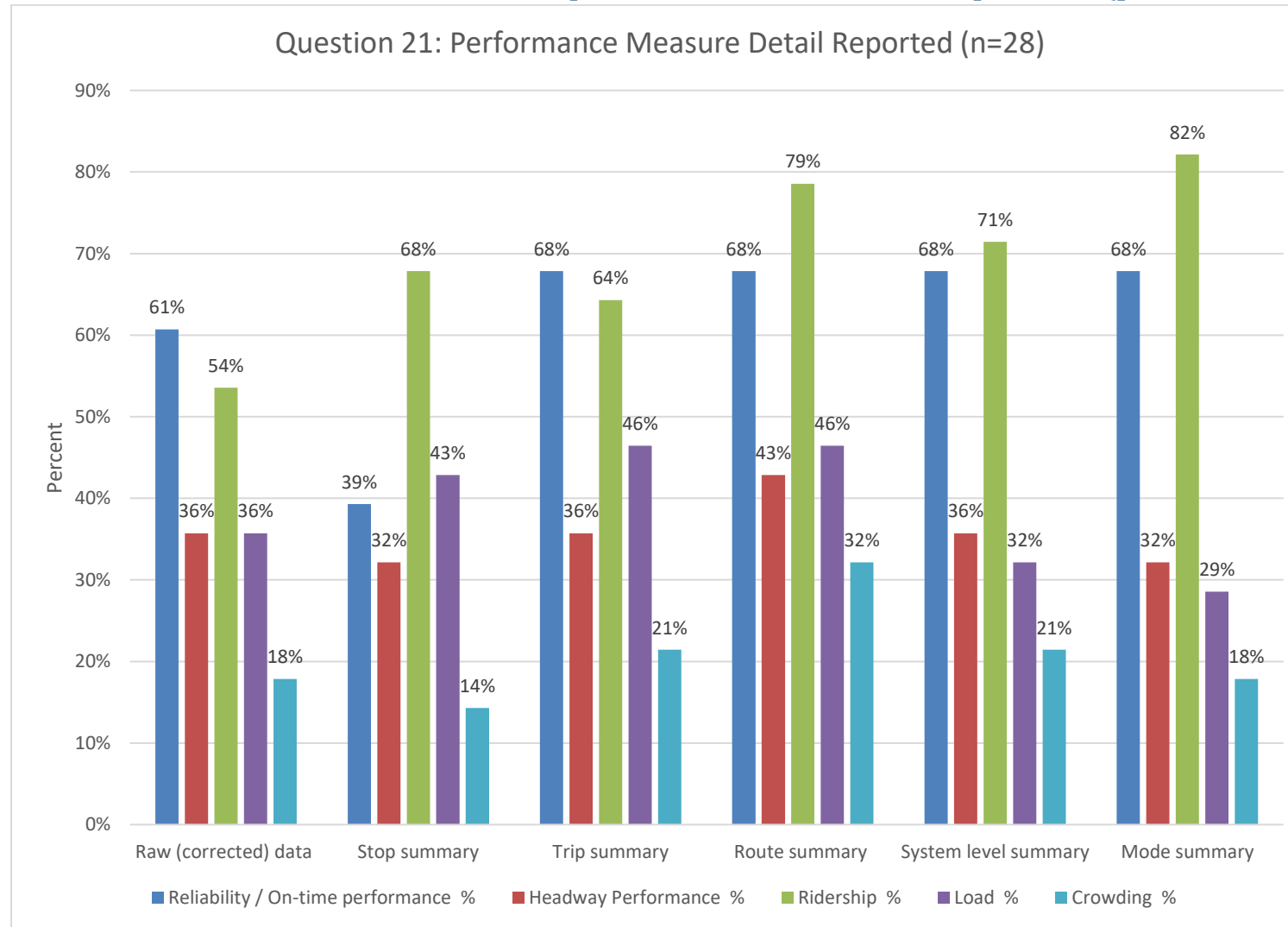
20. Rail Mode Ridership: Do you use additional data sources for determining ridership for rail modes only? Please list all that apply.



Value	Percent	Count
Not applicable	47%	8
APC	12%	2
AFC	18%	3
Operator trip cards	6%	1
Ride checkers	18%	3
Other - Write In (Required)	18%	3

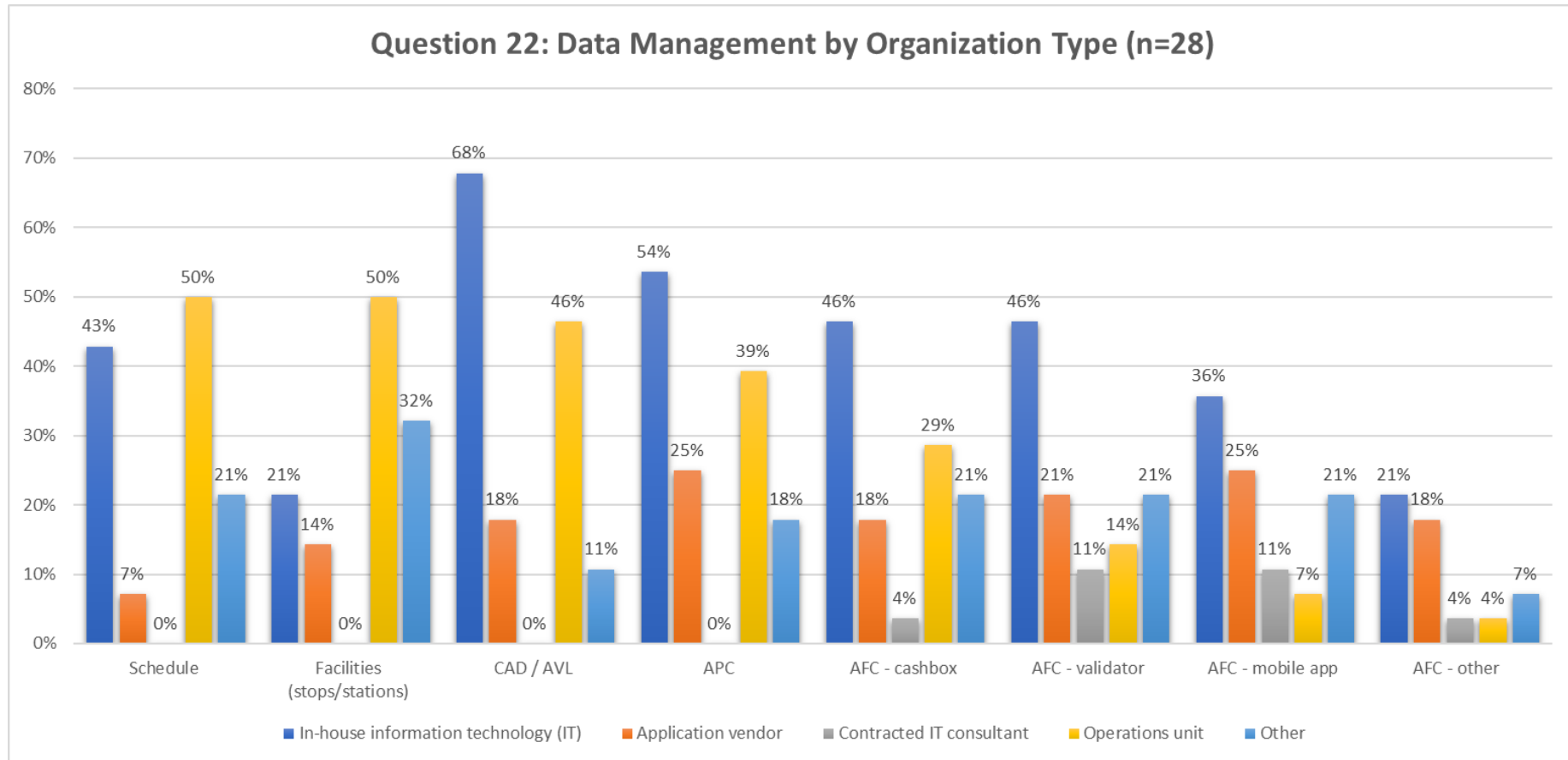
Other - Write In (Required)	Count
Fare Card and Transit app	1
ICS Integrated Computer System along with Passenger Flow Model (PSM)	1
Schedule of Actual Service Provided	1
Totals	3

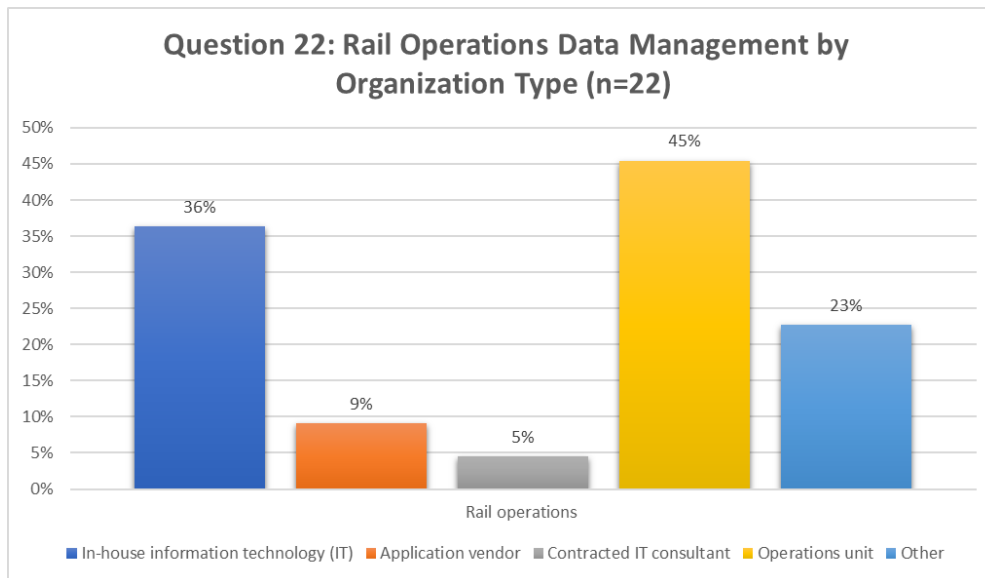
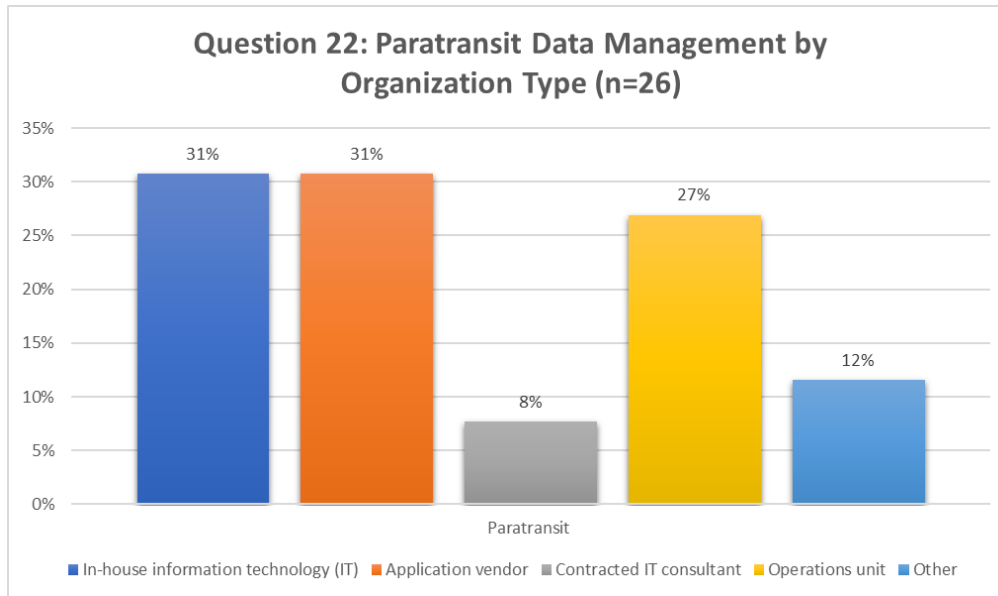
21. At what level of detail are these performance measures reported? (please select all that apply)



Performance Measure Level Reported	Reliability / On-time performance	Reliability / On-time performance	Headway Performance	Headway Performance	Ridership	Ridership	Load	Load	Crowding	Crowding
	Count	%	Count	%	Count	%	Count	%	Count	%
Raw (corrected) data for each day and time	17	61%	10	36%	15	54%	10	36%	5	18%
Summary data at stop level	11	39%	9	32%	19	68%	12	43%	4	14%
Summary data at trip/route direction level	19	68%	10	36%	18	64%	13	46%	6	21%
Summary data at route level	19	68%	12	43%	22	79%	13	46%	9	32%
Summary data at system level	19	68%	10	36%	20	71%	9	32%	6	21%
Summary data by mode	19	68%	9	32%	23	82%	8	29%	5	18%
Other: Swiftly reports	1	4%	1	4%	0	0%	0	0%	0	0%

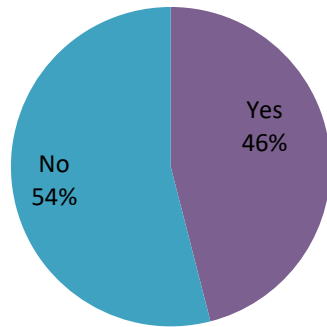
22. Which organizational units manage the raw data? (select all that apply)





