APPENDICES

APPENDIX A

DETAILED INFORMATION FOR MULTIMODAL METRICS

Table A.1
Detailed Information for Multimodal Metrics

Mode	Performance Measure	Definition/Description	Required Data	Data Sources/Dataset Provider	Thresholds	Threshold Source	Type of Multimodal Transportation Goal Performance Measure Assesses
Bicycle	Bicycle Equivalent Property Damage Only (EDPO) per Mile	This performance metric analyzes the safeness of a corridor, based on the presence of crashes near a corridor. The Massachusetts state crash database is used to determine the locations and prevalence of bicycle crashes. Bicycle crashes will be assessed based on the bicycle EDPO score in the corridor. The EDPO score is presented on a per-mile basis for the entire corridor. This metric is different from the Absence of Bicycle Crash metric that was presented in the bicycle level of service study, which rates bicycle safety by the presence of Highway Safety Improvement Program (HSIP) clusters.	Number of bicycle crashes Severity of bicycle crashes Corridor Length	MassDOT crash database	*Good* - Less than four per mile *Average* - Four to six per mile *Poor* - Six or higher per mile	Development of a Scoring System for Bicycle Travel in the Boston Region[1] (modified to use EDPO)–Boston Region MPO	Safety
Bicycle	Bicycle Facility Continuity (Bicycle Facility Presence)	The Bicycle Facility Continuity metric examines the length of a bicycle facility (such as a bicycle lane) compared to the roadway segment where the bicycle facility is located.	Corridor length Length of bicycle facility	Aerial imagery	*Good* - Bicycle facility matches corridor length *Average* - Facility is shorter than corridor *Poor* - No facility is present in the corridor	Development of a Scoring System for Bicycle Travel in the Boston Region –Boston Region MPO	Capacity Management and Mobility
Bicycle	Level of Traffic Stress	The Level of Traffic Stress (LTS) experienced by bicyclists is based on vehicular travel speeds, vehicular volumes, and the presence of buffers between vehicles and bicyclists. Distinct levels of stress that are present on a roadway segment or corridor, which would determine the recommended experience needed for a bicyclist to traverse through a roadway segment or corridor. A modified version of the LTS from the Mineta Low-Stress Bicycling and Network Connectivity Study will represent the LTS for this study. Bicycle lane blockage will not be included due to data availability. The factors that will be used for LTS are: • Type of bicycle facility/mixed traffic • Number of vehicle travel lanes • Presence of street parking • Bike lane width or sum of bike lane width and parking lane width • Speed limit or vehicle speeds LTS evaluation tables are present in Appendix B: If there is a bike lane present alongside a parking lane, refer to table B.1. If there is a bike lane but no parking lane present, refer to table B.2. If there is a pocket bike lane present, refer to table B.3. If there is no bike lane and no right turn lane, refer to table B.4. If there is no bike lane and but there is a right turn lane, refer to table B.5.	Number of travel lanes (for mixed traffic or regular bike lane) Roadway speed limit (for mixed traffic or regular bike lane) Bike lane width (not alongside parking lane) Sum of bike width and parking lane width (alongside parking lane)	MassDOT roadway inventory Aerial imagery Field collection	*Good* - LTS 1 *Average* - LTS 2 or 3 *Poor* - LTS 4	Low-Stress Bicycling and Network Connectivity - Mineta Transportation Institute[2]	Safety
Bicycle	Bicycle Rack Presence and Utilization	This metric indicates if a corridor has bicycle parking nearby. This may include bicycle racks along a street, bicycle racks located near a transit station or bus stop, or bicycle racks located on nearby private property in which any bicyclist is permitted to park their bike. Bicycle racks should be available every quarter-mile of a corridor. For a bicycle rack to count towards this metric, it should be safe, visible, and have spaces available during the time of observation. Racks located at a transit or bus stop have the additional benefit of providing a connection of multiple modes for travelers. This metric shows the ratio of bicycles parked per mile to bicycle spaces per mile.	Number of bicycle spaces along corridor Number of bicycles parked along corridor Corridor length	Boston MPO Bicycle Rack Survey Field collection	*Good* - Utilization is less than 50 percent *Average* - Utilization is 50 to 70 percent *Poor* - No bicycle spaces or utilization is more than 70 percent	CMP Monitoring – Boston Region MPO/Evaluation Results	Capacity Management and Mobility

[1] Casey-Marie Claude, "Development of a Scoring System for Bicycle Travel in the Boston Region," Boston Region Metropolitan Planning Organization, accessed February 15, 2019, https://www.ctps.org/data/pdf/studies/bikeped/bicycle-level-of-service.pdf.

[2] Maaza C. Mekuria Ph.D.,P.E, PTOE, Peter G. Furth, Ph.D., and Hilary Nixon, Ph.D., "Low-Stress Bicycling and Network Connectivity," Mineta Transportation Institute, accessed February 15, 2019, https://transweb.sjsu.edu/sites/default/files/1005-low-stress-bicycling-network-connectivity.pdf.

Table A.1 (Cont.)
Detailed Information for Multimodal Metrics

Mode	Performance Measure	Definition/Description	Required Data	Data Sources/Dataset Provider	Thresholds	Threshold Source	Type of Multimodal Transportation Goal Performance Measure Assesses
Bicycle	Proximity to Bike Network	The Proximity to Bike Network performance metric considers how a roadway segment serves as a connection along a bicycle route. This addresses one Capacity Management and Mobility objective, which calls for creating a connected network of bicycle facilities by expanding existing facilities and closing gaps. Roadway segments within one-quarter mile of a bicycle facility, defined as bicycle accommodations that separate bicyclists from mixed traffic, that have a robust connection to the corridor will be rated as "good."	Presence of any nearby trails Connection to any nearby trails	Aerial imagery	*Good* - Corridor fully connects to a nearby bike trail *Average* - Corridor partially connects to a nearby bike trail *Poor* - Corridor does not connect to a nearby bike trail	Development of a Scoring System for Bicycle Travel in the Boston Region – Boston Region MPO	Capacity Management and Mobility
Pedestrians	Safe crossing opportunities/Safe Crossing Opportunities per Mile	The Safe Crossing Opportunities performance metric reflects the number of crosswalks that are present alongside roadway segments. A corridor is deemed to have safe crossing opportunities if there are at least seven crosswalks per mile. This metric states the number of safe crossing opportunities per linear mile. For a crossing opportunity to be safe, the following criteria must be met: • There should be a crosswalk or bridge crossing the street. • The crosswalk should not cross any more than two lanes at a time unless there is a pedestrian indication present. • If the roadway speeds are more than 30 miles per hour (mph), then the crossing should be protected for pedestrians, either with an exclusive phase or an extended phase, to allow sufficient time to cross the roadway. *Safe Crossing Opportunities per Mile = number of safe crosswalks along a roadway segment/length of roadway segment in miles*	Number of safe crossing opportunities Corridor length Pedestrian phase for locations with roadway speeds higher than 30 mph	Aerial imagery Field collection Functional design reports	*Good* - More than 7 safe crossings per mile *Average* - between 5 to 7 safe crossings per mile *Poor* - Less than 5 safe crossings per mile	Pedestrian Level-of-Service Memorandum - Boston Region MPO[3]	Safety
Pedestrians	Sidewalk Presence and Condition	The Sidewalk Presence and Condition performance metric indicates whether sidewalks are present along a roadway segment and are in good condition. For the sidewalk coverage to be valid, the sidewalk must meet the American with Disabilities Act (ADA) standards, as stated below: • Sidewalk width must be at least 5 feet wide. • Sidewalks must have a slope of less than 1:20. • Curb cuts are required on sidewalks that cross a curb. • The sidewalk must remain at least three feet wide when passing an obstruction, such as light poles, trees, or other infrastructure. • A cross slope must be between 1.0 percent to 2.0 percent. • A clear space of 80 inches must be maintained above the sidewalk. • Additionally, the sidewalks must be in generally good condition, as determined by the surveyor's discretion. *Sidewalk Presence and Condition (calculate for each individual direction of travel) = total length of sidewalks in good condition/total length of roadway*	Length of sidewalk facilities that meet minimum ADA standards Corridor length	MassDOT roadway inventory Field collection	*Good* - Sidewalks are present on both sides of the street and in good condition *Average* - Sidewalks are present on one side of the street *Poor* – No sidewalk facilities	Pedestrian Level-of-Service Memorandum - Boston Region MPO	System Preservation/ Capacity Management and Mobility
Pedestrians	Pedestrian Equivalent Property Damage Only (EDPO) per Mile	The Pedestrian EPDO performance metric documents areas where pedestrian crashes are common. This performance metric is presented based on the EDPO in the corridor. The EDPO score is presented on a per-mile basis for the entire corridor.	Number of pedestrian crashes Severity of pedestrian crashes Corridor length	MassDOT crash database	*Good* - Less than five per mile *Average* - Five to ten per mile *Poor* - Ten or more per mile	Pedestrian Level-of-Service Memorandum - (modified to use EDPO)–Boston Region MPO	Safety

[3] Ryan Hicks and Casey Marie- Claude, "Pedestrian Level of Service Memorandum," Boston Region Metropolitan Organization, accessed February 15, 2019, https://www.ctps.org/data/pdf/studies/bikeped/pedestrian_level_of_service.pdf.

Table A.1 (Cont.)
Detailed Information for Multimodal Metrics

Mode	Performance Measure	Definition/Description	Required Data	Data Sources/Dataset Provider	Thresholds	Threshold Source	Type of Multimodal Transportation Goal Performance Measure Assesses
Pedestrians	Vehicle-Pedestrian Buffer	The Vehicle-Pedestrian Buffer measures the total distance between vehicular traffic and pedestrian traffic. The vehicle-pedestrian buffer includes any infrastructure that is present between a vehicle travel lane and an adjacent sidewalk or walkway. This includes, but is not limited to, marked roadway shoulders, bicycle lanes, pedestrian furniture, vehicle parking, grass strips, and vegetation. A buffer is good for reducing vehicle-pedestrian traffic incidents, which often result in injuries or fatalities.	Distance between vehicle travel lanes and sidewalks or pedestrian walkways	Aerial imagery	*Good* - More than ten feet of buffer *Average* - Five feet to ten feet of buffer *Poor* - Less than five feet of buffer	Pedestrian Level-of-Service Memorandum - Boston Region MPO	Safety
Transit	Transit Time Index	The Transit Time Index compares the average travel time of a transit vehicle to the tenth percentile daily travel time of the daily bus run. This measure is used to calculate delay along a transit route. Routes that have a Transit Time Index value greater than 1.3 shows congestion. *Transit Time Index = average travel time/tenth percentile daily travel time*	Travel times from MBTA Timepoint dataset	MBTA Timepoint dataset	*Good* - Less than 1.30 Transit Time Index *Average* - 1.30 to 2.00 Transit Time Index *Poor* - More than 2.00 Transit Time Index	CMP Monitoring – Boston Region MPO	Capacity Management and Mobility
Transit	Level of Transit Time Reliability	Level of Transit Time Reliability measures the variation of the travel time for a transit route during a typical weekday. This metric indicates if there is variability or consistency in travel times on a route from day to day. A transit route that has a Level of Transit Time Reliability of more than 1.5 is unreliable. MBTA crossing summary data will be used to measure this metric. *Level of Transit Time Reliability= 80th percentile travel time for transit vehicle/50th percentile travel time*	Travel times from MBTA Timepoint dataset	MBTA Timepoint dataset	*Good* - Less than 1.30 Level of Transit Time Reliability *Average* - 1.30 to 1.50 Level of Transit Time Reliability *Poor* - More than 1.50 Level of Transit Time Reliability	Evaluation results	Capacity Management and Mobility
Transit	Person Hours of Delay per Bus Trip	This metric combines ridership numbers with the travel time delay of transit vehicles. The delay for each run is multiplied by the average ridership. The results represent the peak period, the entire day, or the entire year. *Person Hours of Delay = transit vehicle delay * average number of people on transit*	Travel times from MBTA Timepoint dataset Automatic Passenger Count (APC) data	MBTA Timepoint dataset MBTA APC data	*Good* - Less than one hour *Average* - One to two hours *Poor* - More than two hours	CMP Monitoring – Boston Region MPO	Capacity Management and Mobility
Transit	Vehicle Delay per Mile per Bus Run	This performance metric shows the average vehicle delay per trip for a bus route regardless of service frequency. *Bus Run Delay = (average travel time for bus run + departure delay time) – free-flow or baseline travel time*	Travel times from MBTA Timepoint dataset Departure time delay from MBTA Timepoint dataset	MBTA Timepoint dataset	*Good* - Less than 30 seconds per mile *Average* - 30 to 60 seconds per mile *Poor* - More than 60 seconds per mile	CMP Monitoring – Boston Region MPO	Capacity Management and Mobility
Transit	Load Factor/Passenger Crowding	Passenger Crowding is measured as the ratio of the number of passengers on a vehicle to the number of seats on a bus. The comfort load point is 0.90, which indicates that all riders can easily find a seat. The maximum load point is 1.40, which indicates that all riders are experiencing an uncomfortable ride. *Passenger Crowding = number of passengers on a bus/number of seats on a bus*	Automatic Passenger Count (APC) data Number of seats on a bus	MBTA APC data	*Good* - Less than 0.90 *Average* - 0.90 to 1.40 *Poor* - More than 1.40	MBTA/CMP Monitoring – Boston Region MPO	Capacity Management and Mobility

