A

AADT. See average annual daily traffic

AASHTO. See American Association of State Highway and Transportation Officials

AASHTO Highway Safety Design and Operations Guide, 385

acceleration/deceleration delay, 100 on freeways, 191

accelerometers, 407–408, 407f
advisory speed and, 409t, 412
for bicycles, 242
centerline markings and, 139
definition of, 9
for pedestrians, 242

accepted gap, 110–112
definition of, 9
Ramsey and Routledge method and, 111t

accepted lag, 9, 110

access, 463–483
classification for, 435t

accessibility
for bicycles, 252
definition of, 9
for pedestrians, 238, 252
for public transportation, 270

Accessibility Community Transportation in our Nation (ACTION), 264

accident modification factor (AMF), 9, 375–378

accumulation studies, of parking, 330–332, 332f

acknowledgments, on written reports, 551

ACTION. See Accessibility Community Transportation in our Nation

ADA. See Americans with Disabilities Act

ADT. See average daily traffic

advanced traffic management (ATM), 9, 179

advisory speed, 406–412
accelerometers and, 409t, 412
ball-bank indicator and, 409t, 411–412, 411t
data reduction and analysis for, 409–412
definition of, 9
design equation method for, 410, 410t
design speed and, 406
samples for, 408

aerial surveys
for density, 187
for TTD, 172

air cargo, 293

air quality, 457–460
nonattainment area and, 457
reports on, 460, 460f
standards for, 458t

algorithms, 205
for CF, 10, 202
definition of, 9
DTA, 211
for gap acceptance, 13, 222
for lane-changing, 15, 225
for microscopic model, 202
NGSIM, 204, 204f
for operating speed, 227
optimization, 16
for simulation, 19, 205, 218

alleys, 419

all-vehicle sampling
for spot speed, 86–88
spot speed and, 136–137

American Association of State Highway and Transportation Officials (AASHTO), 9, 385

collisions and, 348
freeways and, 178
ISD and, 112, 115
TCD and, 144

American National Standard Practice for Roadway Lighting, 415

Americans with Disabilities Act (ADA), 128, 385

AMF. See accident modification factor

analogy, 475

ANOVA. See one-way analysis of variance

APC. See automatic passenger counting

appendix, in written reports, 552

approaches
collisions at, 369
delay at, 222
definition of, 9
delay at, 210
to intersections, 28, 210, 488
left-turn signals at, 355
of minor street, 125
roundabouts and, 46
speed at, 79, 98, 115, 401
video at, 65
volume at, 44, 47, 146t

approach sight triangle, 113

appropriate knowledge, principle of, 26

area
chart, 544, 544f
classifications, 419–420
counts, 49–57
transportation plan, 477–478

arithmetic mean, 523–524

Arizona Freight Network Analysis Decision Support System, 295, 296f

arrival volumes, intersection counts and, 45, 45f
ATM. See advanced traffic management

ATR. See automatic traffic recorder

attainment area

Clean Air Act and, 9
definition of, 9
EPA and, 9

automatic counts

for bicycles, 242–245
data reduction for, 68
for flow, 183
freeways and, 195f
for pedestrians, 242–245
periods for, 69
for public transportation, 281–283
for test vehicles, 165
for TTD, 161, 165
for volume data collection, 62–66

automatic passenger counting (APC), 272, 281
ITS and, 281

automatic traffic recorder (ATR), 192

automatic vehicle identification (AVI), 173

automatic vehicle location (AVL), 281–282
GPS and, 281
ITS and, 281
travel time variability from, 282f
visualization with, 282f

pavement markings. See also centerline markings
compliance with, 144
at crosswalks, 388
retroreflectivity of, 139–140, 139t
retroreflectometer for, 139f

average, 522
mobility, 197
for spot speeds, 523f

average annual daily traffic (AADT), 49, 57, 192
collisions and, 355
definition of, 9