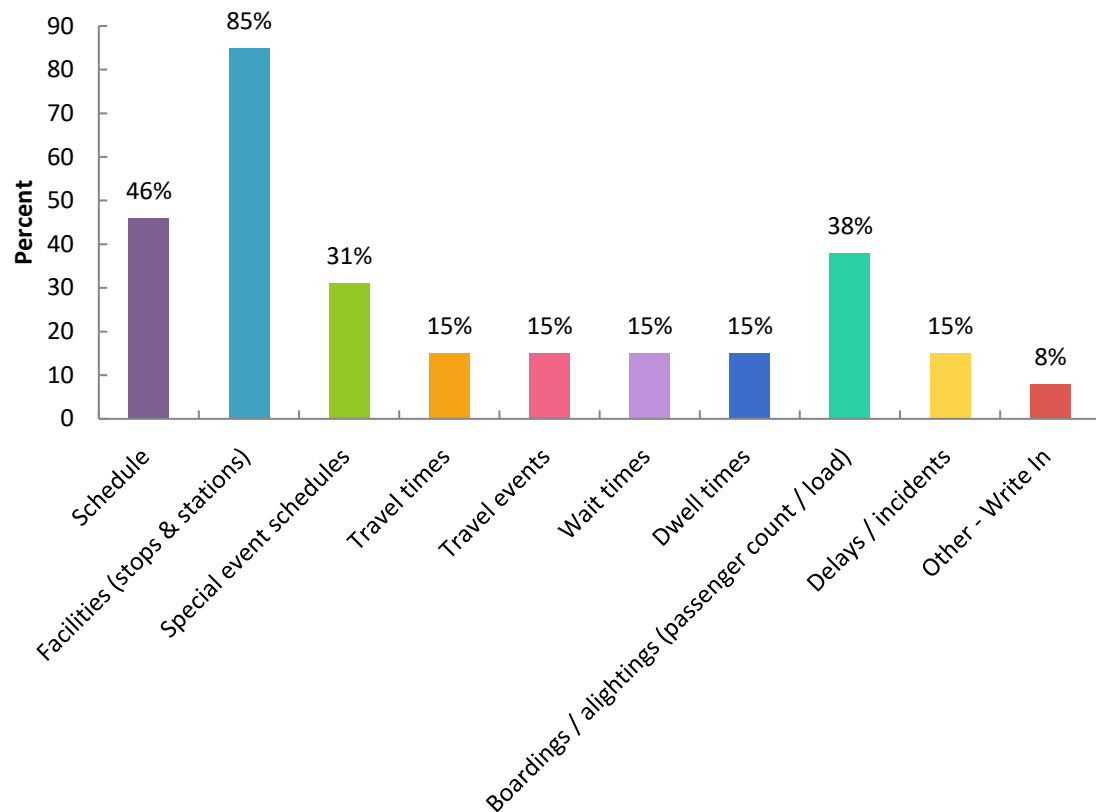
Organizational Units Managing Raw Service Data	In-house information technology (IT)	In-house information technology (IT)	Application vendor	Application vendor	Contracted IT consultant	Contracted IT consultant	Operations unit	Operations unit	Other	Other
	Count	%	Count	%	Count	%	Count	%	Count	%
Schedule	12	43%	2	7%	0	0%	14	50%	6	21%
Facilities (stops/stations)	6	21%	4	14%	0	0%	14	50%	9	32%
CAD / AVL	19	68%	5	18%	0	0%	13	46%	3	11%
APC	15	54%	7	25%	0	0%	11	39%	5	18%
Paratransit	8	31%	8	31%	2	8%	7	27%	3	12%
Rail operations	8	36%	2	9%	1	5%	10	45%	5	23%
AFC - cashbox	13	46%	5	18%	1	4%	8	29%	6	21%
AFC - validator	13	46%	6	21%	3	11%	4	14%	6	21%
AFC - mobile app	10	36%	7	25%	3	11%	2	7%	6	21%
AFC - other	6	21%	5	18%	1	4%	1	4%	2	7%

23. Do you have multiple applications and/or organizational units generating similar data (e.g., bus stop inventory)?



Value	Percent	Count
Yes	46%	13
No	54%	15
	Totals	28

25. Please specify the specific data sets that are duplicated by multiple sources or organizational units.



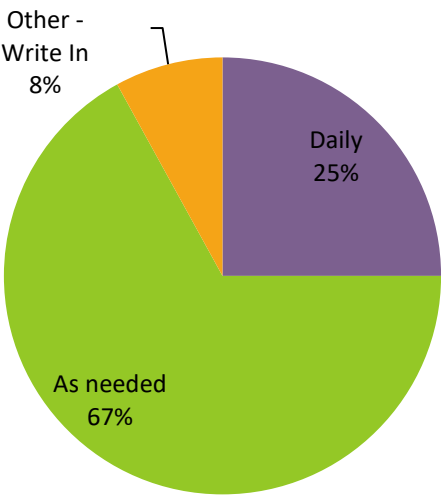
SPECIFIC SERVICE DATA WITH DUPLICATE SOURCES	Percent	Count
Schedule	46%	6
Facilities (stops and stations)	85%	11
Special event schedules	31%	4
Travel times	15%	2
Travel events	15%	2
Wait times	15%	2
Dwell times	15%	2
Boardings/alightings (passenger count / load)	38%	5
Delays / incidents	15%	2
Other – Write in <ul style="list-style-type: none"> On-time performance 	8%	1

26. Which organizational units manage each data set and for what purpose? and 27. Which organizational unit is responsible for synchronizing the data?

#	Organization Unit's Responsibility for Duplicate Data [unit – data responsibility] (Question 26)	Responsible for Synchronization (Question 27)
1	Operations	Operations
2	Planning – Boardings Facilities & Operations – stop data	Planning
3	Multiple orgs – schedule data	Information Technology
4	Schedule & Service Planning shares stop/station data management Schedules – digitizes stop / station for operations and customer information Service Planning – manages stop attribute	Not applicable
5	Scheduling – stop data Facility – physical stop asset and maintenance	Facilities
6	Facilities with operational units – raw data in <i>scheduling software</i> Operating unit – special event schedules (creates duplication when imported into <i>scheduling software</i>) Other Unit - On-time performance (tracked through APCs and Central control)	NA (Facilities)
7	Schedule & bus operations – stop/station data Bus & rail operations – special event schedules Finance, Service Develop & Strategic Initiative – vehicle movement and passenger activity	No response
8	Operations Planning – DAS/AFC/ CSE Computer Systems Engineering-ICS	No response
9	Planning – schedules & planning Planning – stop location and passenger info Facilities – bus stop inventory	Data Team
10	Facilities with service planning, maintenance/amenities, and GIS They participate in different areas of the data: GIS: location Maintenance/amenities: installing/confirming location and attributes QA/QC – refines into “system of record” software	Depending on the data set, Finance, Mobility Services, Planning synchronize the data
11	Planning – Schedules, Ridership Facilities – Bus stop inventory Operations – Travel times, on-time performance, wait times, delays/incidents Data Analytics – boardings/alightings Safety – system functionality	IT/Data Analytics

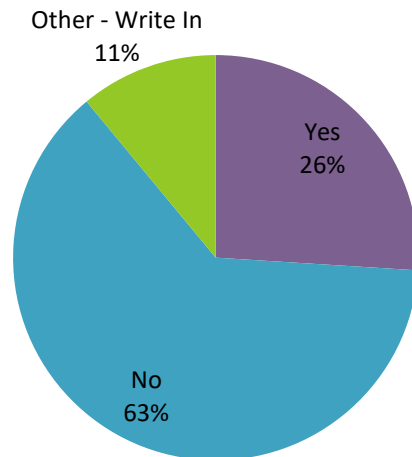
12	Planning – non-standard schedule and facilities data (bus stops) Infrastructure Planning – facilities data (bus stops) IT – non-standard schedule	No synchronization
----	---	--------------------

28. How often are the data sets synchronized?



Value	Percent	Count
Daily	25%	3
As needed	67%	8
Other - Write In <ul style="list-style-type: none">Depends on the data set. Monthly, quarterly, and annually	8%	1
	Totals	12

29. Do you have an Enterprise Architecture Planning Process [i.e., planning process for organizing information technologies to support the business (policies, goals, organization, processes) and the plan for implementing the architecture data, applications, technologies]?

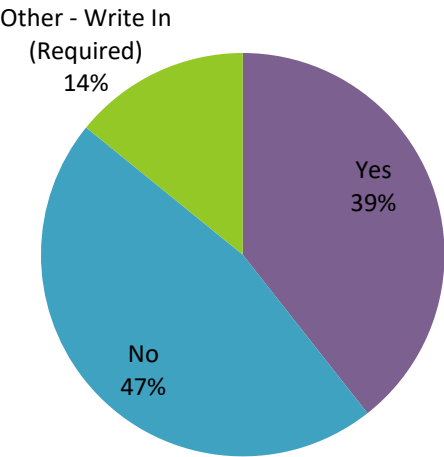


Value	Percent	Count
Yes	26%	7
No	63%	17
Other - Write In <ul style="list-style-type: none"> In Process No. We do have a GIS Strategic Plan and an ITS Strategic Plan, but those are not all-encompassing to be considered an EAP. Operational Analysis and Solutions team support the business and data architecture working with IT who supports the application architecture. 	11%	3
	Totals	27

30. Please share your EAP or related documentation.

0 Files Uploaded

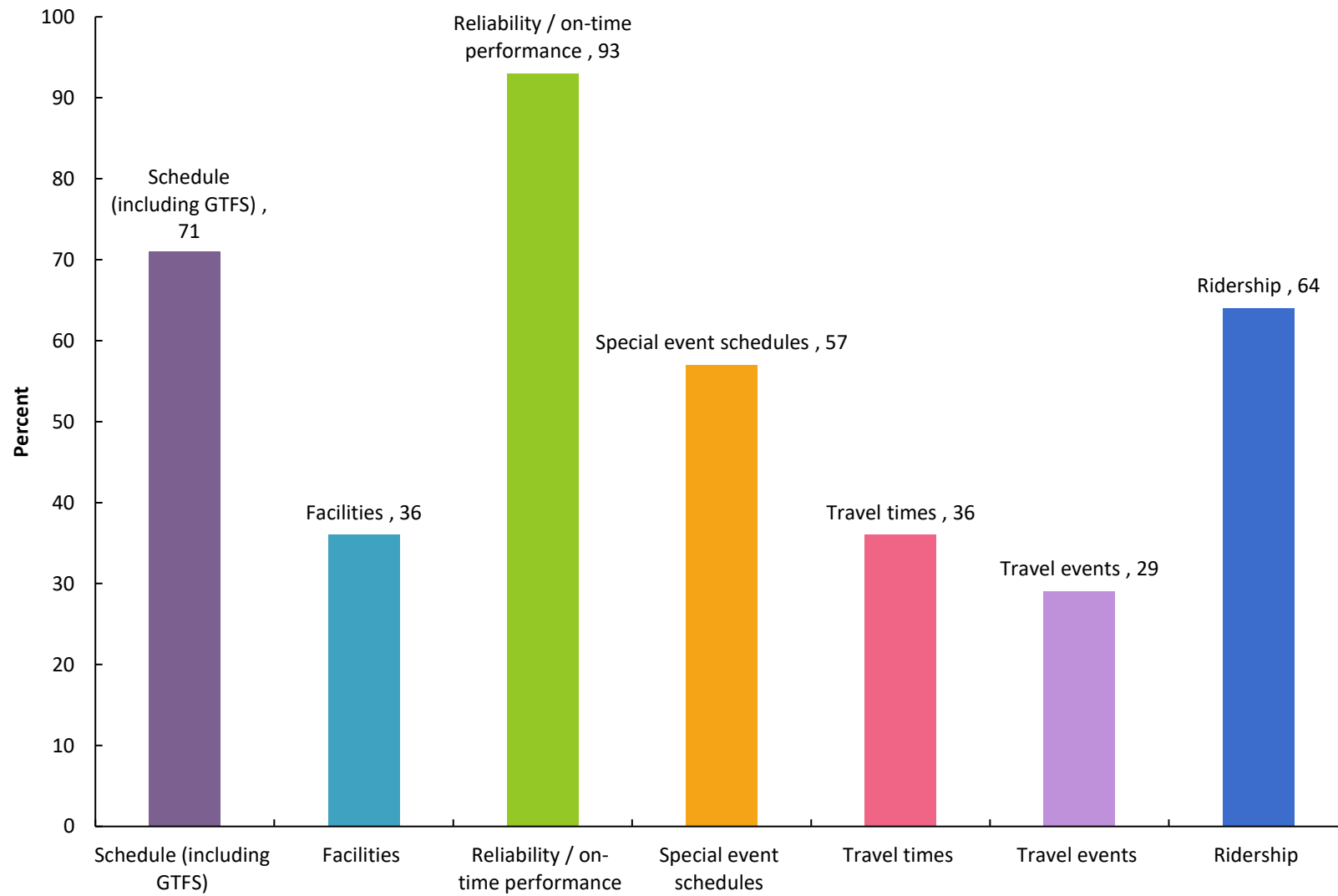
31. Do you have internal cross-disciplinary committees or groups that focus on managing and sharing service data?