Table A.1 (Cont.)
Detailed Information for Multimodal Metrics

Mode	Performance Measure	Definition/Description	Required Data	Data Sources/Dataset Provider	Thresholds	Threshold Source	Type of Multimodal Transportation Goal Performance Measure Assesses
Transit	Safe Crossings at Opportunities Transit Stops	This performance metric analyzes the percentage of transit or bus stops in a corridor that have safe crossings nearby. Ideally, 75 percent of transit or bus stops should have safe crossings leading to the boarding location. This metric may only include transit or bus stops that have a certain amount of boardings and alightings. The definition of a safe crossing at a transit stop is as follows: • There should be a crosswalk or bridge that crosses the roadway leading to the station or stop. • The crosswalk should not cross any more than two lanes at a time unless there is a pedestrian signal present. • If the roadway speeds are more than 30 mph, the crossing should be protected for pedestrians, either with an exclusive phase or an extended phase, to allow sufficient time to cross the roadway.	Number of transit stops Number of transit stops that have safe crossings Pedestrian phase for locations with roadway speeds higher than 30 mph	Aerial imagery Field Collection	*Good* - More than 75 percent of transit stops have safe crossings *Average* - 50 percent to 75 percent of transit stops have safe crossings *Poor* - Less than 50 percent of transit stops have safe crossings	Evaluation results	Safety
Trucks	Truck Travel Time Reliability Index	This performance metric is from the Federal Highway Administration and is calculated using the National Performance Management Research Dataset (NPMRDS). This metric identifies predictable bottlenecks on individual roadway segments. Values on this index are calculated by dividing the 95th percentile travel time by the 50th percentile travel time. Any roadway segment that has a Truck Travel Time Reliability Index value of more than 1.50 is unreliable for truck traffic. *Truck Travel Time Reliability Index = 95th percentile travel time/50th percentile travel time*	Truck Travel Times from NPMRDS	NPMRDS	*Good* - Less than 1.30 Truck Travel Time Reliability Index *Average* - 1.30 to 1.50 Truck Travel Time Reliability Index *Poor* - More than 1.50 Truck Travel Time Reliability Index	Federal Highway Administration[4]	Capacity Management and Mobility
Trucks	Percentage of Truck Traffic	This metric shows the percentage of vehicles on a roadway that are trucks. This performance metric is a useful tool for prioritizing transportation projects. Corridors with a high percentage of truck traffic have different needs from corridors that have little truck traffic. Therefore, if two projects have equal evaluation scores, the project that is located in the corridor that has a higher percentage of trucks will be prioritized higher concerning freight. This metric is not rated as good, average, or poor. Instead, this metric is rated as *low truck traffic*, *medium truck traffic*, and *high truck traffic*.	Total number of vehicles traveling through a corridor Number of trucks traveling through a corridor	Functional design reports Field collection	*Low truck traffic* - Less than four percent truck traffic *Medium truck traffic* - Four percent to six percent truck traffic *High truck traffic*- More than six percent truck traffic	Evaluation results	Safety
Trucks	Buffer Time per Trip per Mile	The Buffer Time per Trip per Mile metric indicates the amount of contingency time that freight providers considered to ensure that a truck trip is completed on-time 95 percent of the time. *Buffer Time per Trip (minutes) = 95th percentile travel time - average travel time*	Travel times from NPMRDS Corridor length	NPMRDS Functional design reports Field collection	*Good* - Less than two minutes per mile *Average* - Two to five minutes per mile *Poor* - More than five minutes per mile	Federal Highway Administration (Modified)[5]	Capacity Management and Mobility
Trucks	AM Total Hours of Daily Truck Buffer Time	The Total Hours of Daily Truck Buffer Time metric indicate the total hours of contingency time needed for all daily AM truck traffic. Finding the total daily truck buffer time requires daily truck volumes. *Total Hours of Daily Truck Buffer Time (hours) = (95th percentile travel time – average travel time) * truck volumes*	Travel times from NPMRDS Truck volumes	NPMRDS Functional design reports Field collection	*Good* - Less than 25 hours *Average* - 25 to 60 hours *Poor* - More than 60 total hours	Federal Highway Administration (Modified)	Capacity Management and Mobility

[4] Federal Highway Administration, "Transportation Performance Management," accessed February 15, 2019, https://www.fhwa.dot.gov/tpm/rule/pm3/freight.pdf.

[5] Federal Highway Administration, "Travel Time Reliability: Making it There on Time, All the Time," accessed February 15, 2019, https://ops.fhwa.dot.gov/publications/tt_reliability/TTR_Report.htm.

Table A.1 (Cont.)
Detailed Information for Multimodal Metrics

Mode	Performance Measure	Definition/Description	Required Data	Data Sources/Dataset Provider	Thresholds	Threshold Source	Type of Multimodal Transportation Goal Performance Measure Assesses
Vehicles	Duration of Congestion/ Congested Time	Congested Time is the average number of minutes that drivers experience congested conditions (speeds below 19 mph on arterials), during a peak period. Congested Time is measured in minutes per peak period hour. *Congested Time (in minutes) = (number of minutes with speeds below 19 mph/total number of minutes in sample) * number of minutes in peak period*	Number of total data samples used Number of data samples that are indicated to be congested	INRIX	*Good* - Less than 15 minutes *Average* - 15 to 30 minutes *Poor* - More than 30 minutes	CMP Monitoring – Boston Region MPO	Capacity Management and Mobility
Vehicles	Travel Time Index	Travel Time Index compares travel conditions during the peak period to travel conditions during free-flow periods. Travel Time Index is the ratio of peak period time to free-flow time. For example, a Travel Time Index of 1.20 indicates a trip that takes 20 minutes in the off-peak period will take 24 minutes in the peak period, 20 percent longer. *Travel Time Index = average travel time/free-flow travel time*	Travel times from INRIX dataset	INRIX	*Good* - Less than 1.30 *Average* - 1.30 to 2.00 *Poor* - More than 2.00	CMP Monitoring – Boston Region MPO	Capacity Management and Mobility
Vehicles	Vehicle-Miles Traveled	Vehicle-Miles Traveled (VMT) is the total number of miles that every vehicle travels through a roadway segment, corridor, or region within a specified period. This metric is becoming a basis for measuring transportation patterns, as evidenced by California Senate Bill 743. Additionally, many transportation departments across the United States are switching from level-of-service-based metrics to VMT-based metrics. The reason for this change is that it is desirable to determine if a proposed project will result in an increase in VMT in the surrounding area. *Vehicle-Miles Traveled = segment length * vehicle volumes*	Corridor length Vehicle volumes	Travel demand model Functional design reports Field collection	*Good* - Less than 20,000 miles *Average* - 20,000 miles to 30,000 miles *Poor* - More than 30,000 miles	Evaluation results	Capacity Management and Mobility
Vehicles	Average Vehicle Delay Per Mile	This performance metric shows the amount of delay that a vehicle would experience by traveling during a specific monitoring time. This indicates the expected delay from traveling through a corridor at a designated time. This metric is stated in delay per mile of travel, to eliminate any bias against longer corridors. *Average Vehicle Delay Per Mile(seconds) = (average travel time for monitoring period – free-flow or baseline travel time)/length of corridor*	Corridor length Travel times from INRIX dataset	INRIX	*Good* - Less than 60 seconds *Average* - 60 seconds to 90 seconds *Poor* - More than 90 seconds	CMP Monitoring – Boston Region MPO	Capacity Management and Mobility
Multimodal	Peak Hour Roadway Lane Density	Roadway lanes are most effective when the throughput of people is maximized. This metric will observe travelers that pass through a corridor for a certain period by observing the type of vehicles, vehicle volumes, and vehicle occupancies. Reducing the percentage of single-occupancy vehicles and increasing the percentage of vehicles that have high occupancies, such as buses, would help increase roadway lane density. Bicyclists and pedestrians are not included in this metric. Required data includes the following: • Vehicle volumes • Occupancy counts • Vehicle classification (automobiles, trucks, buses, etc.) *Roadway Lane Density = (vehicle volumes for one hour period * occupancy counts for one hour period)/number of lanes*	Vehicle volumes Occupancy counts	Functional design reports Field collection	*Good* - More than 800 people *Average* - 600 to 800 people *Poor* - Less than 600 people	Evaluation results	Capacity Management and Mobility

Table A.1 (Cont.)
Detailed Information for Multimodal Metrics

Mode	Performance Measure	Definition/Description	Required Data	Data Sources/Dataset Provider	Thresholds	Threshold Source	Type of Multimodal Transportation Goal Performance Measure Assesses
Multimodal	Peak Hour Person Throughput	This time-based metric indicates the number of people attempting to enter a segment or corridor during a specified monitoring period. All parallel transportation facilities, including sidewalks and bicycle lanes, are included in this metric. This metric includes people who travel in a corridor by walking, biking, bus, and automobile. A higher person throughput indicates that a transportation facility is moving more people during a specified time. The following data is required to measure person throughput: • Automobile volumes • Automobile occupancy • Bus volumes • Number of people on buses • Pedestrian counts • Bicycle counts • Truck volumes Peak Hour Person Throughput = vehicle, bicycle and pedestrian volumes for one hour period * occupancy counts for one hour period	Automobile volumes and occupancies Bus volumes and occupancies Pedestrian volumes Bicycle volumes Truck volumes and occupancies	Functional design reports Field collection	*Good* - More than 2,200 people *Average* – 1,400 to 2,200 people *Poor* - Less than 1,400 people	Evaluation results	Capacity Management and Mobility

APPENDIX B

LEVEL OF TRAFFIC STRESS

Table B.1
Criteria for Bike Lanes Alongside a Parking Lane

Criteria	LTS ≥ 1	LTS ≥ 2	LTS ≥ 3	LTS ≥ 4
Street width (through lanes per direction)	1	(no effect)	2 or more	(no effect)
Sum of bike lane and parking lane width (includes marked buffer and paved gutter)	15 feet or more	14 or 14.5 feet[a]	13.5 feet or less	(no effect)
Speed limit or prevailing speed	25 mph or less	30 mph	35 mph	40 mph or more

[a] If the speed limit is less than 25 mph or the roadway is classified as residential, then any width is acceptable for LTS 2.

LTS = level of traffic stress. mph = miles per hour. (no effect) = factor does not trigger an increase to this level of traffic stress.

Table B.2
Criteria for Bike Lanes Not Alongside a Parking Lane

Criteria	LTS ≥ 1	LTS ≥ 2	LTS ≥ 3	LTS ≥ 4
Street width (through lanes per direction)	1	2, if directions are separated by a raised median	more than 2, or 2 without a separating median	(no effect)
Bike lane width (includes marked buffer and paved gutter)	6 feet or more	5.5 feet or less	(no effect)	(no effect)
Speed limit or prevailing speed	30 mph or less	(no effect)	35 mph	40 mph or more

LTS = level of traffic stress. mph = miles per hour. (no effect) = factor does not trigger an increase to this level of traffic stress.

Table B.3
Level of Traffic Stress Criteria for Pocket Bike Lanes

Configuration	Level of Traffic Stress
Single right-turn lane as long as 150 feet starting abruptly while the bike lane continues straight, and having an intersection angle and curb radius such that turning speed is less than 15 mph	LTS ≥ 2
Single right-turn lane longer than 150 feet starting abruptly while the bike lane continues straight, and having an intersection angle and curb radius such that turning speed is less than 20 mph.	LTS ≥ 3
Single right-turn lane in which the bike lane shifts to the left but the intersection angle and curb radius are such that turning speed is less than 15 mph.	LTS ≥ 3
Single right-turn lane with any other configuration: dual right-turn lanes or right-turn lane along with an option (through-right) lane.	LTS = 4

LTS = level of traffic stress. mph = miles per hour.

Table B.4
Criteria for Level of Traffic Stress in Mixed Traffic

Speed Limit	2-3 lanes	4-5 lanes	6+ lanes
25 mph or less	LTS 1[a] or 2[a]	LTS 3	LTS 4
30 mph	LTS 2[a] or 3[a]	LTS 4	LTS 4
35+ mph	LTS 4	LTS 4	LTS 4

[a] Use lower value for streets without marked centerlines or classified as residential and with fewer than three lanes; use higher value otherwise.

LTS = level of traffic stress. mph = miles per hour.

Table B.5
Level of Traffic Stress Criteria for Mixed Traffic in the Presence of a Right-turn Lane

Configuration	Level of Traffic Stress
Single right-turn lane less than 75 feet long and intersection angle and curb radius limit turning speed to 15 mph	(no effect on LTS)
Single right-turn lane between 75 and 150 feet long and intersection angle and curb radius limit turning speed to 15 mph	LTS ≥ 3
Other configurations	LTS = 4

LTS = level of traffic stress. mph = miles per hour.

APPENDIX C

SAMPLE SURVEY

New and Emerging Metrics for Roadway Usage—Survey

New and Emerging Metrics for Roadway Usage

This survey is being conducted by the Boston Region Metropolitan Planning Organization (MPO) to better evaluate the multimodal transportation network in the Boston region. Your role is valuable in providing input about performance metrics that could be used to determine the mobility of the transportation network at specific locations.

1. **What type of organization do you represent?**

- ◯ Municipal Government
- ◯ MPO or other regional government organization
- ◯ Regional Transit Agency
- ◯ Other
- ◯ Private transportation provider or Transportation Management Association
- ◯ State Department of Transportation

2. **Please rank each mode of transit by importance to multimodal transportation planning? (1= highest rank; 5=lowest rank)**

- Automobiles
- Transit
- Bicycle
- Pedestrian
- Freight

3. **What are the most important attributes for measuring multimodal mobility?**

- ◯ Measuring vehicle speeds
- ◯ Measuring person throughput
- ◯ Ensuring that corridors are suitable for multiple modes
- ◯ Measuring modal split

New and Emerging Metrics for Roadway Usage—Survey

Please look over the performance metric definitions provided below. The performance metrics are separated by travel mode. What is your opinion of the definitions provided for each performance metric listed below?

Bicycle Metrics

Pavement Condition:

Pavement condition for roadways are collected through the Highway Performance Monitoring System (HPMS). The HPMS supplies an International Roughness Index (IRI) for most of the National Highway System and arterial roadways. Generally, it is preferred that a roadway segment have an IRI of 95 inches per mile or less to ensure a comfortable ride. (Please note that IRI data coverage may be limited for off road trails).

Bicycle Crashes:

This performance metric analyzes the safeness of a bicycle network, based on the presence of crashes near a segment or corridor. The Massachusetts state crash database is used to determine the locations and prevalence of bicycle crashes.