Average-Car Technique, 161

average daily traffic (ADT)
control counts and, 55–56
cordon count and, 50
definition of, 9
volume and, 119

average day, 474
definition of, 9
eight-hour vehicular volume warrant and, 124
four-hour vehicular volume warrant and, 125
peak hour warrant and, 127

AVL. See automatic vehicle identification

AVL. See automatic vehicle location

axle counts, 68

B

ball-bank indicator, 407–408, 407f
advisory speed and, 409t, 411–412, 411t
centerline markings and, 139
definition of, 9

bar graphs, 27t
grouped, 28, 28f
stacked, 29, 29f
for volume counts, 71f

beacon, 10

before-and-after test, 92, 93t
analysis for, 492
for bicycles, 255
comparison in, 494
with controls, 492–494, 493f
drawbacks to, 489–490
in experiments, 489–494
history in, 489, 491
for lighting, 415
maturation in, 489, 491
overcoming drawbacks, 490–492
for pedestrians, 255
for TCD, 136
units in, 489, 493
warm up period in, 491

benefit-cost ratio
for countermeasures, 374t, 377–379, 378t
definition of, 10

for lighting, 425–426, 425t
biased responses, in surveys, 513
bibliography, in written reports, 552
bicycles, 237–259
accelerometers for, 242
accessibility for, 252
automatic counts for, 242–245
before-and-after test for, 255
classification for, 419
compliance and, 252
conflict and, 251–252
data collection for, 253–256
definition of, 10
GPS for, 242
handheld count boards for, 239
HCM and, 240
intersection counts and, 46
laptop computers for, 239
LOS and, 240
manual counts for, 238–242
map for, 259f
MOE for, 253–254
networks and, 252–253
TCD and, 252
time-lapse photography for, 242
time paths and, 252
visualization for, 258
volume and, 238–245

bicycle lane
definition of, 10
QOS and, 253

bikeability checklists, 252
bikeways, 419
bins, for gaps, 110
blanket method, 139
block and curb face numbering system, for parking, 326f
block designs, 496

A Blueprint for NEPA Document Content (NCHRP), 452
bottlenecks, graphs for, 32
BRT. See bus rapid transit

buffer index, 197
build-up, 477
Bureau of Census, 450, 508t
bus rapid transit (BRT)
definition of, 10
public transportation and, 264