Value	Percent	Count
Yes	39%	11
No	46%	13
Other - Write In (Required) <ul style="list-style-type: none">• Data governance is a new initiative for ... this upcoming year.• Depending on the data, a committee may be formed or data just shared.• In process• No. Working to develop a team.	14%	4
	Totals	28

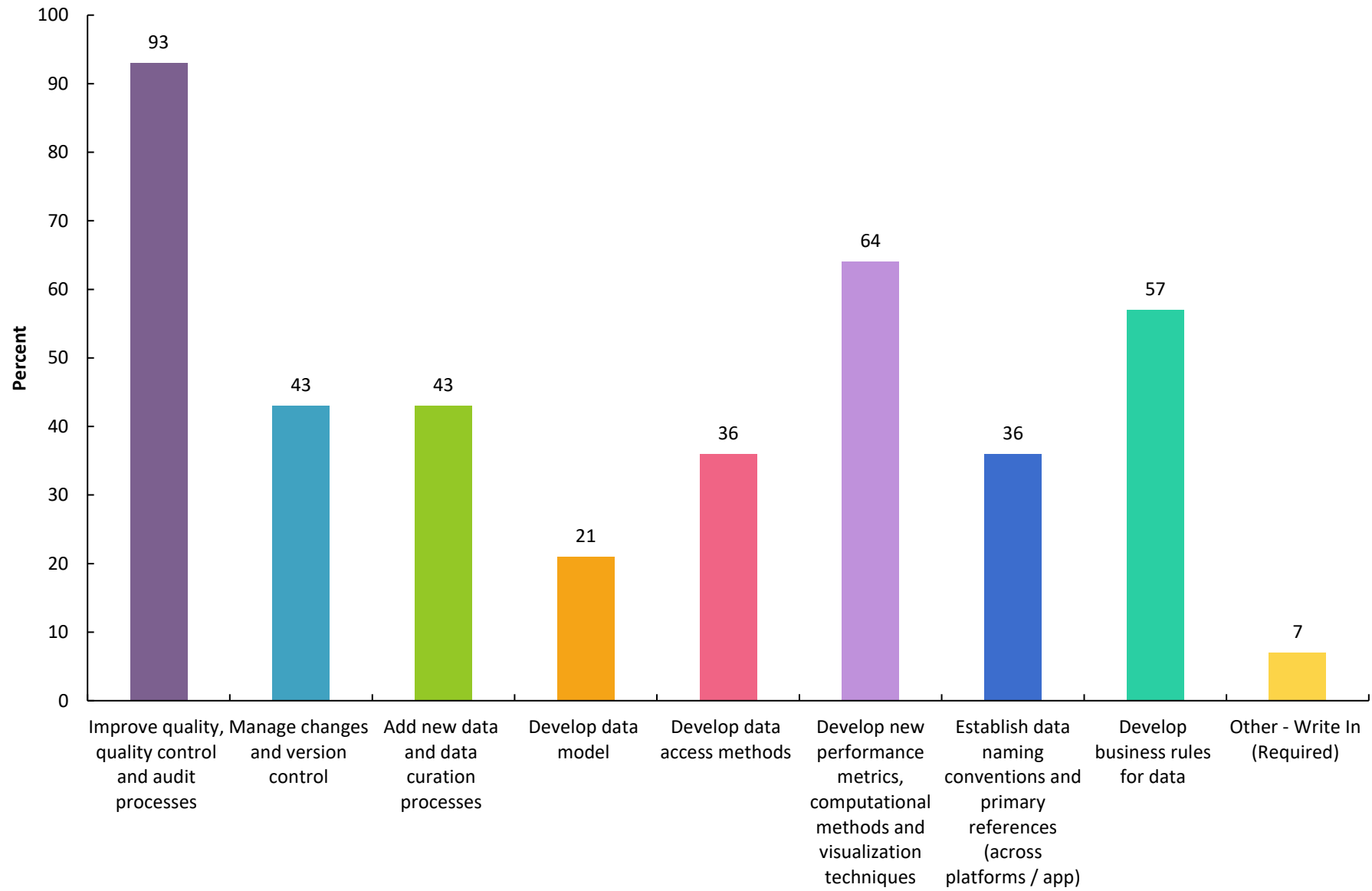
32. Which data sets are governed within scope of the committee?

Value	Percent	Count
Schedule (including GTFS)	71%	10
Facilities	36%	5
Reliability / on-time performance	93%	13
Special event schedules	57%	8
Travel times	36%	5
Travel events	29%	4
Ridership	64%	9



33. Describe the purpose of the committee. (select all that apply)

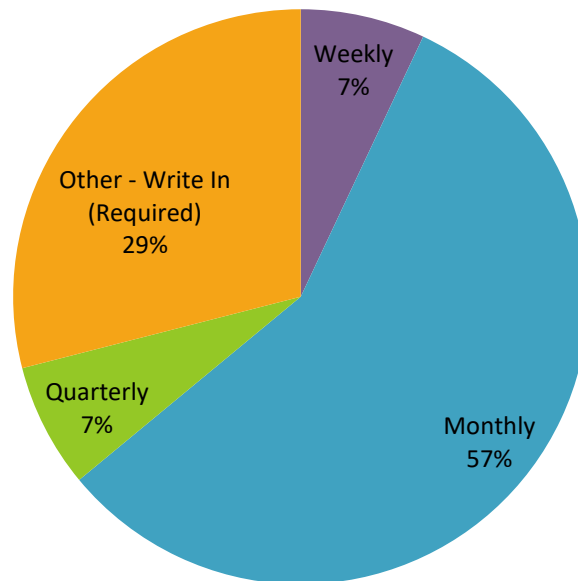
Value	Percent	Count
Improve quality, quality control and audit processes	93%	13
Manage changes and version control	43%	6
Add new data and data curation processes	43%	6
Develop data model	21%	3
Develop data access methods	36%	5
Develop new performance metrics, computational methods and visualization techniques	64%	9
Establish data naming conventions and primary references (across platforms/applications)	36%	5
Develop business rules for data	57%	8
Other - Write In (Required)	7%	1
<ul style="list-style-type: none"> Determine microtransit zones 		



34. Please attach a charter or other documents that describe policies, procedures, rules, or tools used by committee members.

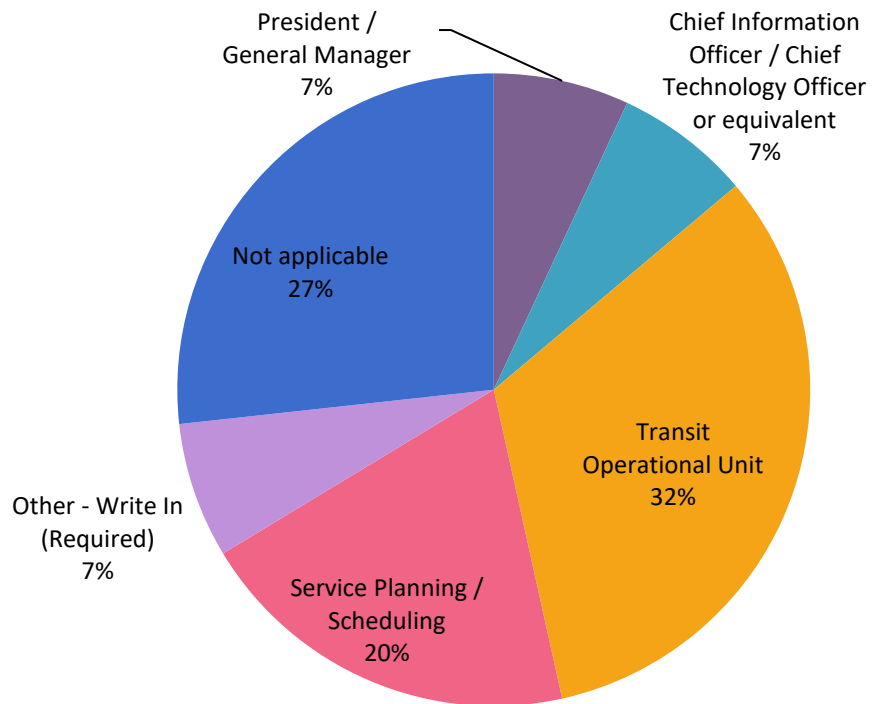
1 File Uploaded

35. How often are data meetings scheduled?



Value	Percent	Count
Weekly	7%	1
Monthly	57%	8
Quarterly	7%	1
Other - Write In (Required) <ul style="list-style-type: none"> As needed (x2) Daily Weekly Planning leading up to a new run board 	29%	4
	Totals	14

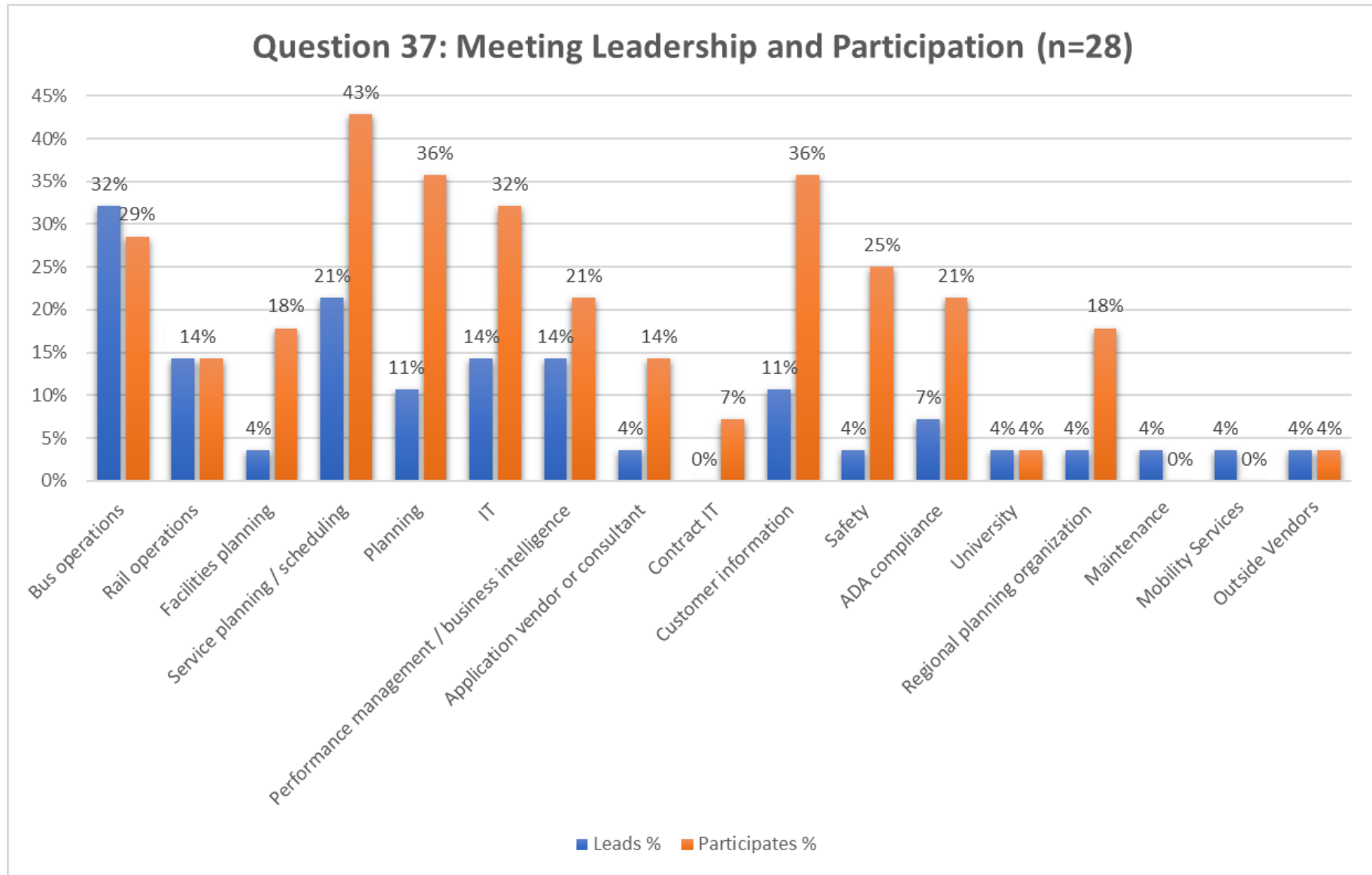
36. Is there an executive level sponsor for the data committee?