Bicycle Facility Continuity:

The Bicycle Facility Continuity metric examines the length of a bicycle facility (such as a bicycle lane) compared to the roadway segment where the bicycle facility is located.

Bicycle-Miles Traveled:

Bicycle-Miles Traveled is a travel demand model-based performance metric that observes the number of miles traveled by bicycle on a designated roadway network. This metric is calculated by multiplying the volume of bicycles by the length of a roadway segment.

Bicycle-Miles Traveled = segment length * bicycle volumes

Level of Traffic Stress:

The level of traffic stress experienced by bicyclists is based on vehicular travel speeds, vehicular volumes, and the presence of buffers between vehicles and bicyclists. There are various levels of stress that can be present on a roadway segment or corridor, which would determine the recommended experience needed for a bicyclist to traverse through a roadway segment or corridor.

4. *Bicycle Definitions*

	Understandable and Accurate	Understandable but Inaccurate	Unclear but Accurate	Unclear and Inaccurate
Pavement Condition	○	○	○	○
Bicycle Crashes	○	○	○	○
Bicycle Facility Continuity	○	○	○	○
Bicycle-Miles Traveled	○	○	○	○
Level of Traffic Stress	○	○	○	○

Pedestrian Metrics

Crossing Opportunities/Crosswalks per Mile

The Crossing Opportunities performance metric reflects the number of crosswalks that are present along roadway segments. This metric is reported as the number of crosswalks per linear mile. Crossing opportunities are also measured at intersections by analyzing the presence of crosswalks at each approach.

Crossing Opportunities per Mile = number of crosswalks along a roadway segment/length of roadway segment in miles

Pedestrian Signal Presence:

The Pedestrian Signal Presence performance metric quantifies the characteristics of pedestrian signals. This metric documents whether the pedestrian signals are exclusive or concurrent, if there are *no turn on red* signs, or if there is a Leading Pedestrian Interval at an intersection.

Percent Sufficient Walkway Width:

This metric indicates whether a sidewalk that is located parallel to a roadway is at least five-feet wide.

Percent Sufficient Walkway Width = length of sidewalks (5'+)/total sidewalk length

Sidewalk Presence:

The Sidewalk Presence performance metric indicates whether sidewalks are present along a roadway segment or at an intersection.

Sidewalk Presence = total length of sidewalks/total length of roadway (If measuring sidewalk length on both sides of the roadway, double the roadway length.)

Pedestrian Volumes:

The Pedestrian Volumes performance metric represents the number of pedestrians traveling through a location during a period of time.

5. *Pedestrian Definitions*

	Understandable and Accurate	Understandable but Inaccurate	Unclear but Accurate	Unclear and Inaccurate
Crossing Opportunities	○	○	○	○
Pedestrian Signal Presence	○	○	○	○
Walkway Width	○	○	○	○
Sidewalk Presence	○	○	○	○
Pedestrian Volumes	○	○	○	○

Transit Metrics

On Time Performance:

On Time Performance of transit service is measured at both terminuses of the route and at midpoints. These locations are called time points. If a transit vehicle arrives late to a time point, then the time point is flagged. A transit route is determined not to be on time if less than 60 percent of its time points are reached by the designated time.

Transit Time Index:

The Transit Time Index compares the average travel time of a transit vehicle to the scheduled travel time. This measure can be used to calculate delay along a transit route. Routes that have a Transit Time Index value greater than 1.3 are considered to be congested.

Transit Time Index = average travel time/scheduled travel time

Person Hours of Delay:

This metric combines ridership numbers with the travel time delay of transit vehicles. The delay for each run can be multiplied by the average ridership. The hours of delay can be calculated for the peak period, entire day, or entire year.

Person Hours of Delay = transit vehicle delay * average number of people on transit

Load Factor/Passenger Crowding:

Passenger Crowding is measured as the ratio of the number of passengers on a vehicle at the maximum load point (1.40) to the number of seats on the vehicle.

Passenger Crowding Threshold = maximum load of more than 1.40 passengers per seat

Transit Passenger-Miles Traveled:

Transit-Miles Traveled is a performance metric that observes the number of miles that are traveled by transit on a designated roadway network. This metric is calculated by multiplying the volume of passengers on transit by the length of a roadway segment.

Transit Passenger-Miles Traveled= segment length * transit ridership

6. *Transit Definitions*

	Understandable and Accurate	Understandable but Inaccurate	Unclear but Accurate	Unclear and Inaccurate
On Time Performance	◯	◯	◯	◯
Transit Time Index	◯	◯	◯	◯
Person hours of delay	◯	◯	◯	◯
Load Factor/Passenger Crowding	◯	◯	◯	◯
Transit Passenger-Miles Traveled	◯	◯	◯	◯

Truck Metrics

Truck Vehicle-Miles of Travel:

This metric can be calculated by using truck volumes. To calculate this metric, the number of trucks are multiplied by the length of a roadway segment.

Truck Vehicle-Miles of Travel = segment length * truck volumes

Curb Radius:

This metric measures the curb radius of each curb at an intersection. A small curb radius ensures that trucks have enough space to execute a right turn without endangering pedestrians.

Truck Travel Time Reliability Index (TTTRI):

This is a performance metric that was introduced by the Federal Highway Administration and is calculated using the National Performance Monitoring Research Dataset. Values on this index are calculated by dividing the 95^{th} percentile travel time by the 50^{th} percentile travel time. Any roadway segment that has a TTTRI value of more than 1.50 is considered to be unreliable.

Truck Travel Time Reliability Index = 95^{th} percentile travel time/50^{th} percentile travel time

Truck Volumes:

This metric indicates the truck annual average daily traffic for a specific roadway segment. Truck volumes can be obtained from various data sources such as the Highway Performance Monitoring System or manual counts.

Buffer Time Index:

The Buffer Time Index measures trip reliability in terms of the amount of extra buffer time needed to arrive on time for 95 percent of the trips taken. Values on this index are calculated by the 95^{th} percentile travel time subtracted by the average travel time, and then divided by the average travel time.

Buffer Time Index = (95^{th} percentile travel time - average travel time)/average travel time

7. *Truck Definitions*

	Understandable and Accurate	Understandable but Inaccurate	Unclear but Accurate	Unclear and Inaccurate
Truck Vehicle-Miles Traveled	○	○	○	○
Curb Radius	○	○	○	○
Truck Travel Time Reliability Index	○	○	○	○
Truck Volumes	○	○	○	○
Buffer Time Index	○	○	○	○

Vehicle Metrics

Average Travel Speed:

Average Travel Speed for vehicles is associated with specific roadway segments and is calculated using travel times and segment lengths. The average travel speed can be measured for various times of the day.

Average Travel Speed (in miles per hour) [mph]) = (segment length/travel time) * 60

Duration of Congestion/Congested Time:

Congested Time is the average number of minutes that drivers experience congested conditions (speeds below 35 mph on expressways, or 19 mph on arterials), during a peak period. Congested Time is measured in minutes per peak period hour.

Congested Time (in minutes) = (number of minutes with speeds below 35 mph/total number of minutes in sample) * number of minutes in peak period

Travel Time Index:

Travel Time Index compares travel conditions during the peak period to travel conditions during free-flow periods. Travel Time Index is the ratio of peak period time to free-flow time. For example, a Travel Time Index of 1.20 indicates a trip that takes 20 minutes in the off-peak period, will take 24 minutes in the peak period, which is 20 percent longer.

Travel Time Index = average travel time/free-flow travel time

Vehicle-Miles of Travel:

Vehicle-Miles of Travel are the total number of miles that every vehicle travels through a roadway segment, corridor, or region within a specified period of time.

Vehicle-Miles of Travel = segment length * vehicle volumes

Volume-to-Capacity Ratio:

This metric indicates the ratio of traffic volume compared to the perceived capacity of a roadway segment. Roadway capacity is determined by the travel demand model.

Volume-to-Capacity Ratio =traffic volume of roadway/capacity of roadway

8. *Vehicle Definitions*

	Understandable and Accurate	Understandable but Inaccurate	Unclear but Accurate	Unclear and Inaccurate
Average Travel Speed	○	○	○	○
Duration of Congestion/Congested time	○	○	○	○
Travel time Index	○	○	○	○
Vehicle-Miles of Travel	○	○	○	○
Volume-to-Capacity Ratio	○	○	○	○

Multimodal Metrics

Travel time per Person:

This metric indicates the average travel time that a person would experience by traveling through a roadway segment or corridor at a specific time, regardless of the mode traveled.

Peak Period Length:

This metric indicates the peak times of the day that people travel through a roadway corridor. This performance metric factors in all people who travel on all modes. The peak period lengths can cover the AM peak, PM peak, off peak, or a combination of these time periods.

Person Throughput:

This metric indicates the number of people present on a segment or corridor at the beginning of the monitoring period, plus the number of people attempting to enter or who successfully entered a segment or corridor during a specified monitoring period. This metric includes people who travel using any mode of transportation.

Funds allocated by Mode:

This metric analyzes the amount of public funds spent on a transportation network, separated out by transportation mode. This metric can be shown numerically or as a percentage of the total amount spent.

9. *Multimodal Definitions*

	Understandable and Accurate	Understandable but Inaccurate	Unclear but Accurate	Unclear and Inaccurate
Travel Time per Person	○	○	○	○
Peak Period Length	○	○	○	○
Person Throughput	○	○	○	○
Funds allocated by Mode	○	○	○	○

10. **Please rank each bicycle performance metric based on their significance of being incorporated into multimodal performance monitoring ? (1= highest rank, 5=lowest rank)**

- Pavement Condition
- Bicycle Crashes
- Bicycle Facility Continuity
- Bicycle-Miles Traveled
- Level of Traffic Stress

11. **Please rank each pedestrian performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)**

- Crossing Opportunities
- Pedestrian Signal Presence
- Walkway Width
- Sidewalk Presence
- Pedestrian Volumes

12. **Please rank each transit performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)**

- On Time Performance
- Transit Time Index
- Person Hours of Delay
- Load Factor/Passenger Crowding
- Transit Passenger-Miles Traveled

13. **Please rank each truck performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)**

- Truck Vehicle-Miles Traveled
- Curb Radius
- Truck Travel Time Reliability Index
- Truck Volumes
- Buffer Time Index

14. **Please rank each vehicle performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)**

- Average Travel Speed
- Duration of Congestion/Congested Time
- Travel time Index
- Vehicles-Miles Traveled
- Volume-to-Capacity Ratio

15. **Please rank each multimodal performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 3=lowest rank)**

- Travel Time per Person
- Peak Period Length (AM, PM or both)
- Person Throughput
- Funds allocated by Mode

16. **How important do you think it is to ensure good multimodal transportation in areas with the demographic characteristics listed below? Please assign a weight between one and five (1= lowest importance, 5=greatest importance)**

	1	2	3	4	5
Disabled population	◯	◯	◯	◯	◯
Population over 75 years of age	◯	◯	◯	◯	◯
Population under 18 years of age	◯	◯	◯	◯	◯
Commuters who exclusively walk, bike, or take public transit	◯	◯	◯	◯	◯
Population without access to vehicles	◯	◯	◯	◯	◯
Residents in environmental justice areas (Low income or minority)	◯	◯	◯	◯	◯
Residents within a quarter mile of a school or college	◯	◯	◯	◯	◯

17. **Are there any performance metrics not on this list that should be added? Please elaborate.**

18. **Are there any performance metrics definitions that you would change? Please elaborate.**

19. **Please provide any feedback you would like to share regarding the multimodal performance metrics. Feel free to elaborate on any of the survey questions above.**

APPENDIX D

SURVEY RESULTS

New and Emerging Metrics for Roadway Usage—Survey

Thursday, May 09, 2019

Powered by SurveyMonkey

17

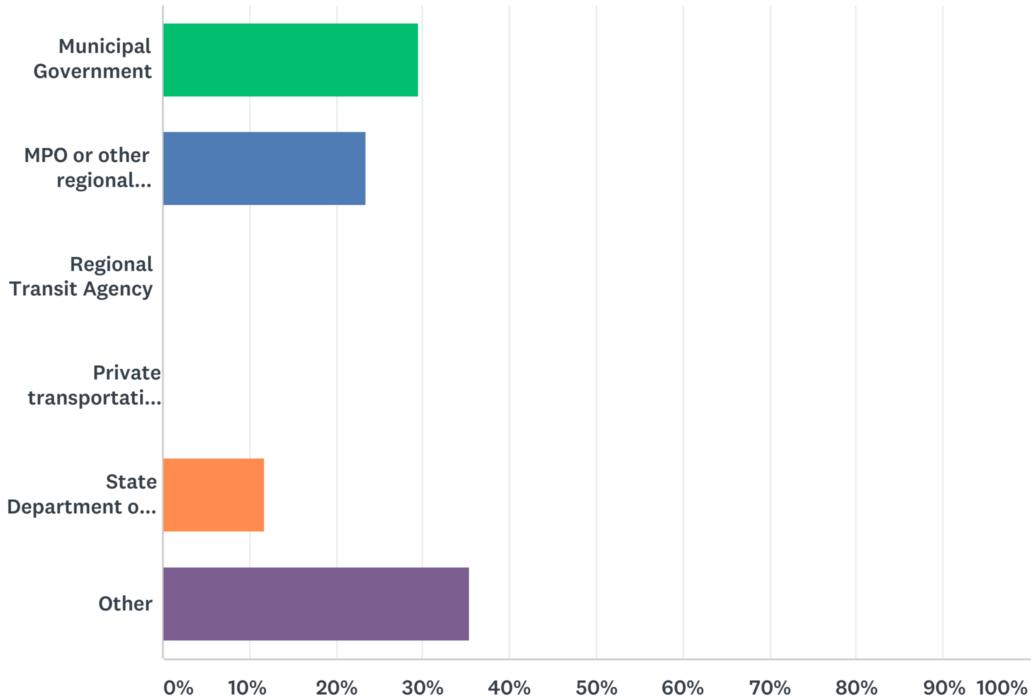
Total Responses

Date Created: Thursday, March 28, 2019

Complete Responses: 10

Q1 What type of organization do you represent?