C
CAD. See computer-aided design
calibration, 205
definition of, 10
of inputs, 223–227
for lasers, 85
for radar, 85
from screen-line counts, 54
for SLM, 455
for spot speed, 88
with video-base counts, 65
capacity, 479–480
definition of, 10
capacity limitations, principle of, 27
carbon dioxide (CO₂), 457
car-following (CF), 225–226
algorithm for, 10, 202
definition of, 10
sensitivity analysis and, 206
Carload Rail Waybill Sample, 294t
causal chain
for collisions, 356, 357, 372
definition of, 10
CBD. See central business district
cellular phone observation method
probe vehicle and, 174
for TTD, 172
centerline markings
accelerometers and, 139
ball-bank indicator and, 139
definition of, 10
middle ordinate and, 15
raised reflective pavement marker and, 139
sensors and, 66
central business district (CBD)
definition of, 10
parking for, 325
truck and, 300
TTD and, 161
central tendency, 522–526
CF. See car-following
CFCs. See chlorofluorocarbons
CFS. See Commodity Flow Survey
charts, 27t
area, 544, 544f
flow diagrams, 548, 548f
high-low graphs, 543, 544f
organization, 547, 547f
pictograms, 545, 545f
project, 549, 549f
statistical maps, 546, 546f
types of, 543–549
checkers
data collection and, 264, 272
definition of, 10
license-plate matching by, 334
for public transportation, 280
surveys by, 284
checklists
bikeability, 252
for graphics, 550
for presentations, 558–559
questions, 506
for transportation studies, 6t
walkability, 252
chlorofluorocarbons (CFCs), 457
chord
for curve radii, 408–410
definition of, 10
CI. See confidence interval
classifications
area, 419–420
for areas, 419–420
for bicycles, 419
counts, 54
definition of, 10
of inventories, 316
of mobility and access, 435t
for pedestrians, 419
for road surfaces, 418t
of streets, 312f, 418f, 419, 435, 436f
of vehicles, 185–186, 185f
Clean Air Act
attainment area and, 9
construction impacts from, 459
clearance interval
compliance with, 151
definition of, 10
clearance lost time, 105, 109
clear sight triangles, 113
clipart, 27t
closed questions, 506
cluster sampling, 506–504
CO₂. See carbon dioxide
coding and reduction errors, 513
coefficient of variation (CV), 400, 401
collectors, 419
collisions, 119, 347–379
AADT and, 355
AASHTO and, 348
at approaches, 369
causal chain for, 356, 357, 372
causes of, 357
countermeasures for, 369–379
data analysis for, 357–379
data collection for, 348–357
data reduction for, 354–355
EB and, 368
engineering judgment and, 355, 365, 426
erroneous data for, 356–357
frequencies of, 359
involvements and, 358
lighting and, 420–423
maps and, 354
ML and, 191
N/D for, 424–425
network screening for, 359–369
night percentage for, 424
numbers and trends with, 358
person injury in, 351–352
random nature of, 356
rates of, 359–360
RQC and, 364
spot maps for, 359
SWP and, 365–368, 366t, 367t
types of, 351, 351t
unreported, 356
volume and, 354
collision diagrams, 369–371, 370f
definition of, 10
TCD and, 137
collision rate for section (RSEC), 359–360
collision rate for spot (RSP), 360
collision rates, 119
collision reports, 348–352, 349f–350f
definition of, 10
lighting and, 421
RSA and, 384
TCD and, 144
collisions
road surfaces and, 370
SPF and, 368
collision severity
definition of, 15
EPDO and, 360–362
KABCO and, 15
lighting and, 420
RSI and, 362–363
warrants for, 131
color, in graphics, 549–550
commercial area, 419
Commodity Flow Survey (CFS), 294t, 297
communication
with graphics, 25–34
presentations for, 37–41
to public, 23–41
with written reports, 34–37
comparison
in before-and-after test, 494
in experiments, 487–488
history and, 494
maturation and, 494
regression to the mean and, 494
units and, 494
compatibility, principle of, 27
compliance. See also TCD
compliance
bicycles and, 252
with clearance interval, 151
with crosswalks, 252
definition of, 10
freeways and, 186–187
with HOV lane, 186
with no-left-turn, 150, 150f
with pavement marking, 144
pedestrians and, 144, 154–155, 154f, 252
with RTOR, 152–153, 152f
with school crossings, 144
with STOP signs, 149, 149f, 155–156
with TCD, 143–156, 146t, 186–187
with traffic signals, 151, 151f
composition
of graphics, 541–542
of vehicle types, 219
computer-aided design (CAD), 540
definition of, 10
for signs, 315f
concurrent flow HOV lane, 10, 180
condition diagrams, 119, 371–372, 371f
definition of, 11
for intersections, 313f
confidence interval (CI), 147, 376, 529
confidence level, 364, 399t, 486
definition of, 11
speed and, 83, 83t