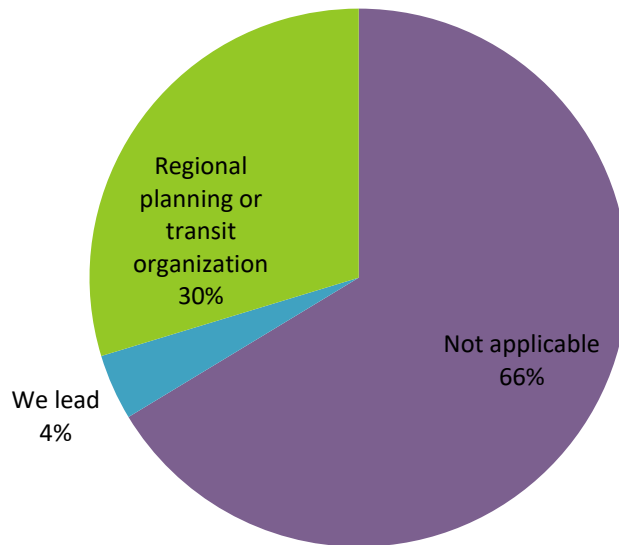
Value	Percent	Count	Write in
President / General Manager	7%	1	
Chief Information Officer / Chief Technology Officer or equivalent	7%	1	
Transit Operational Unit	33%	5	
Service Planning / Scheduling	20%	3	
Other - Write In (Required) <ul style="list-style-type: none"> Assistant GM for Finance & Administration 	7%	1	
Not applicable	27%	4	
	Totals	15	

37. Please indicate which organizational units lead and participate in the meetings? (select all that apply)

ROLES OF ORGANIZATIONAL UNITS IN DATA COMMITTEE	Leads	Leads	Participates	Participates
	Count	%	Count	%
Bus operations	9	32%	8	29%
Rail operations	4	14%	4	14%
Facilities planning	1	4%	5	18%
Service planning / scheduling	6	21%	12	43%
Planning	3	11%	10	36%
IT	4	14%	9	32%
Performance management / business intelligence	4	14%	6	21%
Application vendor or consultant	1	4%	4	14%
Contract IT	0	0%	2	7%
Customer information	3	11%	10	36%
Safety	1	4%	7	25%
ADA compliance	2	7%	6	21%
University	1	4%	1	4%
Regional planning organization	1	4%	5	18%
Other				
• Maintenance	1	4%	0	0%
• Mobility Services	1	4%	0	0%
• Outside Vendors	1	4%	1	4%



38. Does your agency participate in regional data meetings? If yes, who leads the meetings?



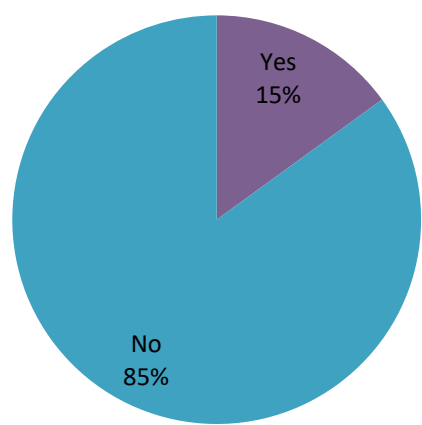
Value	Percent	Count
Not applicable	67%	18
We lead	4%	1
Regional planning or transit organization	30%	8
	Totals	27

39. What are your roles and responsibilities in the regional data committee?

Responses

- Depends upon the committee. Mostly advisory but for fare cards, voting member in the regional committee.
- Collaborate.
- Not sure.
- Transit-related data.
- Provide updates to Commission and develop future service plan.
- Provide data and serve as subject matter expert of the data.
- Community Transportation Coordinator (CTC) - sharing the data.

40. Do you have a policy related to data licensing or intellectual property?



Value	Percent	Count
Yes	15%	4
No	85%	22
	Totals	26

41. If available, please attach copies of your policy(ies).

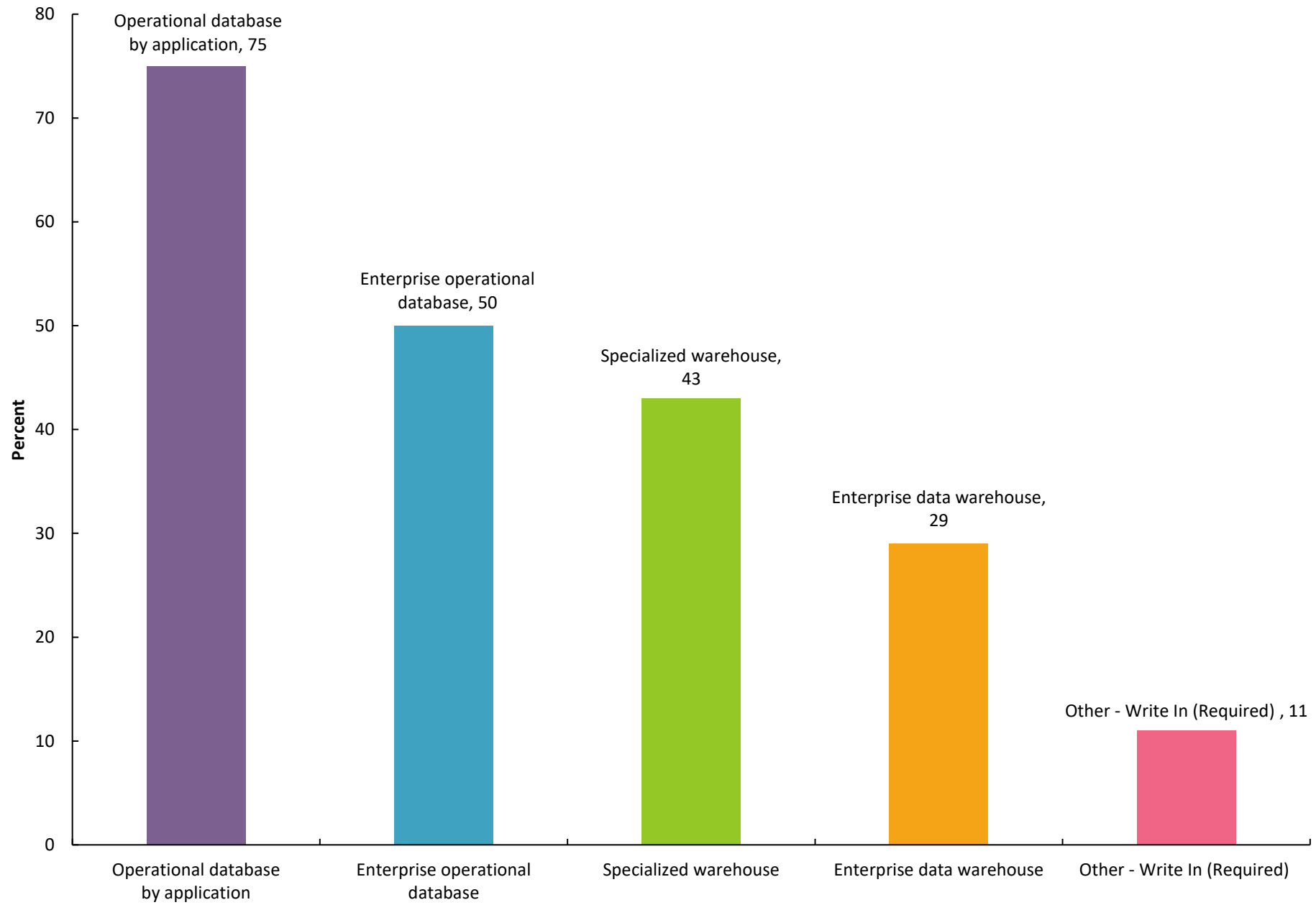
0 Files Uploaded

42. Please describe your data licensing and/or IP policies below:

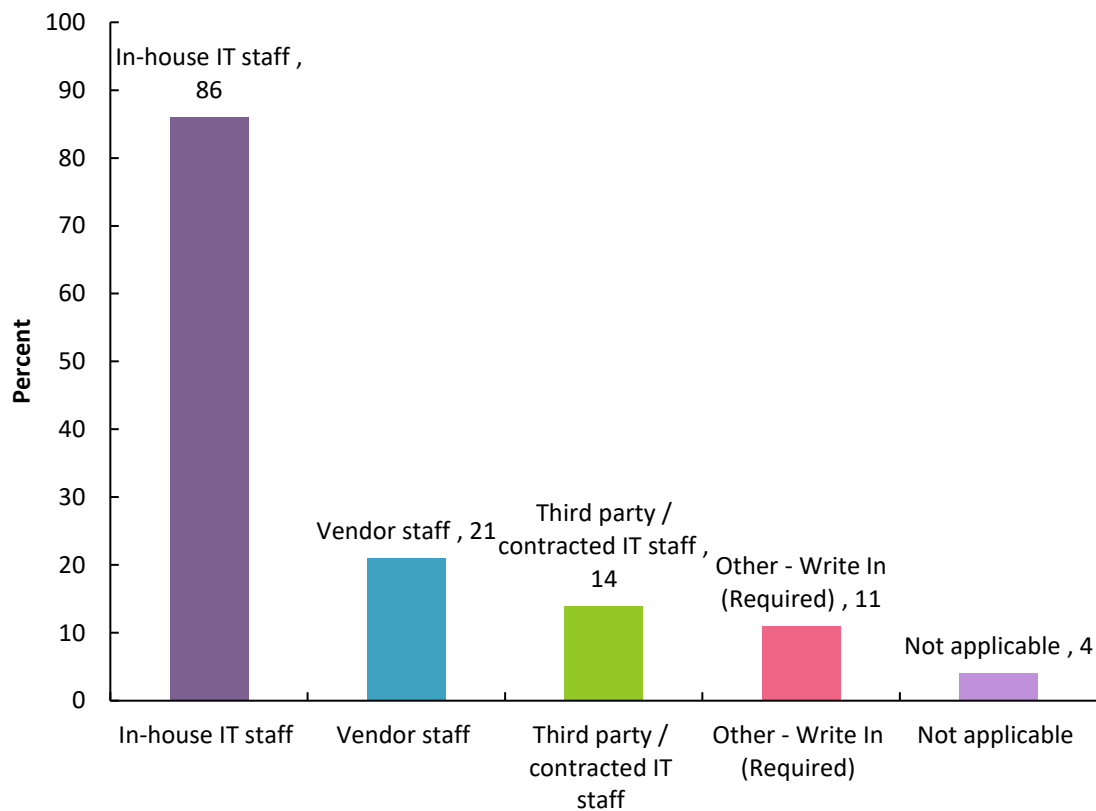
Responses
In our web site in our open data portal
It's a standard agreement for spatial data; accuracy neither expressed nor implied...only use the data for the purpose proposed, etc.
https://www.golynx.com/lynxmap/DataDownload/index_files/Page414.htm

43. What types of data storage systems does your organization have? (select all that apply)

Value	Percent	Count
Separate operational databases for each application with "cleaned" raw data from each system (AVL, APC, AFC, etc.)	75%	21
Enterprise (centralized) operational database (with cleaned raw data)	50%	14
Specialized data warehouse with summary and performance metrics by mode and system (e.g., ridership only, fare collection only, AVL only)	43%	12
Enterprise (centralized) data warehouse with summary and performance metrics	29%	8
Other - Write In (Required) <ul style="list-style-type: none"> • It varies depending on data sets • Offsite, hosted server database for GIS • We are in the process of building an enterprise data warehouse to store raw and curated data products from all transit systems 	11%	3

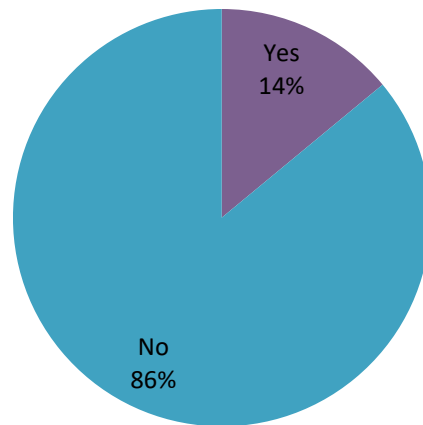


44. Who operates and manages the enterprise database(s)?



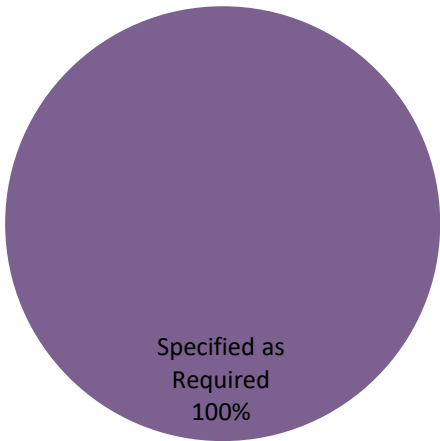
Value	Percent	Count
In-house IT staff	86%	24
Vendor staff	21%	6
Third party / contracted IT staff	14%	4
Other - Write In (Required) <ul style="list-style-type: none"> Operation Performance Analysis and In-house IT staff support the database infrastructures. Operations Analysis and Solutions is a key data stewardship working with IT and other stakeholders. The City's IT Department manages the actual infrastructure. 	11%	3
Not applicable	4%	1