Answered: 17 Skipped: 0

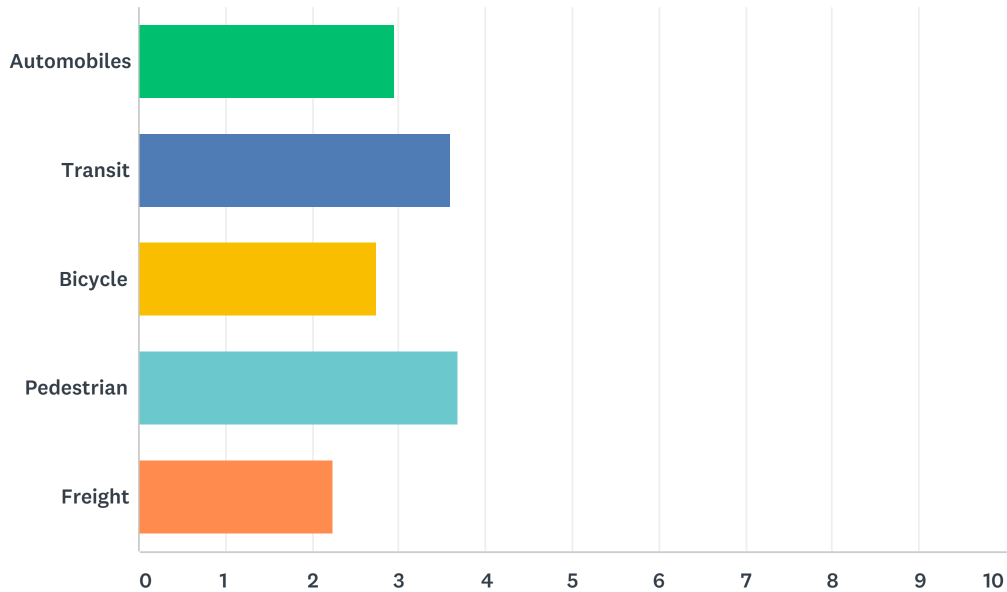


ANSWER CHOICES	RESPONSES	
Municipal Government	29.41%	5
MPO or other regional government organization	23.53%	4
Regional Transit Agency	0.00%	0
Private transportation provider or Transportation Management Association	0.00%	0
State Department of Transportation	11.76%	2
Other	35.29%	6
TOTAL		17

#	OTHER	DATE
1	Non-profit advocact	5/7/2019 1:23 PM
2	Non-profit	4/30/2019 12:24 PM
3	Consultant serving transportation agencies	4/27/2019 8:37 AM
4	State Port Authority	4/26/2019 10:56 AM
5	Transportation Advocacy	4/24/2019 9:08 AM
6	non-profit	4/23/2019 4:42 PM

Q2 Please rank each mode of transportation by importance to multimodal transportation planning? (1= highest rank; 5=lowest rank)

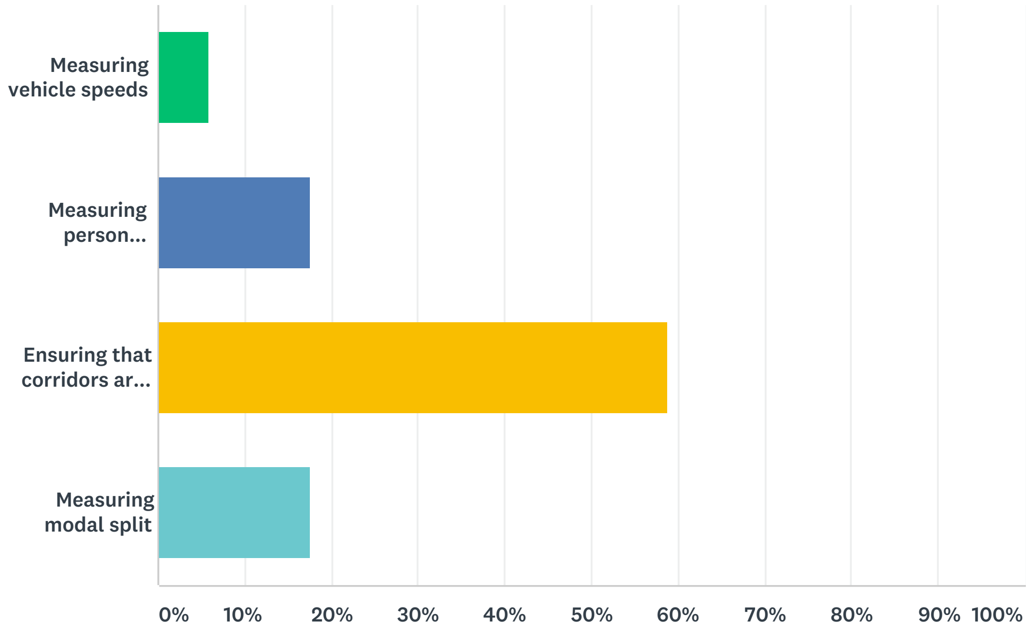
Answered: 17   Skipped: 0



	1	2	3	4	5	TOTAL	SCORE
Automobiles	37.50% 6	0.00% 0	18.75% 3	6.25% 1	37.50% 6	16	2.94
Transit	29.41% 5	17.65% 3	41.18% 7	5.88% 1	5.88% 1	17	3.59
Bicycle	0.00% 0	37.50% 6	18.75% 3	25.00% 4	18.75% 3	16	2.75
Pedestrian	31.25% 5	31.25% 5	18.75% 3	12.50% 2	6.25% 1	16	3.69
Freight	5.88% 1	17.65% 3	0.00% 0	47.06% 8	29.41% 5	17	2.24

Q3 What are the most important attributes for measuring multimodal mobility?

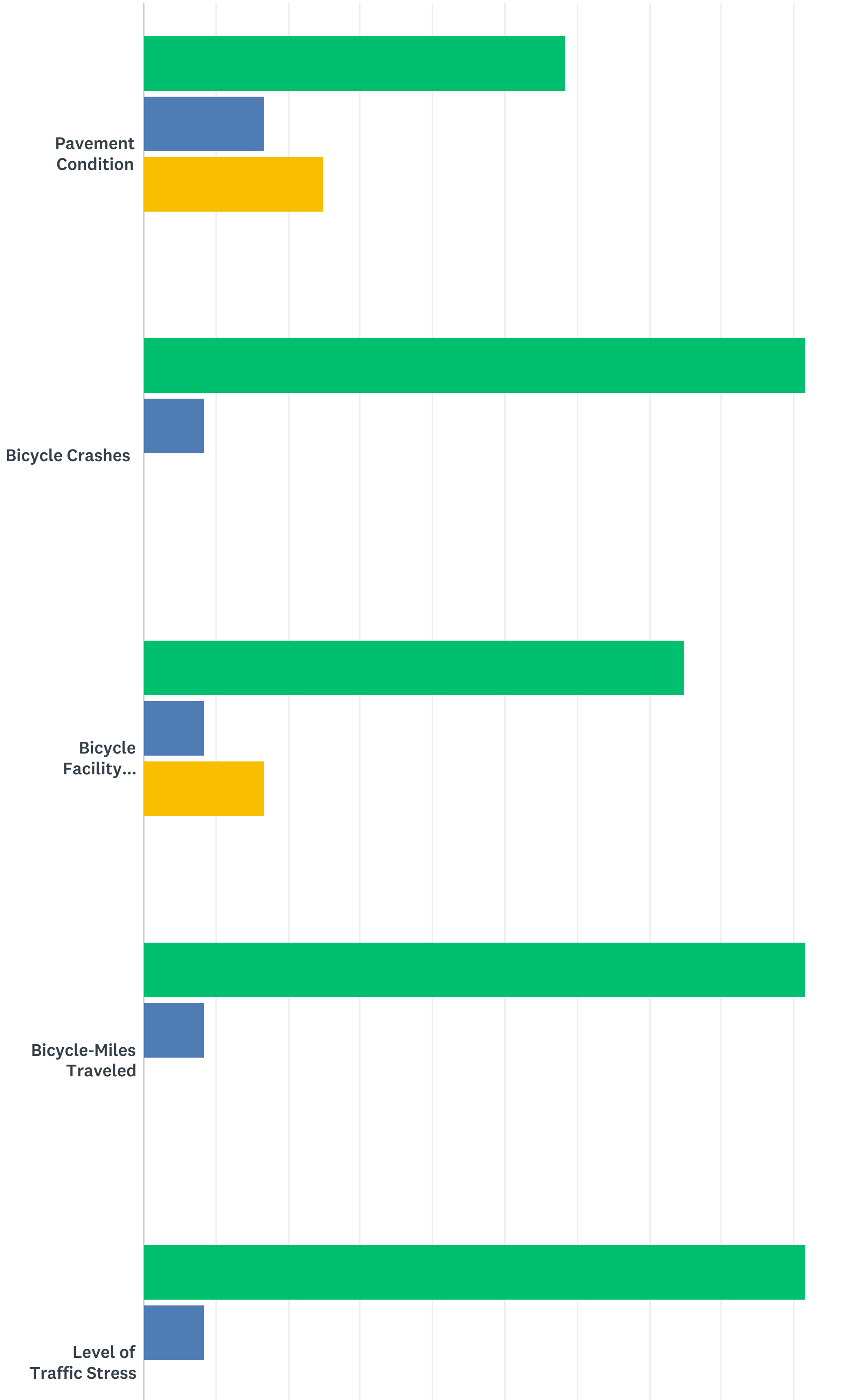
Answered: 17 Skipped: 0

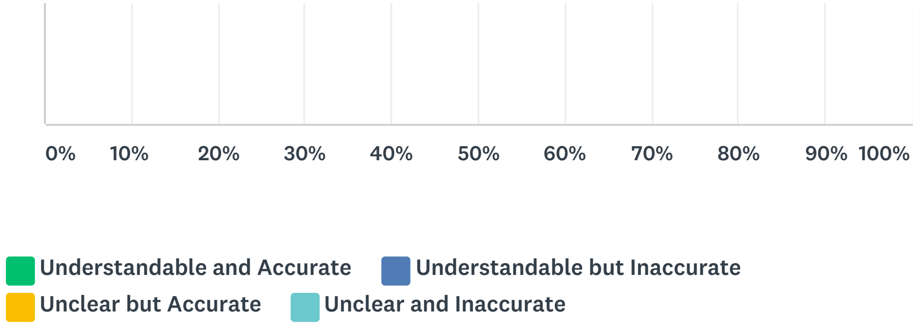


ANSWER CHOICES	RESPONSES	
Measuring vehicle speeds	5.88%	1
Measuring person throughput	17.65%	3
Ensuring that corridors are suitable for multiple modes	58.82%	10
Measuring modal split	17.65%	3
TOTAL		17