for spot speed, 92, 92t
with TCD compliance, 148t, 155
conflict. See also traffic conflicts
bicycles and, 251–252
definition of, 11
at intersections, 391f–394f
multiple threat and, 252
pedestrians and, 251–252
vehicles and, 251–252
congestion
graphs for, 32
HOV lane and, 179
parking and, 325, 331
percent of, 197
queues and, 189
safety and, 191
steady-state and, 212
with trucking, 292
content-driven communication, 25–26
continuous flow intersections, 49
contraflow lane, 180
counts, before-and-after test with, 492–494, 493f
count controls, 54–57, 243
AADT and, 57
ADT and, 55–56
daily factors in, 55–56, 56t
DDHV and, 57
definition of, 11
growth factors and, 55
peak hour and, 57
samples and, 69
seasonal factors in, 55–56, 56t
copyright notice, on written reports, 551
cordon count, 50–53
accumulation computations for, 53t
ADT and, 50
definition of, 11
example of, 53f
O-D and, 50
summary sheet for, 51f–52f
cordon line, 431, 438, 449
cosine error
  definition of, 11
  for lasers, 80, 81t
  for radar, 80, 81f, 81t
cost-effectiveness. See benefit-cost ratio
counts. See specific count types
count boards. See handheld count boards
countermeasures
  benefit-cost ratio for, 374t, 377–379, 378t
  for collisions, 369–379
definition of, 11
evaluation of, 379
count expansion, 70t, 238
definition of, 11
samples and, 69
coverage counts
  AADT and, 57
  definition of, 11
  samples and, 69
crash, 119. See also collisions
  definition of, 11
  warrants for, 131
crash frequency
  definition of, 11
  SPF and, 18, 368
crash rate, 364
  definition of, 11
elderly and, 348
  nonmotorized, 237
  regional, 355
crash reduction factor (CRF), 11, 375–376
crash severity, 11, 360
CRF. See crash reduction factor
crime
  data collection and, 8
  lighting and, 426
critical gap, 247–249
  definition of, 11
  estimation of, 111–112
  gap acceptance and, 226
  for pedestrians, 247, 249
crosswalks
  compliance with, 252
  definition of, 12
  pavement marking at, 388
  pedestrians and, 239f
  QOS and, 253
  unsignalized intersections and, 252
  volume and, 238
cumulative frequency diagrams, 519–520
cumulative frequency distribution, 518
  of spot speeds, 520t
curb parking, 326–327
  map for, 328f
current Industrial Reports, 297
curve radii, 190, 406
  chord for, 408–410
  middle ordinate for, 408–410
CV. See coefficient of variation
cycle length
  definition of, 12
  for signalized intersections, 44
  simulation and, 202
  TTD and, 99
crosswalks
  compliance with, 252
  definition of, 12
  pavement marking at, 388
  pedestrians and, 239f
  QOS and, 253
  unsignalized intersections and, 252
  volume and, 238
cumulative frequency diagrams, 519–520
cumulative frequency distribution, 518
  of spot speeds, 520t
curb parking, 326–327
  map for, 328f
Current Industrial Reports, 297
curve radii, 190, 406
  chord for, 408–410
  middle ordinate for, 408–410
CV. See coefficient of variation
cycle length
  definition of, 12
  for signalized intersections, 44
  simulation and, 202
  TTD and, 99
crosswalks
  compliance with, 252
  definition of, 12
  pavement marking at, 388
  pedestrians and, 239f
  QOS and, 253
  unsignalized intersections and, 252
  volume and, 238
cumulative frequency diagrams, 519–520
cumulative frequency distribution, 518
  of spot speeds, 520t
curb parking, 326–327
  map for, 328f
Current Industrial Reports, 297
curve radii, 190, 406
  chord for, 408–410
  middle ordinate for, 408–410
CV. See coefficient of variation
cycle length
  definition of, 12
  for signalized intersections, 44
  simulation and, 202
  TTD and, 99
crosswalks
  compliance with, 252
  definition of, 12
  pavement marking at, 388
  pedestrians and, 239f
  QOS and, 253
  unsignalized intersections and, 252
  volume and, 238
cumulative frequency diagrams, 519–520
cumulative frequency distribution, 518
  of spot speeds, 520t
curb parking, 326–327
  map for, 328f
Current Industrial Reports, 297
curve radii, 190, 406
  chord for, 408–410
  middle ordinate for, 408–410
CV. See coefficient of variation
cycle length
  definition of, 12
  for signalized intersections, 44
  simulation and, 202
  TTD and, 99
D
daily factors, in control counts, 55–56, 56t
data collection
  for bicycles, 253–256
  checkers and, 264, 272
  for collisions, 348–357
  crime and, 8
  forms, 564
  for freeways, 191–195
  individual vehicle selection method for, 79–84
  for inventories, 318–320
  for lighting, 415–424
  for multi-use paths, 241f
  for parking, 332–339