45. Do you have an Enterprise Data Dictionary?



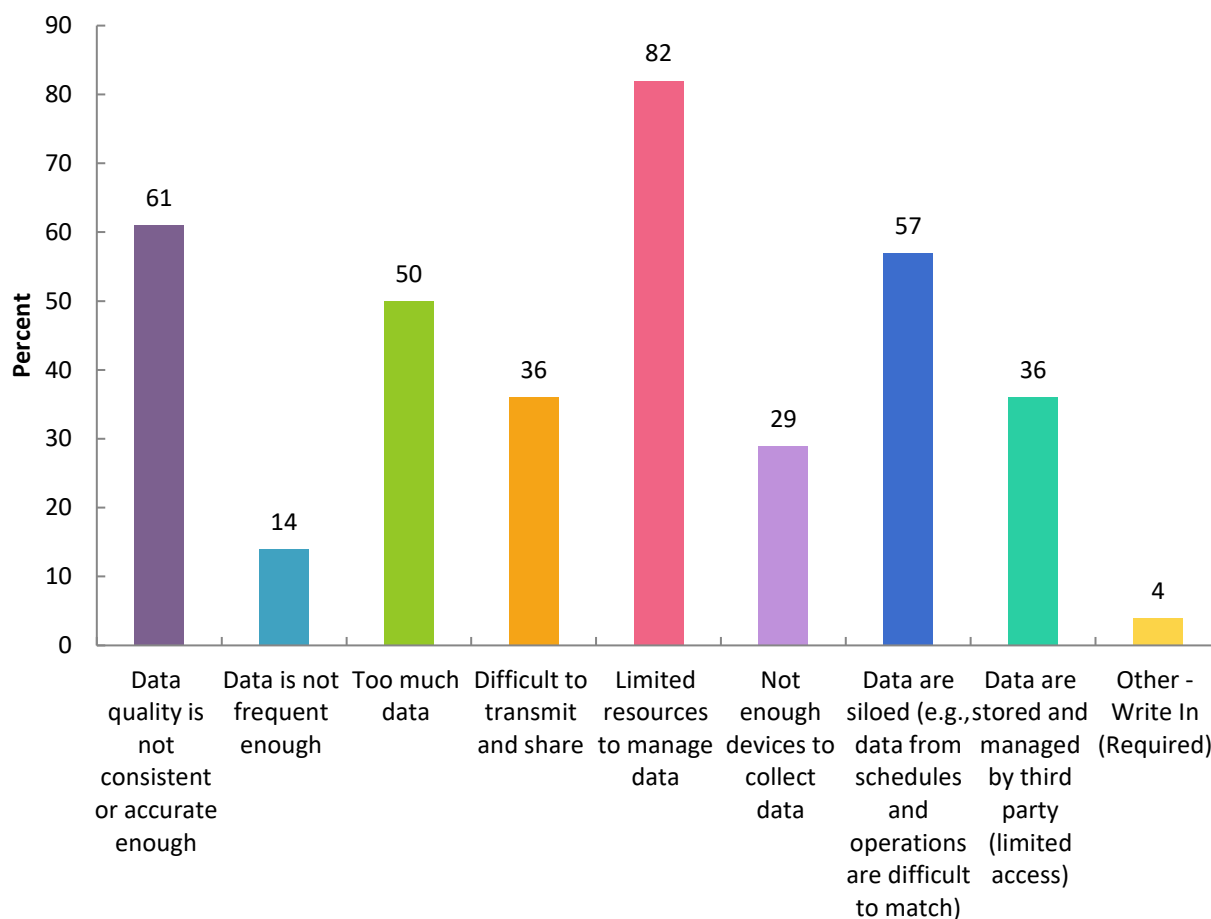
Value	Percent	Count
Yes	14%	4
No	86%	24
	Totals	28

46. How is [are] the Enterprise Data Dictionary, naming conventions, formats or data definitions included in technology bid documents?



Value	Percent	Count
Specified as Required	100%	4
	Totals	4

47. What are your major data collection challenges? (check all that apply)



Value	Percent	Count	Write in
Data quality is not consistent or accurate enough	61%	17	
Data is not frequent enough	14%	4	
Too much data	50%	14	
Difficult to transmit and share	36%	10	
Limited resources to manage data	82%	23	
Not enough devices to collect data	29%	8	
Data are siloed (e.g., data from schedules and operations are difficult to match)	57%	16	

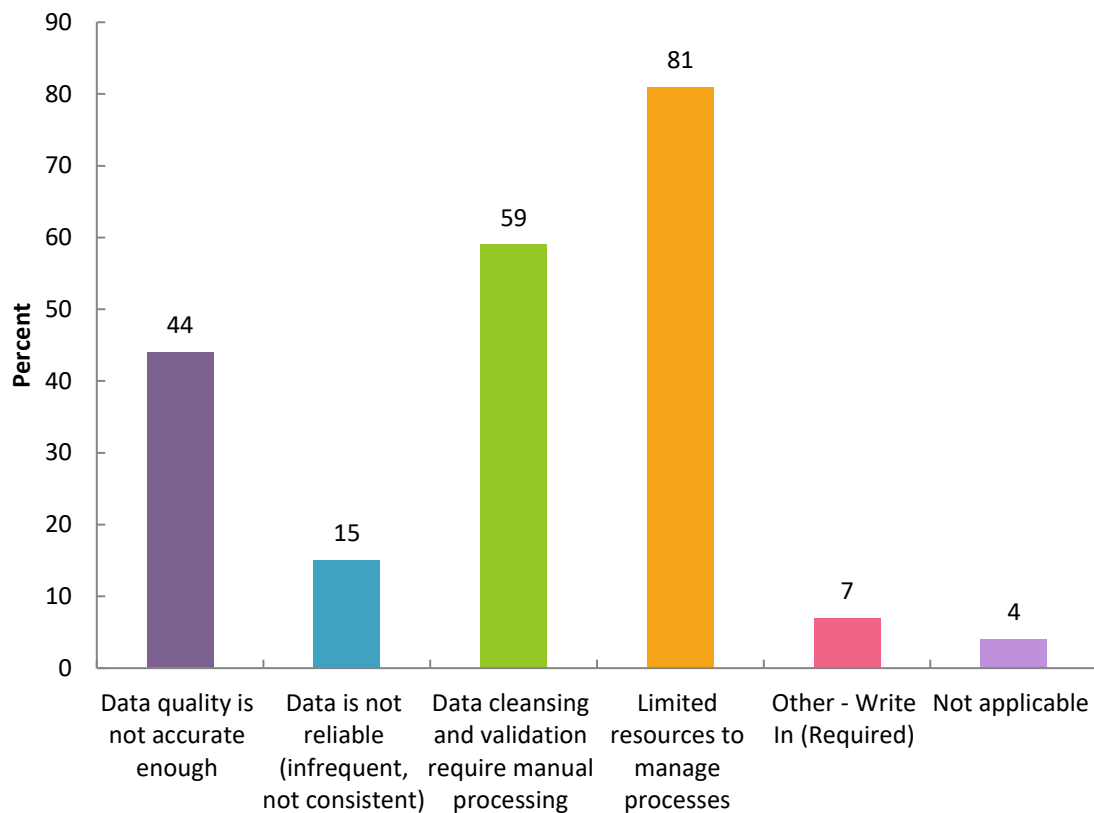
Data are stored and managed by third party (limited access)	36%	10	
Other - Write In (Required)	4%	1	Cost associated with conducting physical data collection

48. Please describe examples of your data collection challenges.

Response	Summary Concept
Some data (fare collection system and fixed route CAD/AVL) is collected and stored by another agency and we are limited in how much access to the data we have. In other systems (commuter rail APC) we are limited in the amount of data available because the system doesn't accurately report faults in the data .	Access to data Lack of data (older systems)
Older systems present challenges sometime with getting data in a timely manner. Operator logon issues can sometimes present issues as well.	Bad data (older systems)
Data is noisy and few options to toss out potentially erroneous data; outdated reporting software that is not updated by AVL vendor .	Bad data from vendor
We are finalizing the installation of our CAD/AVL upgrade and sometimes data is not consistent do to hardware not functioning or bug in system .	Bad data from vendor
Inconsistent definitions in data. No inventory of data resources. Lack of data-driven culture and the awareness of the importance of data assets.	Data is siloed
Data on the same service comes from multiple systems and is difficult to integrate and match to the scheduled service. Service disruptions and systems issues lead to gaps in the data, bad records, etc., which must be addressed before the data can be used easily and systematically. Data must be processed to determine secondary and tertiary metrics that are of the most interest (e.g., calculating travel time or delay vs. vehicle location) .	Data is siloed
IT systems onboard the bus produce varying levels of data quality. Farebox periodically does not operate or accept fares properly. Aligning GPS location across IT systems creates incomplete data.	Data is siloed
Metro has not typically included data ownership or raw data access provisions in its contracting, leaving us to either have to pay more to access the data or to deal with whatever access tools they build for us. Changing these tools (usually dashboards of some sort nowadays) as the business evolves involves change orders, new contracts, capital budgets, etc., which makes us less responsive to business needs than we could be. Data is siloed and inconsistent across data sets , problems our data warehousing effort is designed to improve. We have no data dictionary, nor a good tool for one. Our IT department is working on this, and in the meantime, we are building a data dictionary for the data warehouse using the Agile Data Governance framework using the best tools available to us right now.	Data ownership (do not own data from vendor products) Data is siloed
An example is when scanners miss a car barcode and we miss some car miles and consist length data.	Equipment
Lacks governance.	Governance
Some data still recorded on paper, personal Excel or Database.	Lack of data (older systems or manual techniques)
We will be deploying AVL (no APC) for the first time in 2020. At the moment we have no AVL, no on-time performance data, only GFI farebox boarding data, and Hastus scheduling. For NTD purposes, we follow a random sampling methodology	Lack of data (older systems or manual techniques)

combining those two data sources with 104 random ridecheck surveys throughout the year to arrive at our Passenger Mile calculations for both modes of Bus Service (Commuter Bus and Metro Bus).	
Lack of APCs on Light Rail.	Lack of data (older systems or manual techniques)
Data quality (APCs, etc.) Enough resources to manage data [and] Inconsistent data.	Resources
Too many data sources.	Resources
No dedicated staff for developing reports (aside from excel-based reports), such as SQL queries, crystal reports, business intelligence tools, etc. No centralized enterprise data warehouse.	Resources / skills
Data owners do not have the specialized knowledge to manage large data sets. Inertia to use known technologies/processes instead of adapting to new processes.	Resources / skills

49. What are your major data cleansing, validation and processing challenges? (select all that apply)



Value	Percent	Count	
Data quality is not accurate enough	44%	12	
Data is not reliable (infrequent, not consistent)	15%	4	
Data cleansing and validation require manual processing	59%	16	
Limited resources to manage processes	81%	22	
Other - Write In (Required)	7%	2	<ul style="list-style-type: none"> • APC Data Integrity • Inconsistent definitions of calculation contribute to different numbers for the same metric.
Not applicable	4%	1	

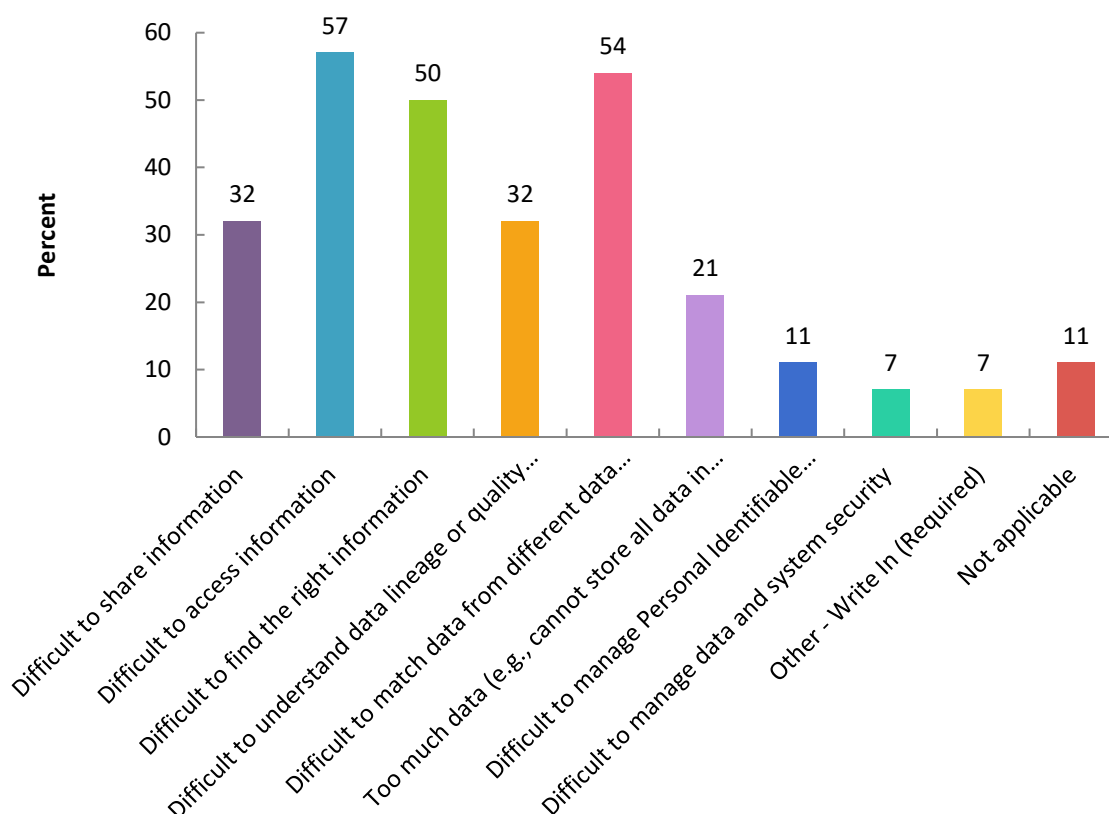
50. Please describe examples of your data cleansing, validation and processing challenges.