Q4 Bicycle Definitions

Answered: 12 Skipped: 5

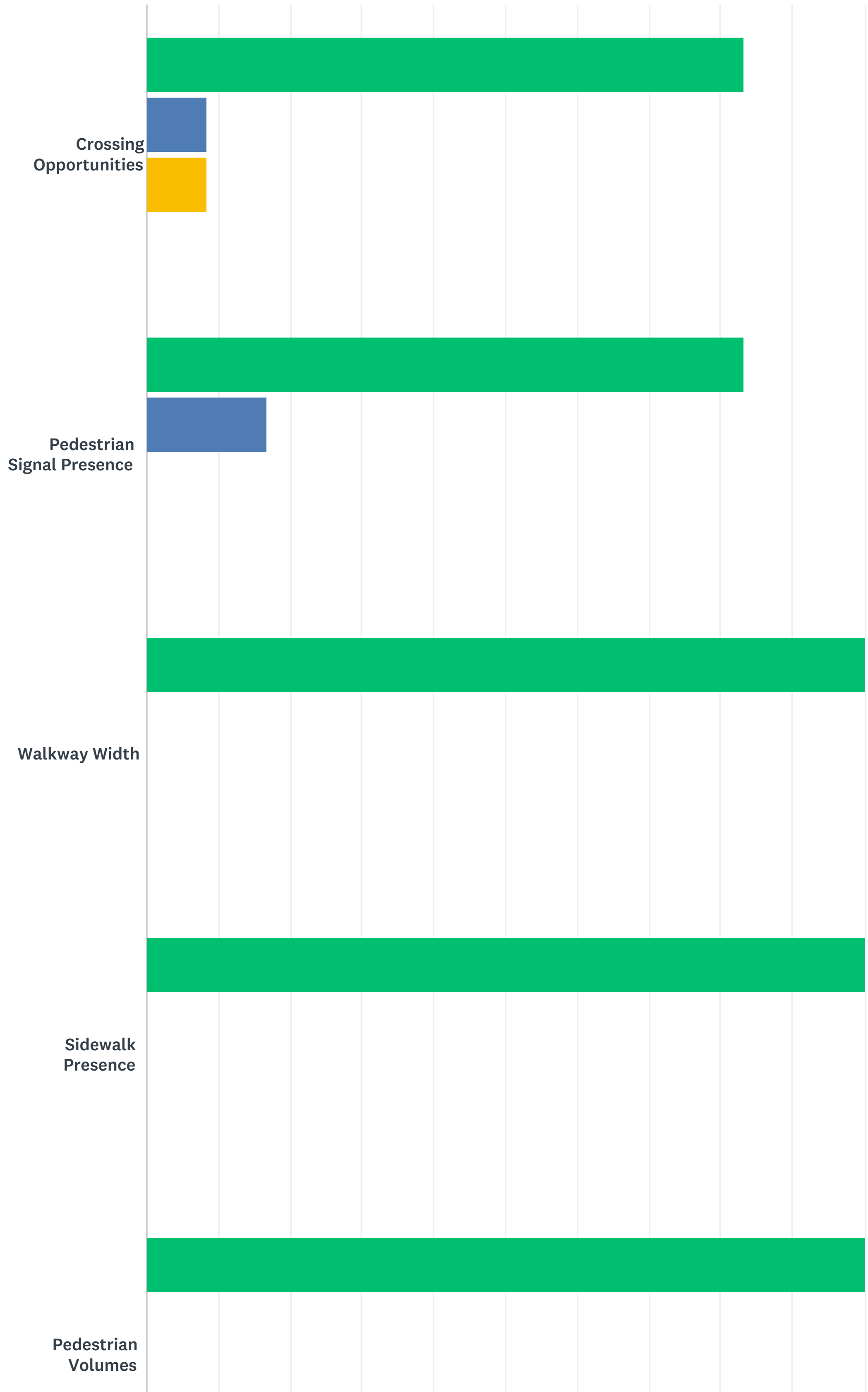


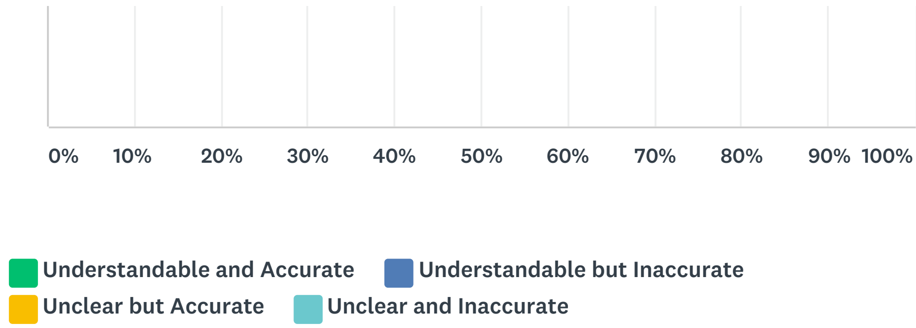


	UNDERSTANDABLE AND ACCURATE	UNDERSTANDABLE BUT INACCURATE	UNCLEAR BUT ACCURATE	UNCLEAR AND INACCURATE	TOTAL
Pavement Condition	58.33% 7	16.67% 2	25.00% 3	0.00% 0	12
Bicycle Crashes	91.67% 11	8.33% 1	0.00% 0	0.00% 0	12
Bicycle Facility Continuity	75.00% 9	8.33% 1	16.67% 2	0.00% 0	12
Bicycle-Miles Traveled	91.67% 11	8.33% 1	0.00% 0	0.00% 0	12
Level of Traffic Stress	91.67% 11	8.33% 1	0.00% 0	0.00% 0	12

Q5 Pedestrian Definitions

Answered: 12 Skipped: 5

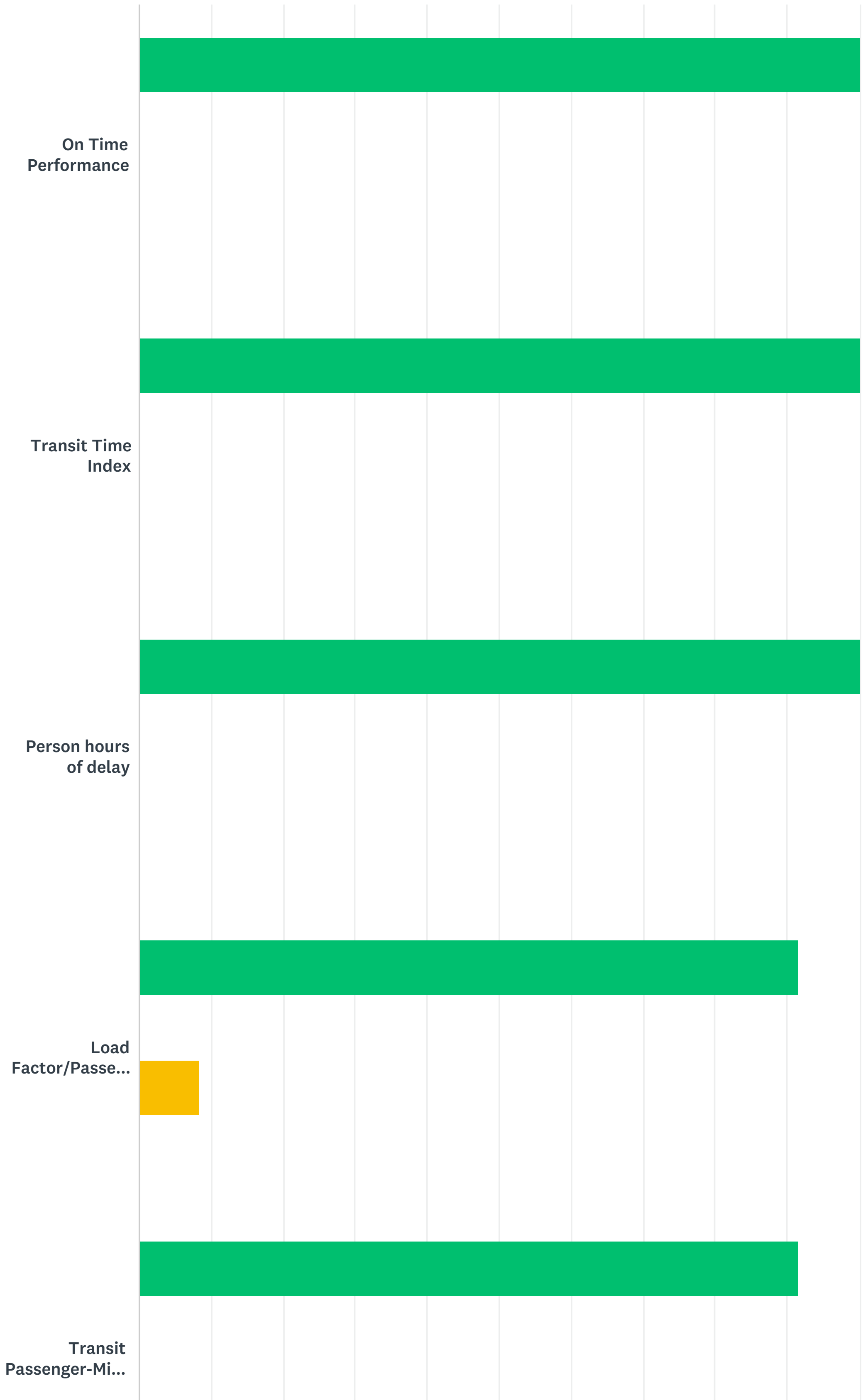


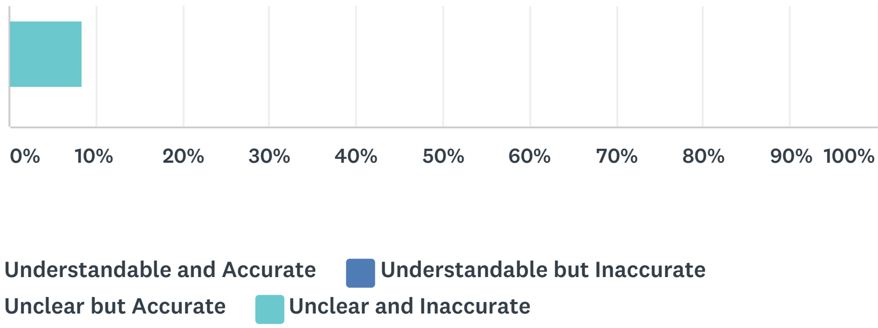


	UNDERSTANDABLE AND ACCURATE	UNDERSTANDABLE BUT INACCURATE	UNCLEAR BUT ACCURATE	UNCLEAR AND INACCURATE	TOTAL
Crossing Opportunities	83.33% 10	8.33% 1	8.33% 1	0.00% 0	12
Pedestrian Signal Presence	83.33% 10	16.67% 2	0.00% 0	0.00% 0	12
Walkway Width	100.00% 12	0.00% 0	0.00% 0	0.00% 0	12
Sidewalk Presence	100.00% 12	0.00% 0	0.00% 0	0.00% 0	12
Pedestrian Volumes	100.00% 12	0.00% 0	0.00% 0	0.00% 0	12

Q6 Transit Definitions

Answered: 12 Skipped: 5

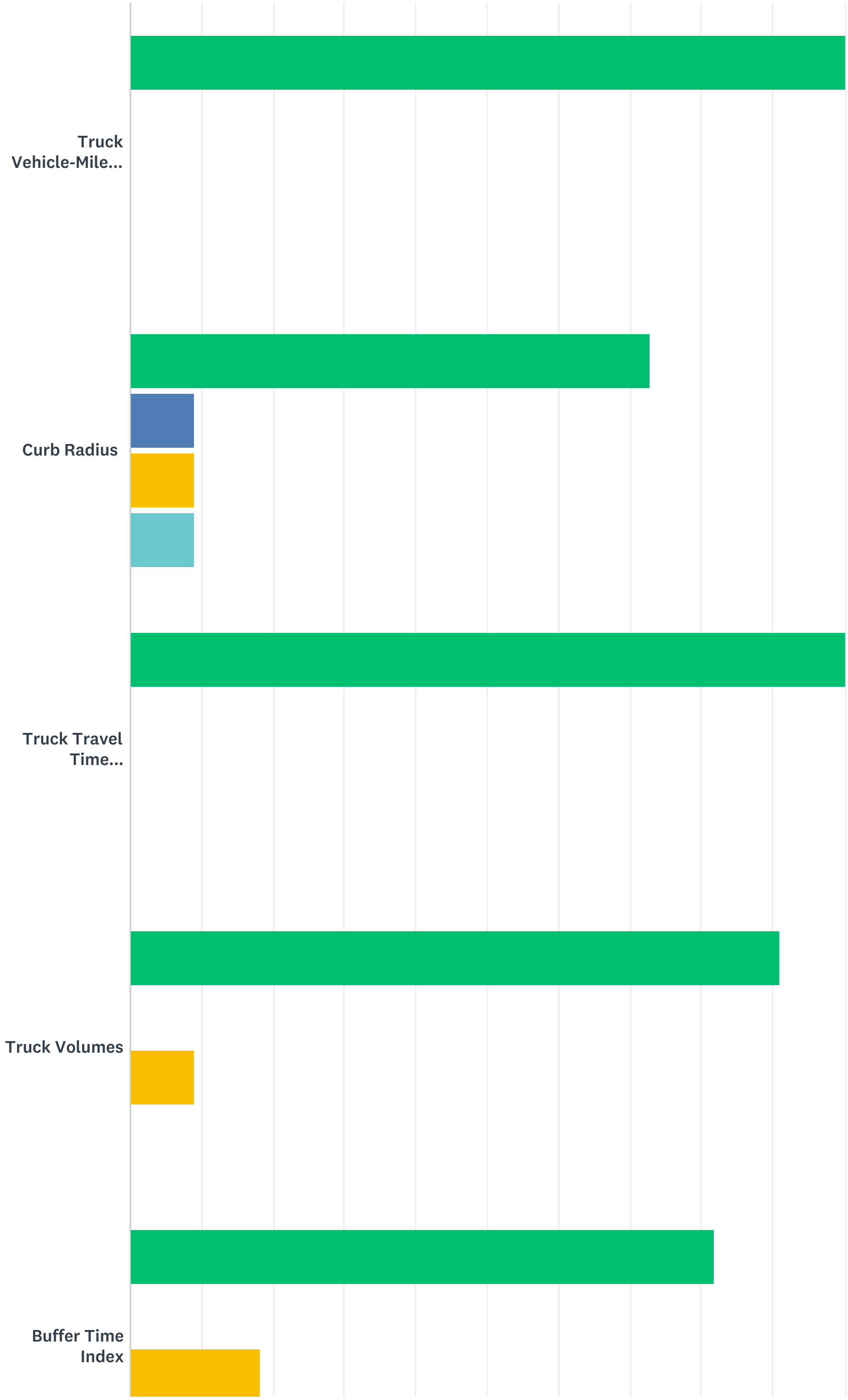


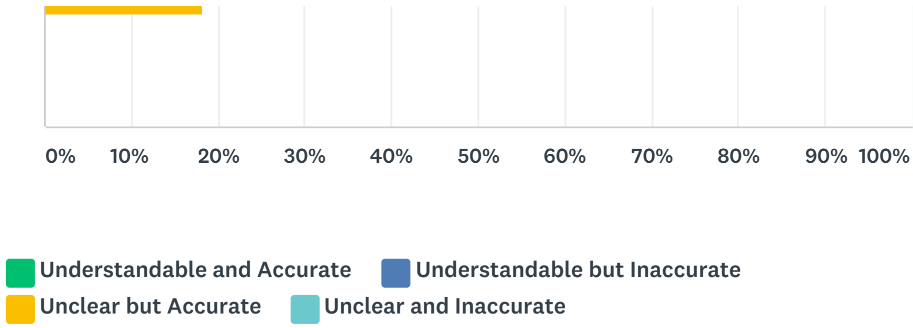


	UNDERSTANDABLE AND ACCURATE	UNDERSTANDABLE BUT INACCURATE	UNCLEAR BUT ACCURATE	UNCLEAR AND INACCURATE	TOTAL
On Time Performance	100.00% 12	0.00% 0	0.00% 0	0.00% 0	12
Transit Time Index	100.00% 12	0.00% 0	0.00% 0	0.00% 0	12
Person hours of delay	100.00% 12	0.00% 0	0.00% 0	0.00% 0	12
Load Factor/Passenger Crowding	91.67% 11	0.00% 0	8.33% 1	0.00% 0	12
Transit Passenger-Miles Traveled	91.67% 11	0.00% 0	0.00% 0	8.33% 1	12