  for pedestrians, 253–256
  pitfalls of, 8
  point data, 221–222
  for public transportation, 272–285, 273f
for RSA, 385–388
  safety with, 7–8
  segments, 222
  for simulation, 218–228
  for spot speed, 84–89
  for surveys, 500–501
  for TCD compliance, 146–155
  with test vehicles, 161–165
  for traffic conflicts, 394–405
  training for, 5
  for transportation planning, 438–448
  for transportation studies, 4
  for TTD, 161–165
  for volumes, 58–66
data display types and purposes, 27t
data mining, 12, 40
data reduction, 516–522
  for advisory speed, 409–412
  for automatic counts, 68
  for collisions, 354–355
  for freeways, 195–198
  for lighting, 424–426
  from manual counts, 67
  for parking, 339–340
  from peak hour, 67t, 68f
  for RSA, 388–389
  for simulation, 229–233
  for spot speed, 88–93, 89t
  for traffic conflicts, 405–406
  for transportation planning, 448–450
  for TTD, 165–166
dB. See decibels
DDHV. See directional design hourly volume
decibels (dB), 452–453
default parameters and distributions, 205
delay. See also specific delay types
  at approaches, 210
  definition of, 12
  intersections and, 98–104
  pedestrians and, 249
  public transportation and, 279f
  TCD and, 123
delay per person, 197
delineator, 12, 370, 374t
  definition of, 12
demand
  definition of, 12
  traffic, 219
  transportation, 463, 481
  volumes, 223–224
density. See also speed-flow-density
aerial surveys for, 187
  definition of, 12
  detector occupancy and, 187
  on freeways, 187, 188f
  LOS and, 187, 188f
  occupancy and, 187
  UAVs for, 187
Department of Motor Vehicles (DMV), 353
departure sight triangle, 113
  STOP signs and, 114
departure volumes, intersection counts and, 45, 45f
descriptive statistics, 522–528
  population and, 522
  samples and, 522
  for spot speed, 91–92
design
  of experiments, 485–496
  factorial, 494–496
  of graphics, 25–34, 540–550
  for interchanges, 203
  principles of, 26
  of surveys, 499–514
  of tables, 542–543
design equation method
  advisory speed and, 410, 410t
  design speed and, 410
design speed
  advisory speed and, 406
  definition of, 12
  design equation method and, 410
  on freeways, 178
  stopping sight distances and, 114t
  YIELD signs and, 114
Desktop Reference for Crash Reduction Factors (FHWA), 375
detector occupancy, 184
  density and, 187
deterministic, 205
diagrams, 27t
  collision, 10, 137, 369–371, 370f
  condition, 11, 119, 313f, 371–372, 371f
  cumulative frequency, 519–520
  flow, 71, 72f, 548, 548f
  frequency, 519
  for intersection flow, 71, 72f
  site, 372, 372t
dilemma zone
  definition of, 12
  lighting and, 370
directional design hourly volume (DDHV)
  control counts and, 57
  definition of, 12
direct measurements, of speed, 79
disclaimers, on written reports, 551
discriminability, principle of, 26
distance measuring instrument (DMI), 12, 162, 165
distribution
  cumulative frequency distribution, 518, 520t
  default, 205
  definition of, 12
  frequency distribution table, 90t, 517–520, 517t
  Poisson-distribution, 491, 492, 492f
  relative frequency distribution, 518
  spatial, 521–522, 522f
  speed, 121, 219
  temporal, 453
  time series, 520, 521t
  trip distribution, 475–476, 475f, 476f
diverging diamond interchanges, 49
  DMI. See distance measuring instrument
DMV. See Department of Motor Vehicles
Domestic Waterborne Commerce, 294t
Doppler effect
  definition of, 12
  laser and, 79–82
  radar and, 79–82
double-barrel questions, 507
double negatives, 507
driver behavior, 273
  ITS and, 223
  RSA and, 384
  simulation and, 210–212, 225–227
  driveways, intersections and, 97–115
DTA. See dynamic traffic assignment
dwelling-unit interviews, 447
dynamic traffic assignment (DTA) algorithm, 211
  definition of, 13
  simulation and, 211
E
EADT. See estimated average daily traffic
Easter Seals Project ACTION, 264
EB. See Empirical Bayes
  edge line markings, 13, 372t
  eight-hour vehicular volume warrant, 124–125, 125t
EIR. See environmental impact report
EIS. See environmental impact statement
elderly, crash rate and, 348
emergency scenario models, simulation and, 212–214, 213f
emissions, 459
  from RR, 292
  from trucks, 292
  from vehicles, 217–218, 217f
Empirical Bayes (EB), 359
  collisions and, 368
  HSM and, 368
engineering judgment
- collisions and, 355, 365, 426
- definition of, 13
- growth factors and, 55
- STOP signs and, 132
- warrants and, 21, 123
- YIELD signs and, 133