Response	Summary concepts
N/A	
On time performance data caused by circular transit centers that report early or late departures.	Data models do not match transit service
Difficult to join different data sets together.	Data siloes / inconsistent data
Decentralized execution model.	Decentralized?
Farebox data often associated to incorrect route, requiring manual correction cross-referenced against historical AVL data. APC data not accurate/complete enough to use confidently for 100% passenger counts.	Inaccurate data collection causes quality checks and processing of data
Many of our data processes are old - dating back to when desktop computing and MS Office first hit the scene. Excel and Access databases are the norm. Business rules for processing data are in some cases poorly defined (if at all) or implemented via cascading SQL queries or VB code within Access databases. None of these processes are fully automated, and nearly all require exceptions to be handled manually.	Legacy systems No automation
Equipment is not reliable that cause missing data. User data entry errors.	Legacy systems
Certain databases are accessed thru websites, vs having the server in our data center. These datasets are only accessible by .csv file downloads and thus cannot be fully integrated into the rest of the data we have on site.	Legacy systems
Biggest issues are with maintenance of the equipment and downtime issues. But that is infrequent.	n/a
Utilize software primarily that is not very good.	No good software
APC data is compared to traffic checker and farebox data. However, traffic checkers are limited in availability and scope.	Not enough data to validate
GFI farebox boarding data is validated against <i>Scheduling Software</i> daily schedules to accuracy in assigning to routes. Hours and miles of all modes are aggregated from daily schedules for NTD purposes. We will soon have data challenges with processing AVL data and are unsure how much help the vendor will be with providing data metrics from the raw data.	Potential inconsistent data to validate farebox data
Limited staff for cleaning and validating data.	Resources
APC data is validated by algorithm and then manually for anything that does not make it through the algorithm. Farebox data is inspected and cleansed daily to ensure accuracy.	Ridership data (resource intensive)
Planners/schedulers make last minute changes to service plan which contributes to the following: APC unable to map to reference data, which costs extra manual processing to estimate gaps; printed schedule required to be	Scheduling errors

reprint; customer service call center does not have most up to date info; bus stop naming inconsistencies; no standard in maintenance employee work order data entry.

Inconsistent data (e.g., bus stop names, work order data entry)

51. What are your major data management challenges? (select all that apply)



MAJOR DATA MANAGEMENT CHALLENGES	Percent	Count
Difficult to share information	32%	9
Difficult to access information	57%	16
Difficult to find the right information	50%	14
Difficult to understand data lineage or quality of data	32%	9
Difficult to match data from different data sources	54%	15
Too much data (e.g., cannot store all data in data store)	21%	6
Difficult to manage Personal Identifiable Information (PII)	11%	3
Difficult to manage data and system security	7%	2
Other – <ul style="list-style-type: none"> Ridership: Not enough devices to capture data. Cooperation between groups 	7%	2
Not applicable	11%	3

52. Please describe examples of your data management challenges.

Response	
Lack of personnel; lack of training as new systems come online; in-house centralized system management understaffed.	Resources
Multiple applications/reports built over years with inconsistent calculations. There is no one stop shopping of all key information for decision making and requires to go into multiple systems to do so.	Siloed systems
All of the above, but again, our data warehousing project is designed to improve all aspects.	Moving in enterprise direction
Too many systems collect similar data but not complete to produce useful information.	Siloed systems
Lack of standards industry wide.	Lack of standards
We have built, and continue to build, a significant data processing infrastructure to move data from operational source systems into reporting data sources that can be used for analysis and reporting.	Moving in enterprise direction
Data is on multiple servers, many off-site. Data is in different systems across different modes (APC data for hybrid rail is from one vendor, APC data for commuter rail is from another vendor, fixed route buses don't all have APC data so ridership is calculated differently). Plus we sometimes have to rely on questionable data to make decisions as we don't have a cleaner source to fall back on.	Siloed systems and lack of standards
Requires a lot of agility in order to set up master data.	Moving in enterprise direction
Staff are discouraged from accessing data due to lack of clarity of correct sources. Lack of security understanding.	Siloed systems
Difficult to join different data sets together.	Siloed systems
Many groups are looking to access or protect their data from other groups.	Access

53. What skills are required to perform the data management and analytics work? Are these skill sets nurtured in your organization or outsourced (to university, consultants, vendors)?

Response	Summary Concepts
We have an operations analyst who creates reports and performs data queries.	
Skills required are the abilities to break down individual trends and insights from large data sets. Understanding the business activities underlying the data and the IT systems producing the data are required for quality work. We attempt to nurture in house but could improve across the organization.	Analytic skills
Standard data analyst skills are required. We have these skills inside our organization.	Data analyst
The agency has a range of data analysts who can handle a fair amount of the analytic work.	Data analyst
Data science and light computer programming.	Data science
Combined data science skills are essential: data access, data exploration data manipulation, statistical methods, data visualization, tools/software development. We have primarily nurtured these within our organization.	Data science (data curation)
Business Intelligence and Analytics development skills, Data Integration development skills, DB Query skills, Analysis skills, Communication skills. These skills are developed in house.	DBA
DBA skills. Computer programming Analytical thinking Understanding transit Generally people are hired with those skills. Not necessarily a specific training program. These skills are not outsourced.	DBA
Data base management and query; programming statistical analysis; data visualization and analytics and presentation; writing.	DBA, GIS, writing
Attention to detail, strong business knowledge in interpreting data and find anomalies. Programming skills in creating procedures to alert data anomalies. Nurtured in the organization, though there will be gap if key personnel retire. <i>Need knowledge transfer plan.</i>	Interpreting anomalies Computing Need knowledge transfer plan
Capability with a data analysis package, either Excel or more specialized for working with larger datasets like Python/R SQL for getting specific and niche data.	Minimum Excel, prefer coding (Python/R)
Problem solving, understanding of statistics, understanding of transit and transit operations. These skills are self-taught.	Problem solving
Data visualization; business literacy; statistics data analysis; coding language proficiency (python, R, M, DAX) These skill sets are now being nurtured in the org., but we still struggle because few well-suited position classifications and position descriptions exist. We are working to change that, as well.	Programming

SQL, knowledge of statistics, advanced excel, access, GIS, data science and programming expertise. Some staff have some of these skills, but none are dedicated to using them to streamline data management and analysis.	Programming and DBA
Organization core business statistical analysis.	Statistical analysis

54. Where do you store your data sets? (select all that apply)

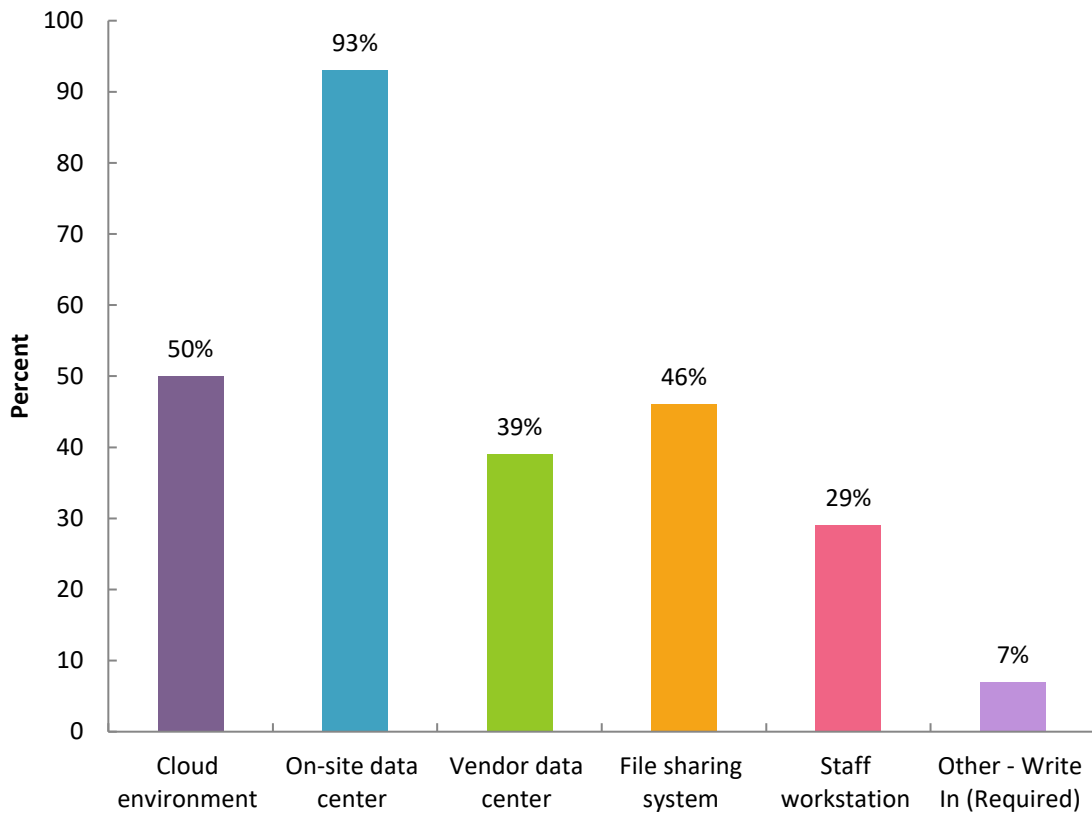
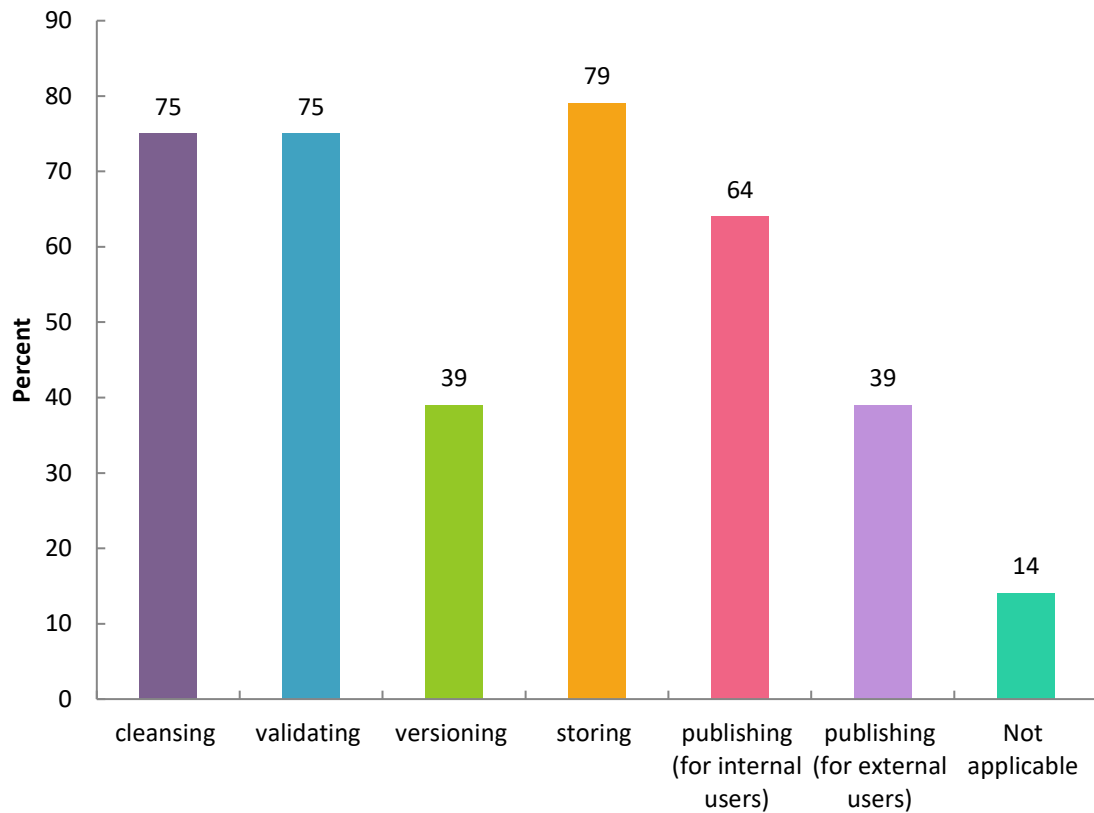