Q7 Truck Definitions

Answered: 11 Skipped: 6

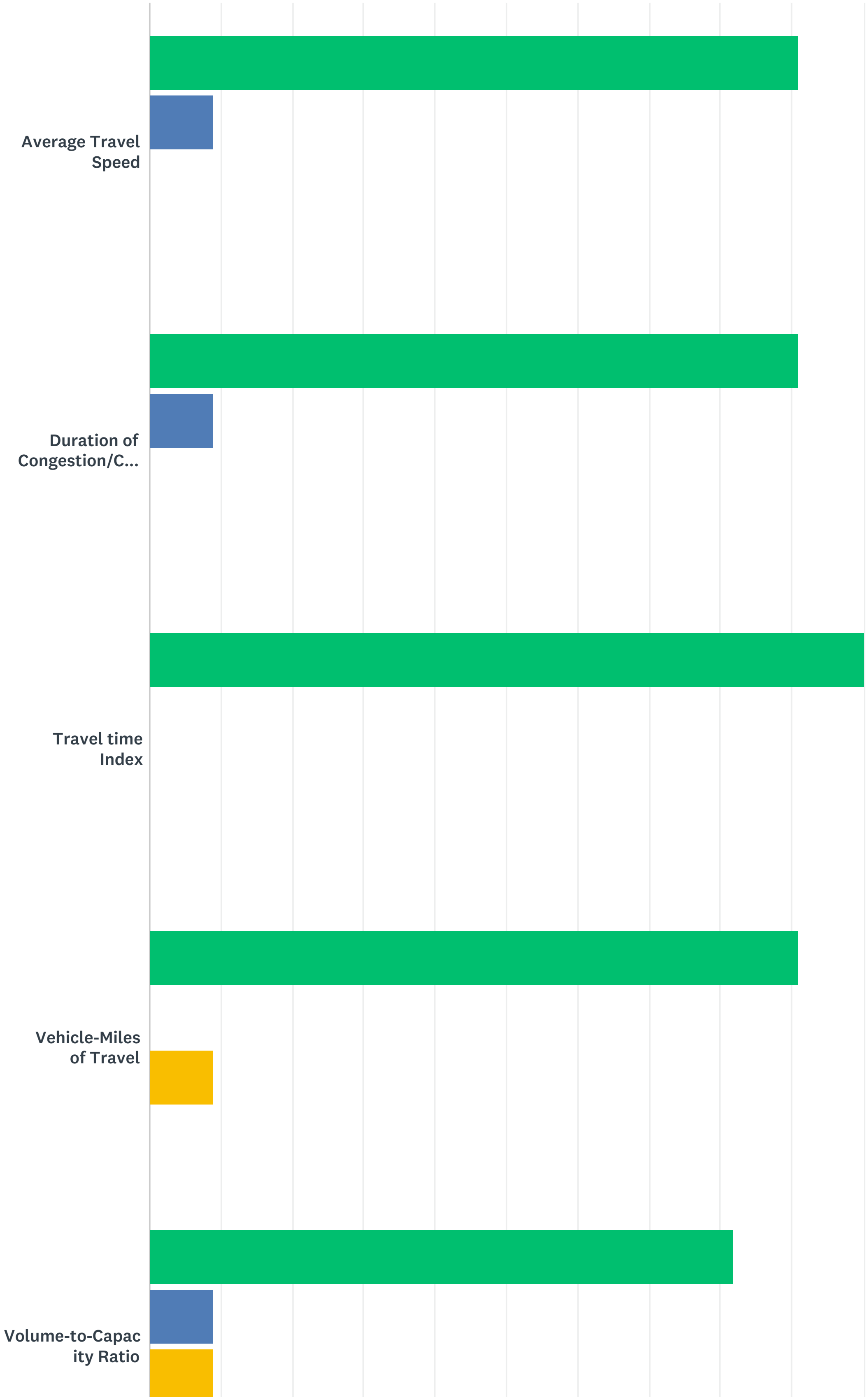


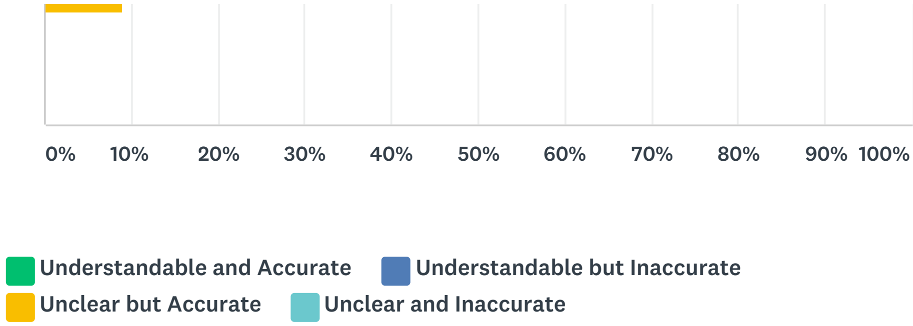


	UNDERSTANDABLE AND ACCURATE	UNDERSTANDABLE BUT INACCURATE	UNCLEAR BUT ACCURATE	UNCLEAR AND INACCURATE	TOTAL
Truck Vehicle-Miles Traveled	100.00% 11	0.00% 0	0.00% 0	0.00% 0	11
Curb Radius	72.73% 8	9.09% 1	9.09% 1	9.09% 1	11
Truck Travel Time Reliability Index	100.00% 11	0.00% 0	0.00% 0	0.00% 0	11
Truck Volumes	90.91% 10	0.00% 0	9.09% 1	0.00% 0	11
Buffer Time Index	81.82% 9	0.00% 0	18.18% 2	0.00% 0	11

Q8 Vehicle Definitions

Answered: 11 Skipped: 6

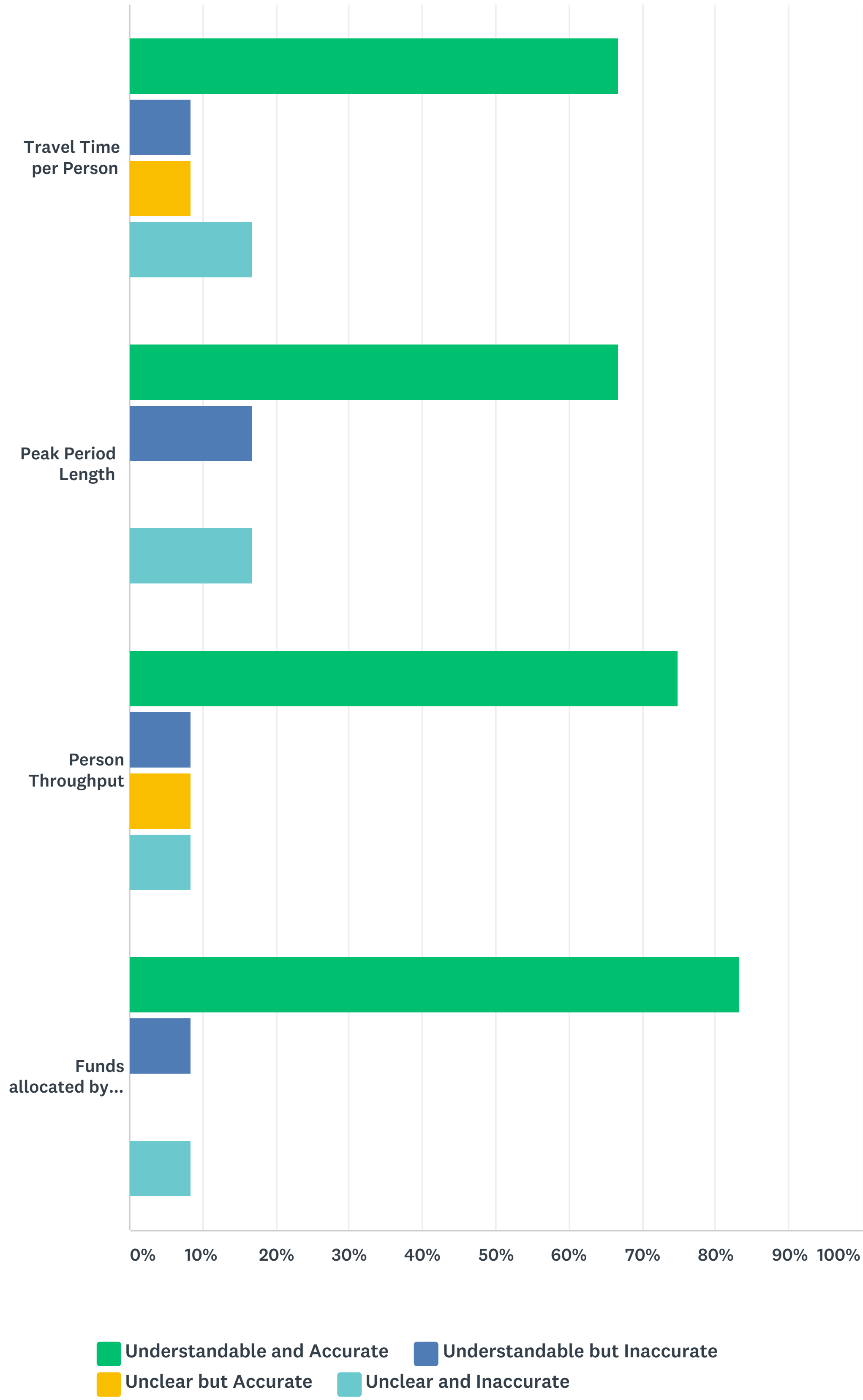




	UNDERSTANDABLE AND ACCURATE	UNDERSTANDABLE BUT INACCURATE	UNCLEAR BUT ACCURATE	UNCLEAR AND INACCURATE	TOTAL
Average Travel Speed	90.91% 10	9.09% 1	0.00% 0	0.00% 0	11
Duration of Congestion/Congested time	90.91% 10	9.09% 1	0.00% 0	0.00% 0	11
Travel time Index	100.00% 11	0.00% 0	0.00% 0	0.00% 0	11
Vehicle-Miles of Travel	90.91% 10	0.00% 0	9.09% 1	0.00% 0	11
Volume-to-Capacity Ratio	81.82% 9	9.09% 1	9.09% 1	0.00% 0	11

Q9 Multimodal Definitions

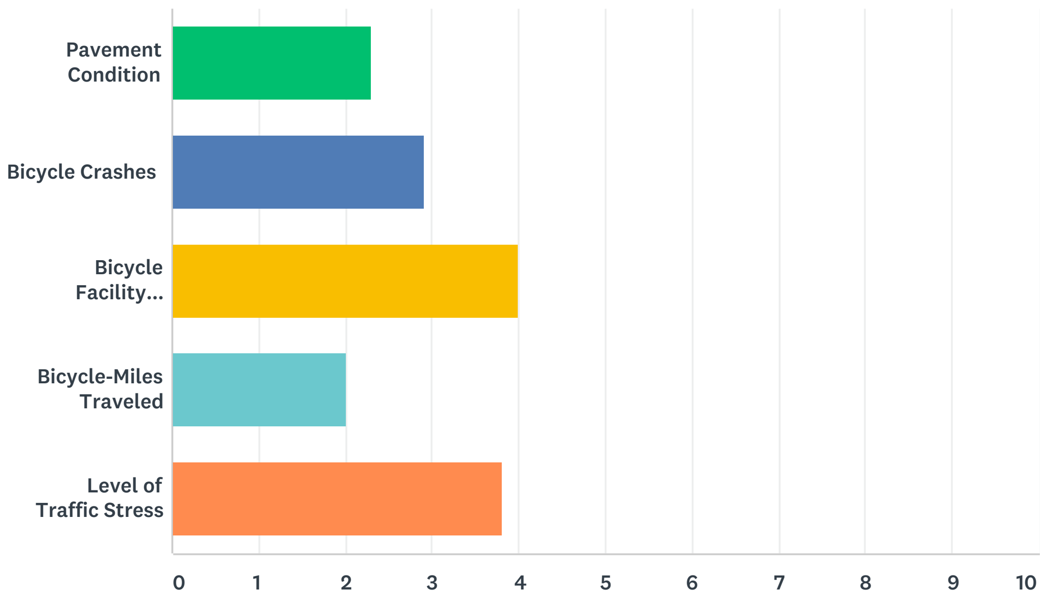
Answered: 12   Skipped: 5



	UNDERSTANDABLE AND ACCURATE	UNDERSTANDABLE BUT INACCURATE	UNCLEAR BUT ACCURATE	UNCLEAR AND INACCURATE	TOTAL
Travel Time per Person	66.67% 8	8.33% 1	8.33% 1	16.67% 2	12
Peak Period Length	66.67% 8	16.67% 2	0.00% 0	16.67% 2	12
Person Throughput	75.00% 9	8.33% 1	8.33% 1	8.33% 1	12
Funds allocated by Mode	83.33% 10	8.33% 1	0.00% 0	8.33% 1	12

Q10 Please rank each bicycle performance metric based on their significance of being incorporated into multimodal performance monitoring ? (1= highest rank, 5=lowest rank)