engineering plans, 32–34, 33f

engineering study
- definition of, 13
- speed limit sign warrants and, 134
- statistical analysis and, 515
- TCD and, 135
- written reports and, 513–554

environment, 451–460
- simulation and, 217–218, 217f

environmental impact report (EIR), 464

environmental impact statement (EIS), 452, 464

Environmental Protection Agency (EPA), 9, 16, 459
- attainment area and, 9
- EPA. See Environmental Protection Agency
- EPDO. See equivalent property damage only
- equivalent property damage only (EPDO)
  - collision severity and, 360–362
  - definition of, 13

ERC. See evacuation response curve

estimated average daily traffic (EADT), 119

estimation, in inferential statistics, 528–529

ET. See express toll lane

evacuation
- freeways and, 190
- simulation and, 212–214

evacuation demand zones, 213

evacuation response curve (ERC), 13, 213, 214f

Evaluating Intersection Improvements: An Engineering Study Guide (NCHRP), 208

Excel, 536

executive summary, in written reports, 552

experiments
- before-and-after test in, 489–494
- comparison in, 487–488
- design of, 485–496
- inferential statistics with, 486–487
- paired comparison in, 488, 488t
- random assignment in, 487
- unpaired comparisons in, 487

expert sampling, 504–505

express toll lane (ET), 177
- definition of, 13
- ML and, 179–180

expressways, 419

extrapolation method, for TTD, 172

F

FABCO, 351–352

factorial design, 494–496
- ANOVA and, 494–495, 495t
- means test for, 495t
- random assignment in, 496, 496t

factors, 486

FAF. See Freight Analysis Framework

FARS. See Fatality Analysis Reporting System

Fatality Analysis Reporting System (FARS), 353

Federal Highway Administration (FHWA), 13, 143, 192, 204, 205t, 353, 375, 384, 456
- on freeway work zones, 190
- noise and, 453
- shared-use path and, 253

Federal Motor Carrier Safety Administration (FMCSA), 353

Federal Transit Administration (FTA), 13

FFS. See free-flow speed

FHWA. See Federal Highway Administration

field reviews, 388

figures, in written reports, 552

flashing, 13, 492, 520

Floating-Car Technique, 161

flow
- automatic counts for, 183
- definition of, 13
- freeways and, 182–183
- HCM and, 182
- speed and, 183
- vph and, 182