FIGURE 1: SERVICE DATA STORAGE APPROACH

TABLE 1: SERVICE DATA STORAGE APPROACH

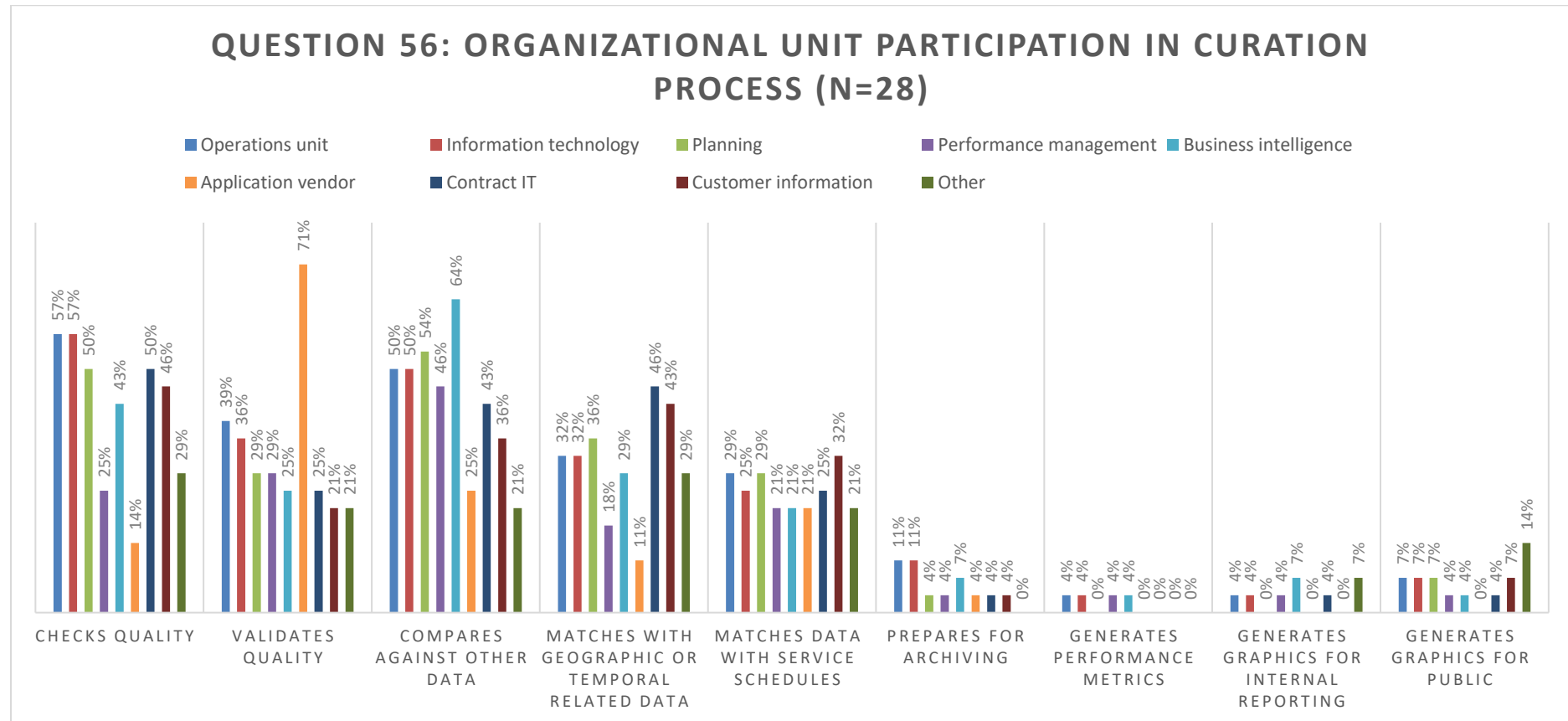
SERVICE DATA STORAGE APPROACH	Percent	Count
Cloud environment	50%	14
On-site data center	93%	26
Vendor data center	39%	11
File sharing system	46%	13
Staff workstation	29%	8
Other – Write In (Required) <ul style="list-style-type: none"> Off-site, but City-controlled, data center. 	7%	2

55. What curation processes are applied to manage raw service data?



PROCESSES IN SERVICE DATA CURATION	Percent	Count
Cleansing	75%	21
Validating	75%	21
Versioning	39%	11
Storing	79%	22
Publishing (for internal users)	64%	18
Publishing (for external users)	39%	11
Not applicable	14%	4

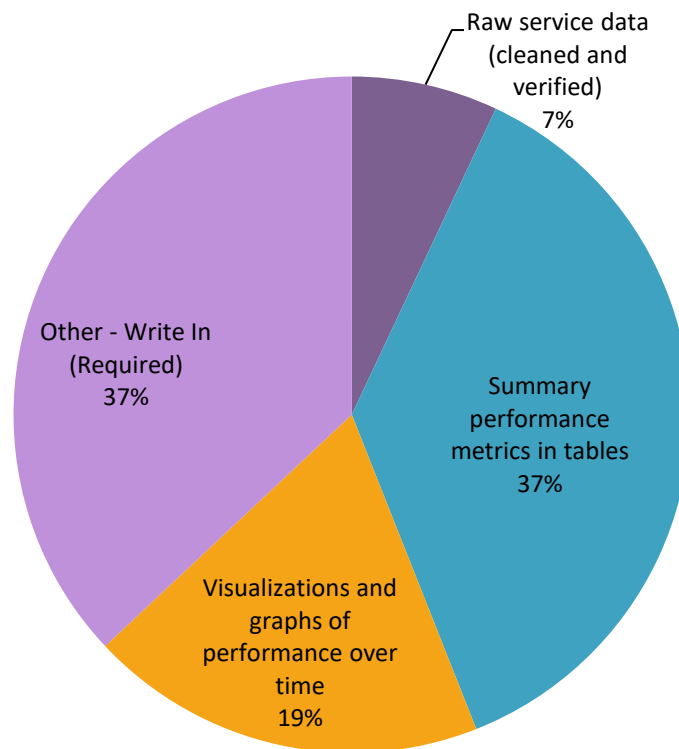
56. Which organizational units perform management processes for performance or summary service data?



Curation process / organizational unit	Operation unit (e.g., bus, rail, facilities)																							
	Operations unit			Information technology						Business intelligence														
	Information technology			Planning						Performance management														
	Planning			Performance management						Business intelligence														
	Application vendor			Application vendor						Contract IT														
	Contract IT			Customer information						Customer information														
	ADA compliance			ADA compliance						University														
	University			Regional planning organization						Regional planning organization														
	Other			Other																				
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Checks for completeness, consistency, errors of raw data	16	57%	11	39%	14	50%	9	32%	8	29%	3	11%	1	4%	1	4%	1	4%	0	0%	0	0%	2	7%
Validates quality / integrity of data	16	57%	10	36%	14	50%	9	32%	7	25%	3	11%	1	4%	1	4%	1	4%	0	0%	0	0%	2	7%
Reconciles / compares against other data	14	50%	8	29%	15	54%	10	36%	8	29%	1	4%	0	0%	0	0%	1	4%	0	0%	0	0%	2	7%
Matches/ integrates data with geographic or temporal related data	7	25%	8	29%	13	46%	5	18%	6	21%	1	4%	1	4%	1	4%	0	0%	0	0%	0	0%	1	4%
Matches data with service schedules	12	43%	7	25%	18	64%	8	29%	6	21%	2	7%	1	4%	2	7%	1	4%	0	0%	0	0%	1	4%
Prepares and transfers data to warehousing or archiving	4	14%	20	71%	7	25%	3	11%	6	21%	1	4%	0	0%	0	0%	1	4%	0	0%	0	0%	0	0%

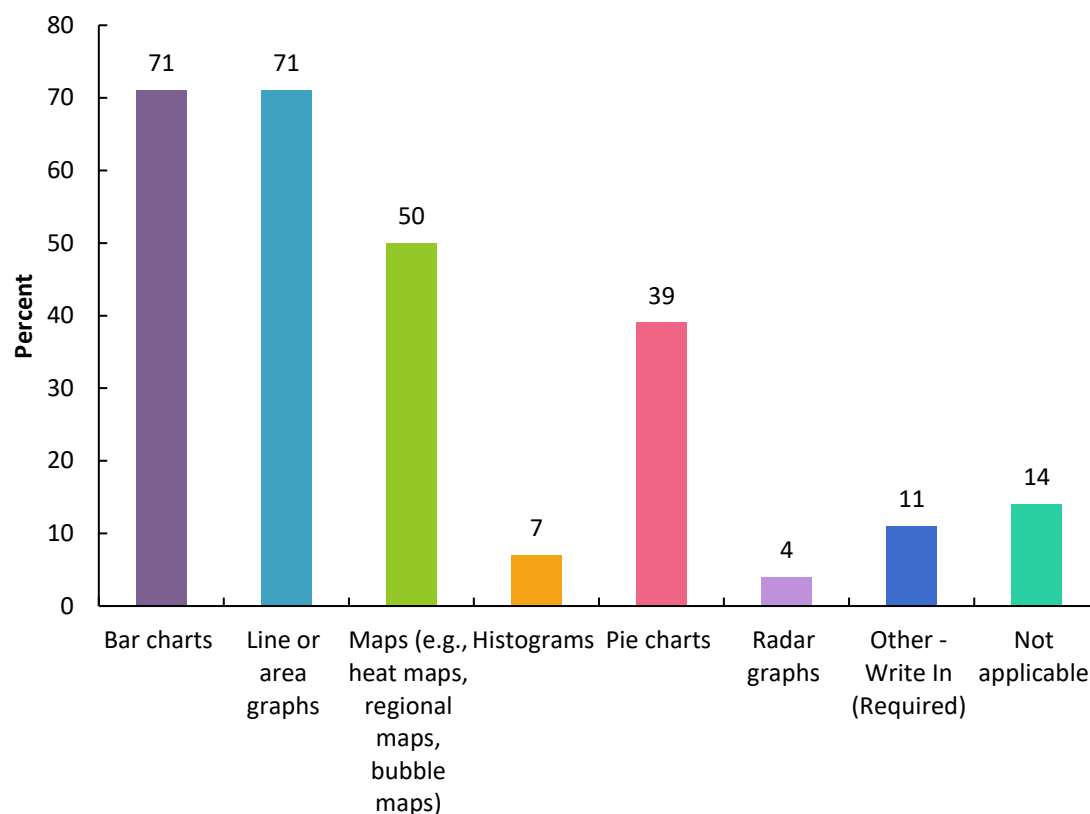
Generates and reviews Performance Metrics	14	50%	7	25%	12	43%	13	46%	7	25%	1	4%	0	0%	1	4%	1	4%	0	0%	0	0%	1	4%
Generates graphics and visualizations of performance metrics for internal reporting	13	46%	6	21%	10	36%	12	43%	9	32%	1	4%	0	0%	0	0%	0	0%	0	0%	0	0%	2	7%
Generates graphics, visualizations and descriptions of performance metrics for public interactive web displays or reports	8	29%	6	21%	6	21%	8	29%	6	21%	0	0%	0	0%	2	7%	0	0%	0	0%	0	0%	4	14%

57. What data is shared with the public? (select all that apply)



SERVICE DATA SHARED WITH THE PUBLIC	Percent	Count
Raw service data (cleaned and verified)	7%	2
Summary performance metrics in tables	37%	10
Visualizations and graphs of performance over time	19%	5
Other – <ul style="list-style-type: none"> • All of the above (2) • All that apply is not working here. We do both summary performance and visualizations/graphs • All would let you only select 1 • As needed. • Bullets 2 and 4 are true. It won't allow to select multiple answers • Could not select multiple items: we do summary performance metrics in tables and visualizations and graphs of performance over time • GTFS, ridership monthly BOD report • Not allowing to "select all." Raw service data; Summary performance metrics; Visualizations and graphs of performance over time • Ridership, bus stop location 	37%	10
	Totals	27

58. What types of visualizations are generated for the public? (select all that apply)

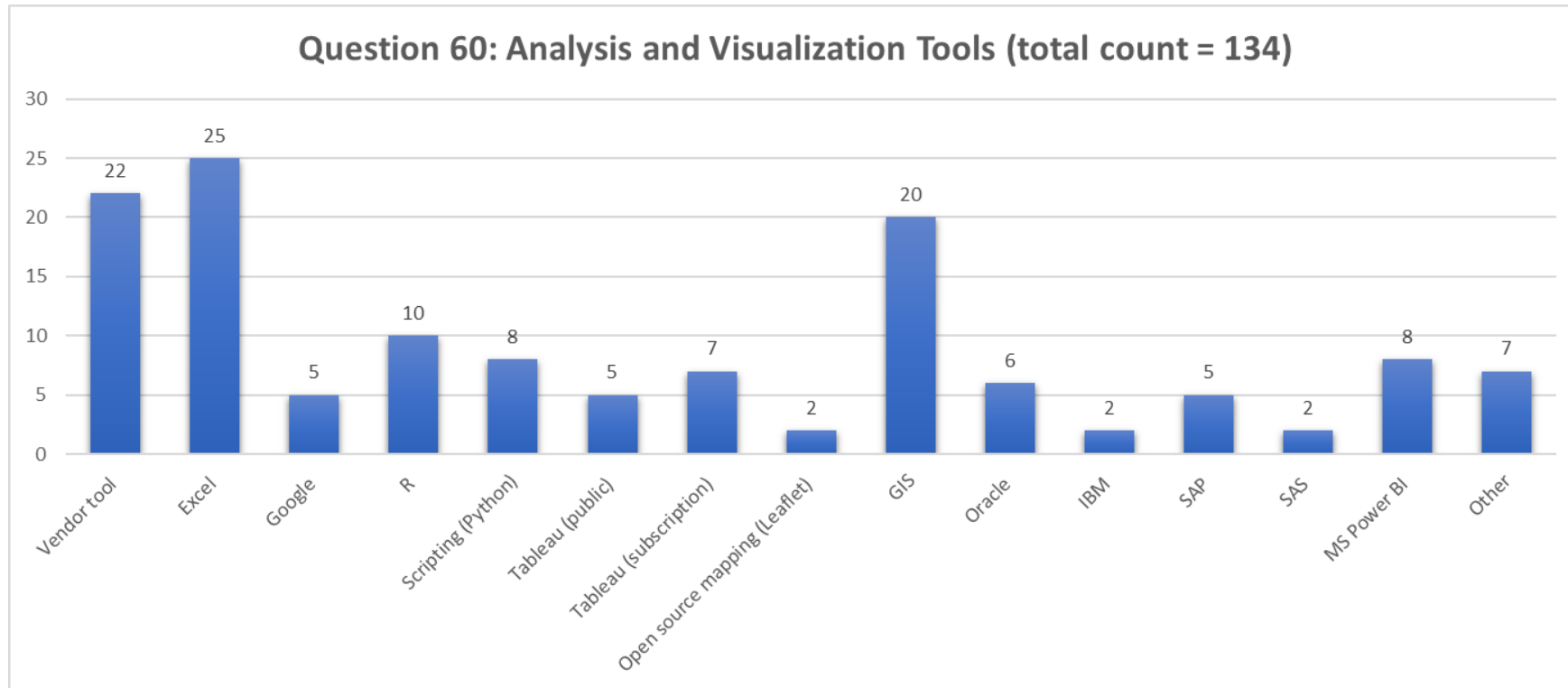


VISUALIZATION METHOD FOR PRESENTING SERVICE DATA	Percent	Count
Bar charts	71%	20
Line or area graphs	71%	20
Maps (e.g., heat maps, regional maps, bubble maps)	50%	14
Histograms	7%	2
Pie charts	39%	11
Radar graphs	4%	1
Other – <ul style="list-style-type: none"> As needed. Depends on the purpose Isochrone maps, for travel sheds 	11%	3
Not applicable	14%	4