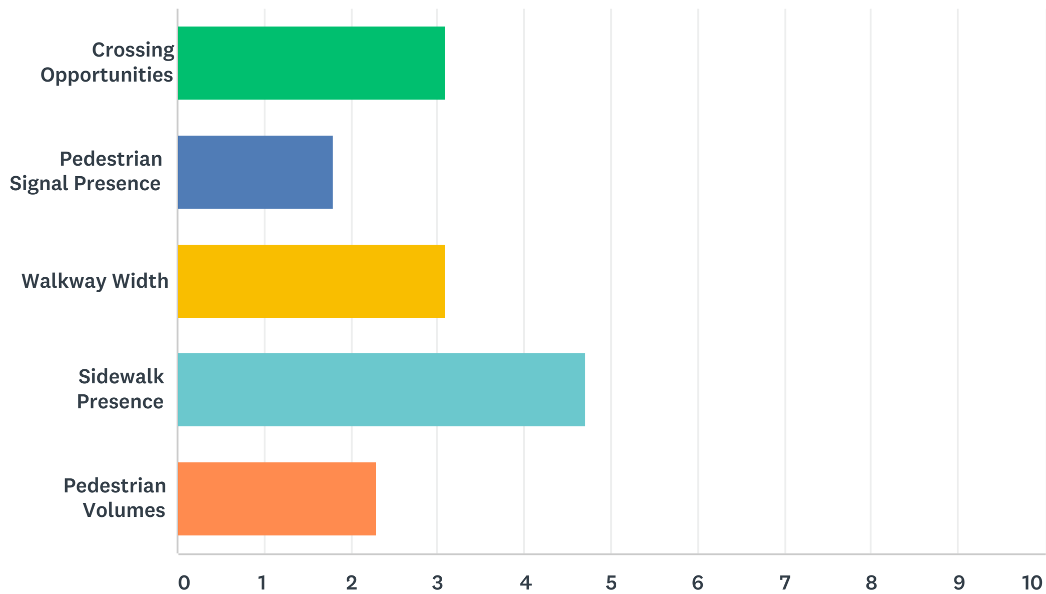
Answered: 10 Skipped: 7



	1	2	3	4	5	TOTAL	SCORE
Pavement Condition	10.00% 1	10.00% 1	10.00% 1	40.00% 4	30.00% 3	10	2.30
Bicycle Crashes	10.00% 1	20.00% 2	40.00% 4	10.00% 1	20.00% 2	10	2.90
Bicycle Facility Continuity	30.00% 3	50.00% 5	10.00% 1	10.00% 1	0.00% 0	10	4.00
Bicycle-Miles Traveled	10.00% 1	0.00% 0	10.00% 1	40.00% 4	40.00% 4	10	2.00
Level of Traffic Stress	40.00% 4	20.00% 2	30.00% 3	0.00% 0	10.00% 1	10	3.80

Q11 Please rank each pedestrian performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)

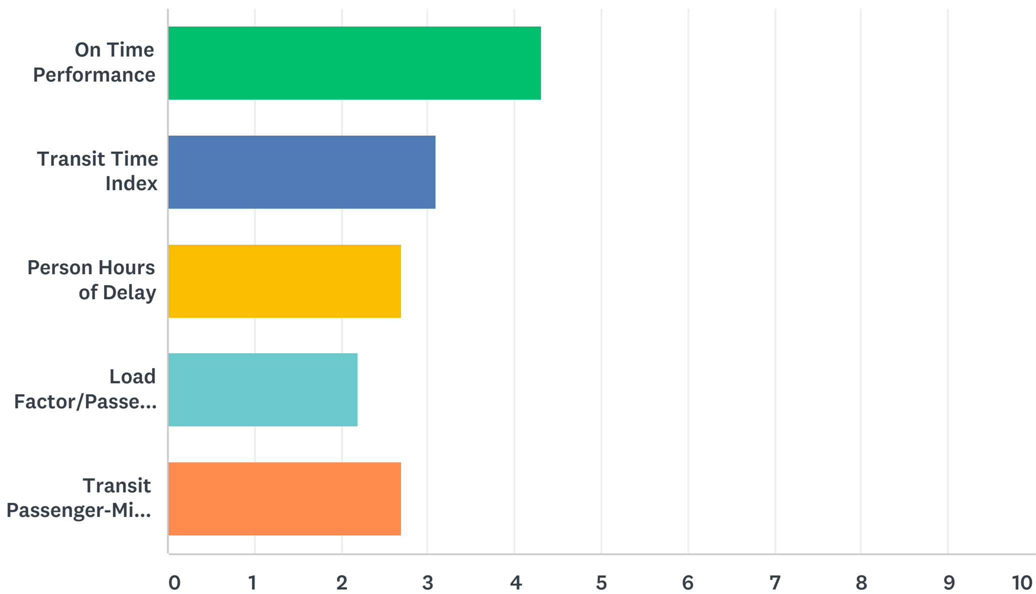
Answered: 10 Skipped: 7



	1	2	3	4	5	TOTAL	SCORE
Crossing Opportunities	10.00% 1	20.00% 2	40.00% 4	30.00% 3	0.00% 0	10	3.10
Pedestrian Signal Presence	0.00% 0	10.00% 1	10.00% 1	30.00% 3	50.00% 5	10	1.80
Walkway Width	0.00% 0	50.00% 5	20.00% 2	20.00% 2	10.00% 1	10	3.10
Sidewalk Presence	80.00% 8	10.00% 1	10.00% 1	0.00% 0	0.00% 0	10	4.70
Pedestrian Volumes	10.00% 1	10.00% 1	20.00% 2	20.00% 2	40.00% 4	10	2.30

Q12 Please rank each transit performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)

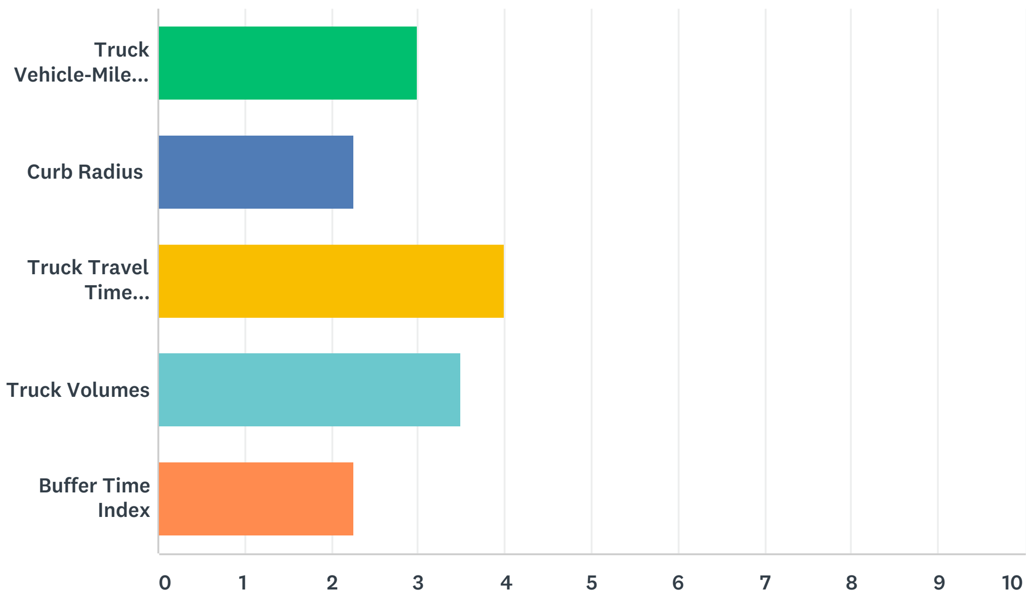
Answered: 10 Skipped: 7



	1	2	3	4	5	TOTAL	SCORE
On Time Performance	60.00% 6	20.00% 2	10.00% 1	10.00% 1	0.00% 0	10	4.30
Transit Time Index	10.00% 1	30.00% 3	40.00% 4	0.00% 0	20.00% 2	10	3.10
Person Hours of Delay	10.00% 1	20.00% 2	10.00% 1	50.00% 5	10.00% 1	10	2.70
Load Factor/Passenger Crowding	0.00% 0	10.00% 1	30.00% 3	30.00% 3	30.00% 3	10	2.20
Transit Passenger-Miles Traveled	20.00% 2	20.00% 2	10.00% 1	10.00% 1	40.00% 4	10	2.70

Q13 Please rank each truck performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)

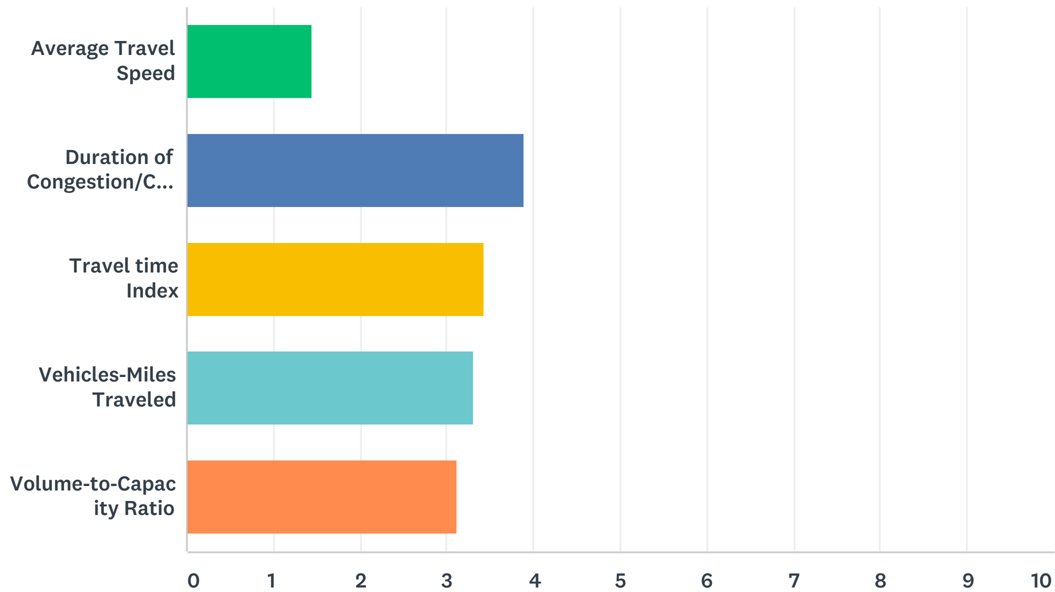
Answered: 8 Skipped: 9



	1	2	3	4	5	TOTAL	SCORE
Truck Vehicle-Miles Traveled	25.00% 2	0.00% 0	50.00% 4	0.00% 0	25.00% 2	8	3.00
Curb Radius	12.50% 1	12.50% 1	0.00% 0	37.50% 3	37.50% 3	8	2.25
Truck Travel Time Reliability Index	37.50% 3	37.50% 3	12.50% 1	12.50% 1	0.00% 0	8	4.00
Truck Volumes	25.00% 2	37.50% 3	0.00% 0	37.50% 3	0.00% 0	8	3.50
Buffer Time Index	0.00% 0	12.50% 1	37.50% 3	12.50% 1	37.50% 3	8	2.25

Q14 Please rank each vehicle performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 5=lowest rank)

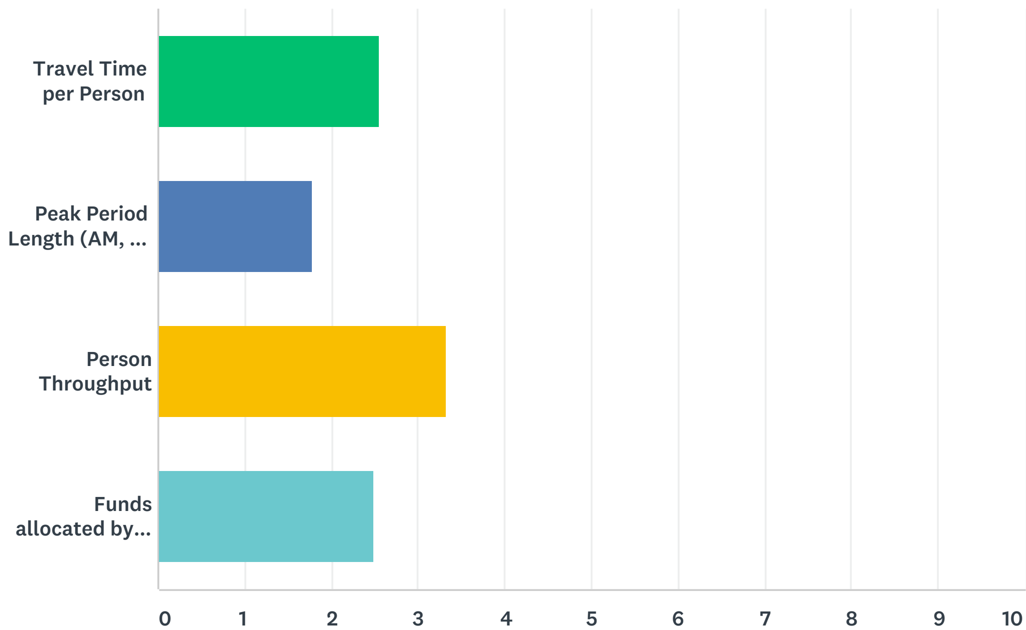
Answered: 10   Skipped: 7



	1	2	3	4	5	TOTAL	SCORE
Average Travel Speed	0.00% 0	0.00% 0	22.22% 2	0.00% 0	77.78% 7	9	1.44
Duration of Congestion/Congested Time	44.44% 4	22.22% 2	11.11% 1	22.22% 2	0.00% 0	9	3.89
Travel time Index	11.11% 1	44.44% 4	33.33% 3	0.00% 0	11.11% 1	9	3.44
Vehicles-Miles Traveled	30.00% 3	20.00% 2	10.00% 1	30.00% 3	10.00% 1	10	3.30
Volume-to-Capacity Ratio	22.22% 2	11.11% 1	22.22% 2	44.44% 4	0.00% 0	9	3.11

Q15 Please rank each multimodal performance metric based on their significance of being incorporated into multimodal performance monitoring? (1= highest rank, 3=lowest rank)

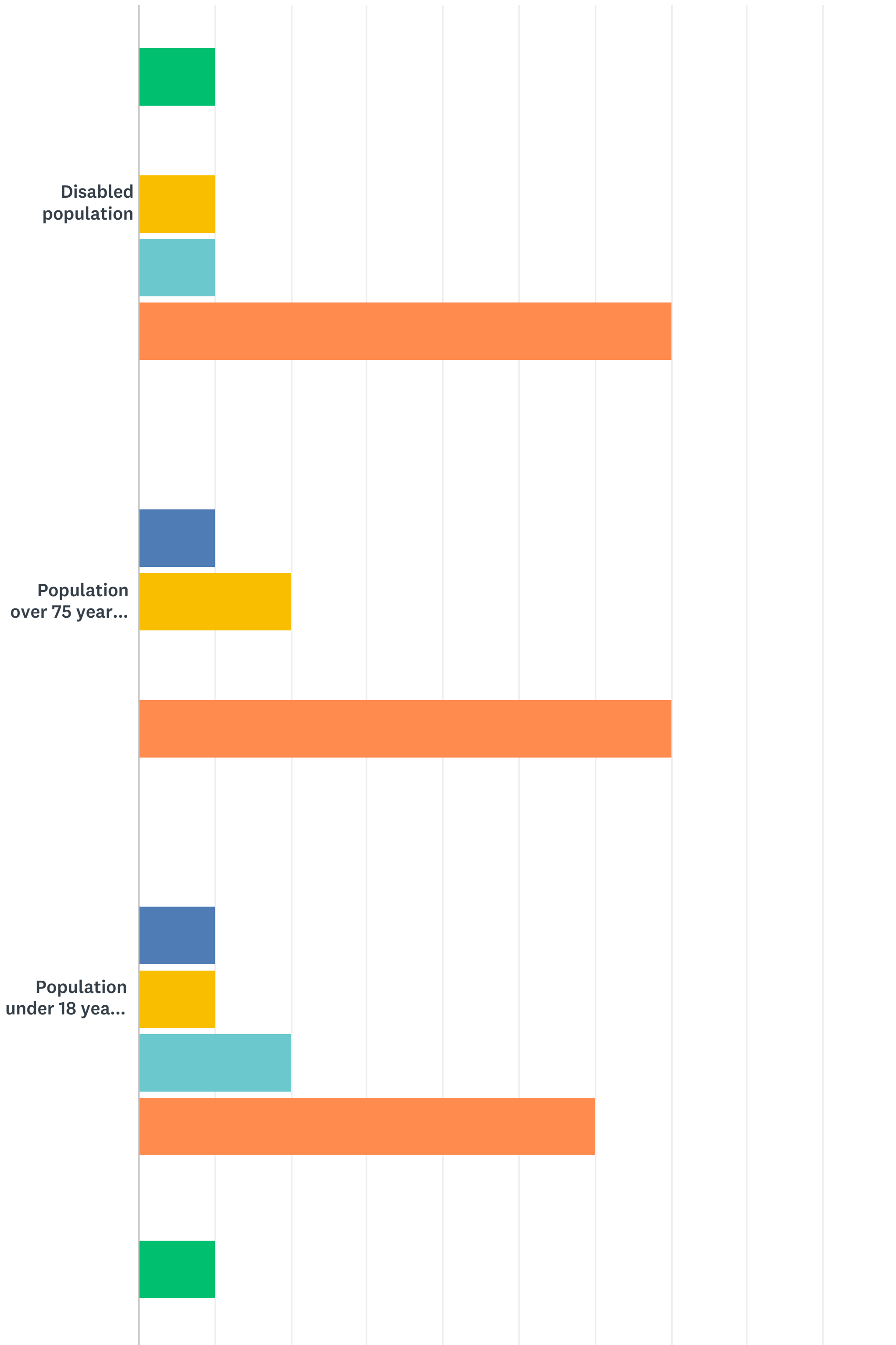
Answered: 10 Skipped: 7

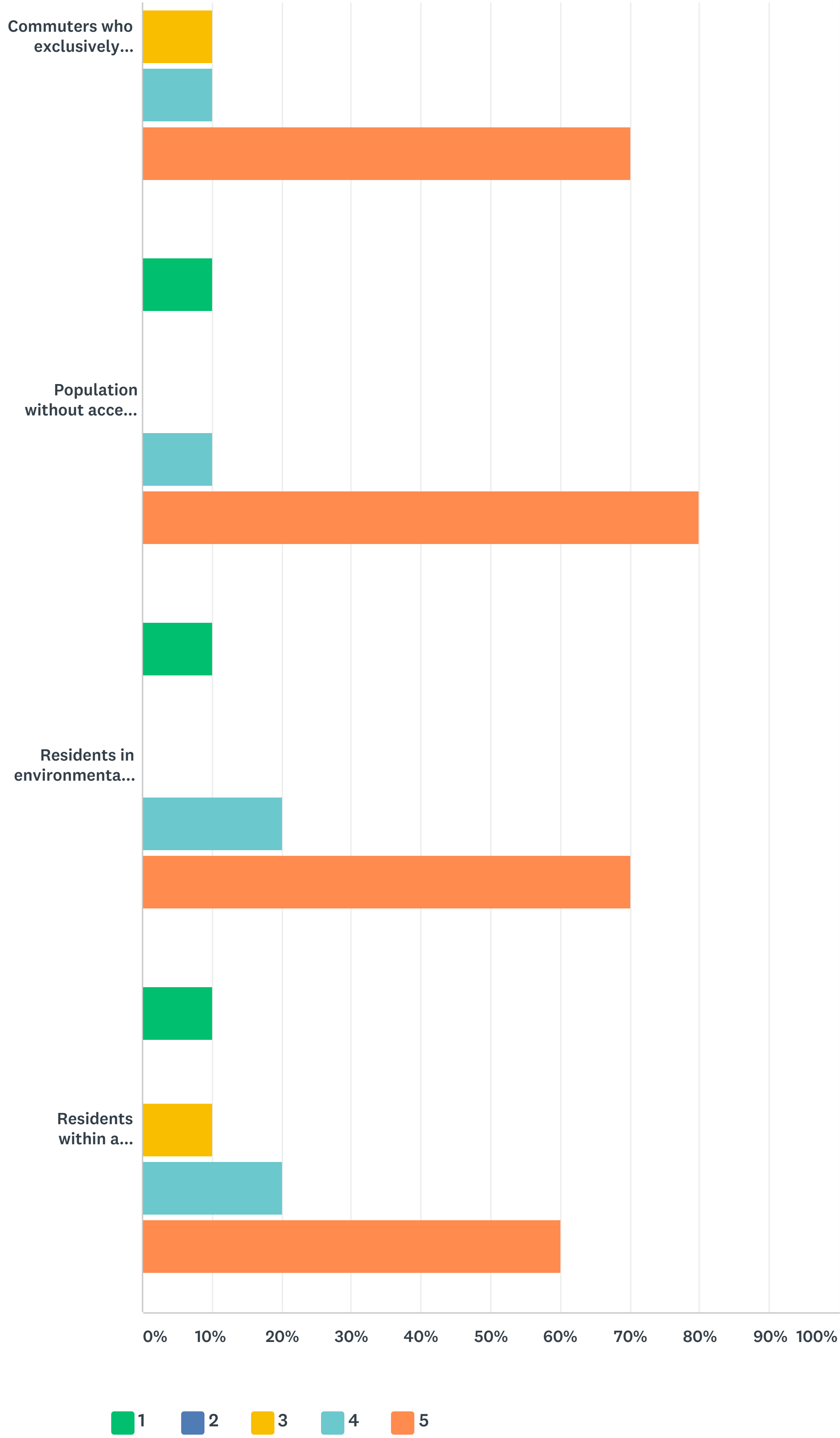


	1	2	3	4	TOTAL	SCORE
Travel Time per Person	11.11% 1	44.44% 4	33.33% 3	11.11% 1	9	2.56
Peak Period Length (AM, PM or both)	11.11% 1	11.11% 1	22.22% 2	55.56% 5	9	1.78
Person Throughput	55.56% 5	22.22% 2	22.22% 2	0.00% 0	9	3.33
Funds allocated by Mode	30.00% 3	20.00% 2	20.00% 2	30.00% 3	10	2.50

Q16 How important do you think it is to ensure good multimodal transportation in areas with the demographic characteristics listed below? Please assign a weight between one and five (1= lowest importance, 5=greatest importance)

Answered: 10 Skipped: 7





	1	2	3	4	5	TOTAL	WEIGHTED AVERAGE

Disabled population	10.00% 1	0.00% 0	10.00% 1	10.00% 1	70.00% 7	10	4.30
Population over 75 years of age	0.00% 0	10.00% 1	20.00% 2	0.00% 0	70.00% 7	10	4.30
Population under 18 years of age	0.00% 0	10.00% 1	10.00% 1	20.00% 2	60.00% 6	10	4.30
Commuters who exclusively walk, bike, or take public transit	10.00% 1	0.00% 0	10.00% 1	10.00% 1	70.00% 7	10	4.30
Population without access to vehicles	10.00% 1	0.00% 0	0.00% 0	10.00% 1	80.00% 8	10	4.50
Residents in environmental justice areas (Low income or minority)	10.00% 1	0.00% 0	0.00% 0	20.00% 2	70.00% 7	10	4.40
Residents within a quarter mile of a school or college	10.00% 1	0.00% 0	10.00% 1	20.00% 2	60.00% 6	10	4.20

Q17 Are there any performance metrics not on this list that should be added? Please elaborate.

Answered: 8 Skipped: 9

#	RESPONSES	DATE
1	maybe cost per mile for different modes.	5/7/2019 2:55 PM
2	Unclear as to why crashes are included in bicycle metrics but not in the other metrics; also, why is bicycle volume not included for bicycle metrics but it is included for pedestrians, vehicles, and freight? There does not seem to be a clear consistency between the different metrics -- comparing similar types of data. Maybe I am confused about this project -- are bicycle volumes not a "new and emerging" data set on roadway usage, but pedestrian volumes are?	5/7/2019 2:00 PM
3	I didn't see any way to measure mult-modality - or how various modes interact.	5/7/2019 1:42 PM
4	Please see soon-to-be-released MassDOT Bike and Pedestrian Final Plans - final to be released in May with updated performance measures. For details, contact colleagues: Jackie DeWolfe and Pete Sutton	5/7/2019 12:51 PM
5	N/A	5/1/2019 4:06 PM
6	I think there need to be some performance metrics about the feeling of safety provided by walking infrastructure. In certain areas, even a 5-foot sidewalk does not feel safe if it immediately abuts a high-speed roadway. The presence of trees, parking, or other barriers can help with this. This kind of "level of walking stress" should somehow be captured. It should also include a factor as to whether the sidewalk is even and/or passable for individuals with limited mobility.	4/30/2019 1:14 PM
7	Intermodal connectivity - Bike and pedestrian facilities connecting to transit stations and corridors are especially important. Even park and ride facilities could be tracked in a connectivity metric. Multimodal journeys should be explicitly tracked.	4/27/2019 9:27 AM
8	shouldn't viability of the mode during weather / seasonal variations be a consideration? If some modes are temporarily unavailable it will impact other modes. The need for storage of transportation modes (parking, bike racks) within the available space should be a factor.	4/23/2019 4:31 PM

Q18 Are there any performance metrics definitions that you would change? Please elaborate.

Answered: 7 Skipped: 10

#	RESPONSES	DATE
1	no - this looks very well thought out	5/7/2019 2:55 PM
2	The first bicycle metric about pavement condition was too technical. Couldn't understand what was meant by "at least 95 inches per mile" on the IRI. Needs more clarification. For the multimodal metrics, the first one about travel time per person doesn't make sense to take the travel time regardless of mode. Pedestrians travel much slower than other modes -- that would skew the data. Even bicycles may be slower than other modes in most conditions, except where vehicle travel is already substantially congested. Finally, the funds spent per mode needs to be pegged to the percent of travel by mode. Often we overspend on infrastructure for private automobiles and underspend for other modes, especially biking and walking. Having percentage of spending next to modal splits would give a better idea of how to allocate resources.	5/7/2019 2:00 PM
3	Crossing opportunities per miles should measure skew - 5 crossings within a quarter mile with 3/4 of a mile without should not equal a full mile with 5 crossings equally spaced.	5/7/2019 1:42 PM
4	N/A	5/1/2019 4:06 PM
5	Cars operating at a high speed is almost always in direct conflict with the safety of other modes. Including this as a positive metric is disadvantageous to other modes.	4/30/2019 1:14 PM
6	Duration of Congested Time – its not clear how peak period will be defined. It seems like this will have a huge impact on this metric. Even within peak periods, congestion levels vary. I wonder if this measure could instead be something like Percent of 2-hour Peak Congested. Ped Signal Presence – Not only should there be LPIs but for concurrent signals it is important that vehicle and pedestrian signals have the same duration – many ped signals are shorter than vehicle signals. Additionally, the metric should consider whether ped signal cycles are on automatic recall or require button activation.	4/27/2019 9:27 AM
7	I'm not sure how you'd be able to separate funding by mode. When you rehab a street it would normally benefit buses, trucks, passenger vehicles, bicyclists and pedestrians. How much of those costs would be allocated to each mode?	4/23/2019 4:31 PM

Q19 Please provide any feedback you would like to share regarding the multimodal performance metrics. Feel free to elaborate on any of the survey questions above.

Answered: 3 Skipped: 14

#	RESPONSES	DATE
1	N/A	5/1/2019 4:06 PM
2	Funding is incredibly important. I was happy to see this.	4/30/2019 1:14 PM
3	Bike-miles Traveled – do you have a TDM that assigns bike trips? Is it even remotely accurate? Crossing Opps / Mi – Its quite unclear how intersections and non-intersection crosswalks will be considered? If this is a segment level metric will intersection crosswalks be assigned to the leg they are associated with? Bike - Pavement Condition – why use HPMS? Many NHS facilities prohibit bike travel? How will mixed-use paths, etc., be captured? Bike Facility Continuity – how will adjacent on-road and mixed-use paths be considered? It is reasonable to measure this at a segment level, or is this only appropriate at corridor and network levels? A bike lane that continues for 3 miles but then dumps the rider into a deadly roundabout is not continuous… Curb Radius – is should be clear what the standard is for this measure at different locations. Presumably not the entire network requires super wide turns. Travel time per Person – it should be made clear how modes will we weighted together to produce an aggregate travel time. Will only the fastest TT be used in which case this will just be an auto measure usually? Will modes be given equal weight? Will mode shares be used? How useful is this measure at a segment level? It seems its most useful at an O-D pair level since the best transit route might be on a parallel facility. Peak Period Length – How is peak defined? Why do we care? Is the goal to narrow peaks or spread peaks? Narrow peaks cause need for more service/infrastructure to serve peaks which is underutilized the rest of the day.	4/27/2019 9:27 AM