59. How do you decide which data set and presentation method (table / visualization) should be published?

Response	Summary concepts
If the data fits in a chart, is clear, and is not overwhelming, a chart can be used. If it is not clear in a chart, a table may be used.	
Depends on the data set and target audience.	
We have KPIs that are reported to the board and included in the board report, which is downloadable via website.	
Depends on the purpose of the report and the audience.	
There is a standard set of data that has traditionally been supplied to the Board of Directors that is also made available to the public.	
Decided by an internal committee.	Internal
Collaboration review with business units.	Internal
Depending on the data set, a department or division has a designated role for publishing data. Example: interactive maps are published by the GIS division, where ridership and performance reports are published by the Service Planning division.	Internal
Digital Marketing makes this decision.	Marketing/public affairs
Public outreach needs, mandatory reporting requirements, public or external partner request.	Marketing/public affairs
determined by public affairs group	Marketing/public affairs
History and as new things such as ferries come online, based on what the public requests.	Public expectations
GM.	Sr Management
Senior Executive Team set the criteria.	Sr Management
Commission materials.	Sr Management
Based on information needs. Ridership related info is our top need.	Top needs
Case-by-case basis.	Top needs
Internal discussion and depending on audience.	Top needs

60. What tools are used to generate analysis and visualizations? (select all that apply)



Tools Used for Analysis and Visualization of Service Data	Count	Open Source Software
Vendor tool	22	
Excel	25	
Google	5	

R	10	x
Scripting (Python)	8	
Tableau (public)	5	x
Tableau (subscription)	7	
Open source mapping (Leaflet)	2	x
GIS	20	
Oracle	6	
IBM	2	
SAP	5	
SAS	2	
MS Power BI	8	
Other <ul style="list-style-type: none"> • TBEST (Transit Boardings Estimation and Simulation Tool) • Adobe CC Illustrator • Conveyal Transit Analyst • Microsoft SSRS • Information Builder Business Intelligence Suite • SPSS • Splunk 	7	
	134	

61. What projects or tools do you plan to develop in the next two years to support analysis, reporting and communicating transit service data?

Response to Question 61 consisted of 19 replies with 29 entries on plans for implementing projects and tools in the next two years. Although presented as an open-ended question, the responses covered nine categories with one response as not applicable. The categories are defined as follows:

Data Collection – tools to better capture specific data such as AFC, APC and other “new *smart* data collection methods.”

Data Governance – establish process for data improvement by implementing data governance.

Tools – specific named tools. Tools focused on GIS analytics and business intelligence tools.

Data Warehouse – development and implementation of a data warehouse to integrate service and operational data.

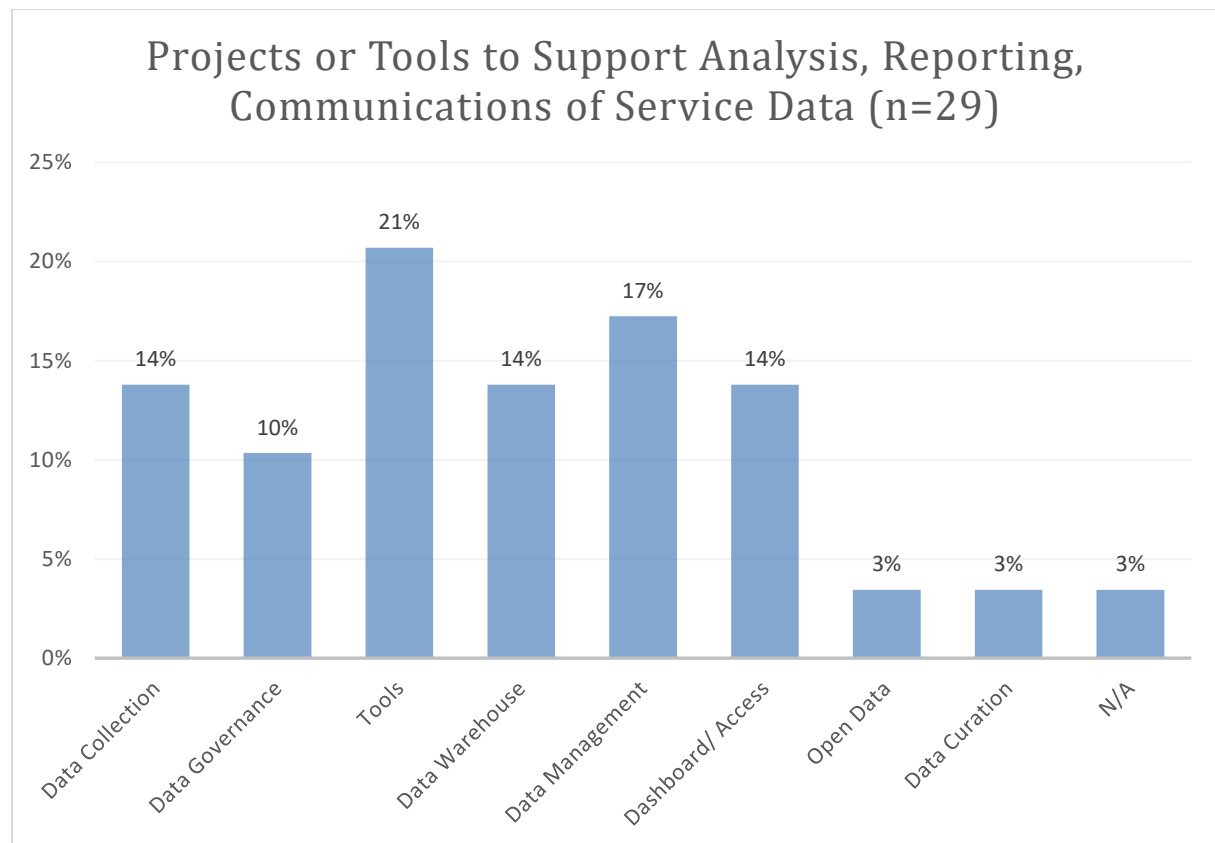
Data Management – includes new data management systems (other than the warehouse), for example, infrastructure software, data parsing and transformation tools (extract, translate, load – ETL), application programming interfaces.

Dashboard/ Access – tools and development of dashboard to provide access to internal and external users.

Open Data – Improving open data portal and public facing dashboards.

Data Curation – tools to support improvement in “data quality and breaking down silos.”

N/A – not applicable.



Projects/Tool Categories	Count	%
Data Collection	4	14%
Data Governance	3	10%
Tools	6	21%
Data Warehouse	4	14%
Data Management	5	17%
Dashboard/Access	4	14%
Open Data	1	3%
Data Curation	1	3%
N/A	1	3%
Respondents = 19	29	

Raw Responses

Better APC data collection; New "smart" data collection methods; On-line reservation booking for specialized services.

Data governance; continue [to] improve Open Data Portal; develop internal data portal to pull info from multiple places into one.

Power BI.

Comprehensive data warehouse for all transit data; bring in-house, custom, and third party data together. Interactive public-facing performance dashboard. Public access to our data warehouse (this has been conceptualized but not planned).

Focus Microsoft BI suites.

Establishing canned tables in AirTable; development of Pandas data frames using IPython Notebooks [now known as Jupyter Notebook] for consistent and repeatable analysis.

Tableau and Power BI.

Next Generation Fare System will improve analysis and reporting. Also, looking at generating analysis from upgraded train control software (ARINC).

We have several data pipeline (ETL) projects in process to make data easier to access. We have a new agency data governance initiative that we hope will provide guidance for better creating and managing data sources. In particular, we hope to expand our metadata processes. We continue to encourage use of self-service BI tools including Power BI.

Dashboard (both public and internal). Implementation of Swiftly Real Time Data Analytics software.

Data Warehouse and Business Intelligence.

New fare collection system; Now beginning to implement TSP on one major corridor; Establish a data warehouse with business intelligence tools built around it.

N/A.

Centralized data governance and decentralized execution strategy.

Loaded question depends of funding. We will continue developing our data warehouse via our BI team.

Trip Broker API Communication. GIS-based Dashboards to communicate data. Use of ArcGIS Pro and ArcGIS Online for data storage and completing map-related analysis and visuals.

APC public data; portfolio of business unit dashboards for internal leadership.

Build out automated scripting of performance metric data.

Plan to have our AFC data in a more easily accessible cloud (MS Azure) format. We want to work more on data quality and breaking down silos.

62. What staffing and skill sets do you wish your organization could acquire to improve transit service data analysis and reporting?

Response to Question 62 consisted of 22 replies, with 30 entries on staffing and skill set needs. Although presented as an open-ended question, the responses covered six categories with one response identifying no needs. The categories are defined as follows:

Resources – more staff, more time, more funds.

Data specialist – staff with experience in data analysis, statistics, and/or programming including on specialized tools.

DBA – database administrator with skills on managing and querying databases.

Training – on specialized tools, including training across organization for data users.

Data Curation – experience with cleaning and verifying operations data.

None – no needs related to resources, staffing, or experience.

Peer Exchange – experience on how other organizations manage their data.

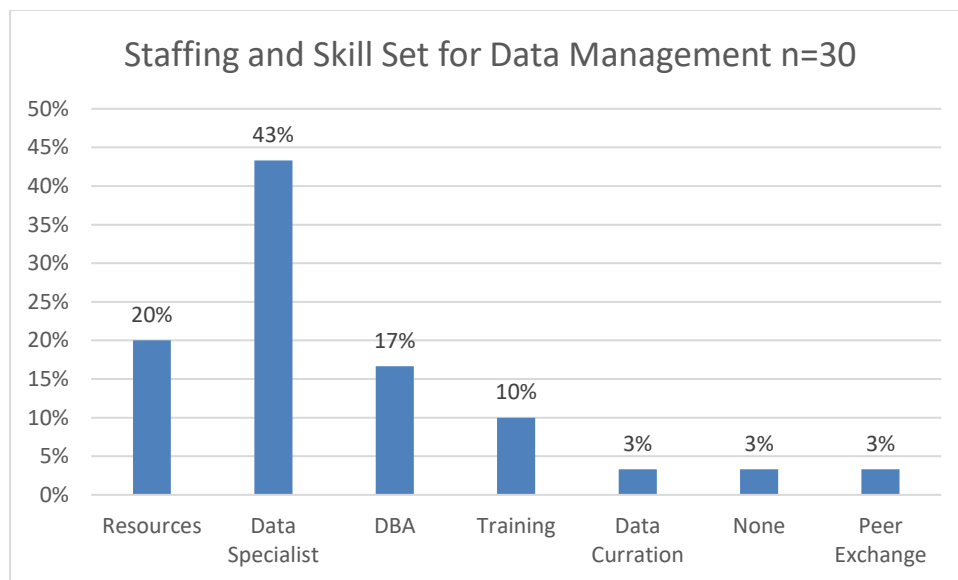


FIGURE 2: STAFFING AND SKILL SET NEEDS FOR DATA MANAGEMENT

TABLE 2: STAFFING AND SKILL SET NEEDS FOR DATA MANAGEMENT

Staffing and Skill Set Needs	Count	%
Resources	6	20%
Data Specialist	13	43%
DBA	5	17%
Training	3	10%
Data Curation Skills	1	3%
None	1	3%

Peer Exchange	1	3%
	30	

Raw Responses

Specialists who are trained in data collection and analysis that is specific to departments and not subject to centralized collection that may not address specific needs of departments.

More bandwidth in analyzing the data. We have excellent employees with SQL, data visualization etc. skill sets, just need more.

More analysts.

Data analysis skills; Coding skills; Data visualization, communication, and graphic design.

Statistical background and computer programming.

Query writing.

Skill sets are good, but additional resources could be beneficial.

More staffing for and experience with Business Intelligence tools (e.g., Power BI, Tableau). More staffing for data pipeline/ETL development.

Dedicated data analyst position. Would also be nice to have staff dedicated to performance measurement across all modes, independent of the operating staff who is focused on day-to-day operations, not necessarily concerned with going back and validating data to ensure completeness.

Have a good staff of data analysts in the agency.

Skills in programming (automation) and data science and statistics.

Data visualization and analytics; Statistical analysis and software such as SAS.

In house DBA to develop reports from multiple data sources.

Data management and statistical analysis.

Data warehousing software and procedure.

Analysts with SQL and reporting skills in every major department. Adaptation of transit data metric standards, and a BI/Data Visualization tools.

Additional staffing in both the BI and analytic roles. Currently, HRT only has 2 in each of those roles agency wide. Their skill set is high but demand is higher.

Comprehensive staff training on our existing software programs, for universal knowledge of what's available and what can be done with the collected data. Presentations on best practices; what other agencies are doing with their data and how they're doing it. Hire a Data Analyst within the Operations Department.

DBA; more data analysis focused positions; data warehousing; data driven decision making across all positions.

More data people.

Increased data management knowledge

Data quality/cleansing. More people familiar with analytics.