flow diagrams, 548, 548f
- for intersections, 71, 72f

flow rate. See also saturation flow rate
- definition of, 13
- peak hour and, 57

FMCSA. See Federal Motor Carrier Safety Administration

focal points, in graphics, 540–542, 541f

footways, 419

forced stop, 149

Foreign Waterborne Commerce, 294t

foreword, on written reports, 551

4D visualization, 24, 39–40, 40f

four-hour vehicular volume warrant, 125–127, 126t

fractional factorials, 496, 497t

frames, 501–502

time

free-flow speed (FFS), 99

ISD and, 112

TTD and, 104

freeways, 177–198, 178f, 419

AASHTO and, 178

acceleration/deceleration delay on, 191

automatic counts and, 195f

compliance and, 186–187
control points on, 161
data collection for, 191–195
data reduction and analysis for, 195–198
definition of, 13
density on, 187, 188f
design speed on, 178
evacuation and, 190
flow and, 182–183
gaps and, 186
GP on, 178
HCM and, 178, 184f
headway and, 186
incidents and, 184–185
performance measures for, 198t
queues and, 189
queue length on, 189
safety and, 190
segment studies for, 187–190, 195–196
SMS and, 183
speed-flow-density on, 184f, 191
sporadic studies for, 195–196
system monitoring for, 197
TTD on, 188–189
vehicles on, 185–186, 185f
work zones on, 190
Freight Analysis Framework (FAF), 294t
frequency, of noise, 453
frequency diagrams, 519
frequency distribution table, 517–520, 517t
for spot speed, 90t
FTA. See Federal Transit Administration
full stop, 149

g

gaps, 109–112. See also accepted gap
bins for, 110
definition of, 13
field procedures for, 110
freeways and, 186
handheld count boards for, 123
in-road sensors for, 186
measurement of, 249–250
pedestrians and, 246–250, 248f
percentile and, 110
rejected, 17
school crossings and, 128–129, 130t
TCD and, 123
time, 114–115
unsignalized intersections and, 123
gap acceptance, 109–112, 226–227. See also accepted gap
algorithm for, 13, 222
critical gap and, 226
data analysis for, 111t–112t
definition of, 13
field procedures for, 110–111
General Estimates System (GES), 353
general purpose lanes (GP)
concurrent flow HOV lane and, 10
definition of, 13
on freeways, 178
HOV and, 179
HOV lane and, 180
generation studies, of parking, 330–332
geographical information system (GIS), 40, 174
definition of, 13
spatial distribution and, 522
geometric delay, 98
definition of, 12
field procedures for, 102–103
GES. See General Estimates System
GHG. See greenhouse gases
GIS. See geographical information system
global calibration, 223
global positioning system (GPS)
AVL and, 281
for bicycles, 242
definition of, 14
for pedestrians, 242
probe vehicle and, 174
for test vehicles, 161–162
for TTD, 161–162
glossary, in written reports, 552
goods movement, 291–305
data sets, 294t–295t
urban problems with, 299t
GP. See general purpose lanes
GPS. See global positioning system
Graeco-Latin square, 496
graphical display of data, 24
graphics
checklists for, 550
communication with, 25–34
composition of, 541–542
design of, 25–34, 540–550
focal points in, 540–542, 541f
visual weight in, 541f
graphs, 27t, 31f, 32f, 516
bar, 27t, 28, 28f, 29, 29f, 71f
line, 27t, 30–31, 30f
pie, 27t, 29, 29f
step, 27t
gravity models, 475
Green Book. See Policy on Geometric Design of Highways and Streets
greenhouse gases (GHG), 457
ground-based radio navigation, 173
grouped bar graph, 28, 28f
growth factors, 477–478
control counts and, 55
engineering judgment and, 55
Guidance for Implementation of the AASHTO Strategic Safety Plan (NCHRP), 375
guide signs, 118, 134–135
definition of, 14

H

handheld count boards, 59–60
for bicycles, 239
for gaps, 110, 123
for pedestrians, 239
for TCD compliance, 146
handheld speed measurement devices, 80f
hardware-in-the-loop (HIL), 224
hazardous materials, 292, 304–305, 304t
HCM. See Highway Capacity Manual
headways, 109
definition of, 14
freeways and, 186
in-road sensors for, 186
heavy vehicles, 185–186
HFCs. See hydrofluorocarbons
high-low graphs, 543, 544f
high occupancy and toll facility (HOT), 177
definition of, 14, 15
HOV and, 180
ML and, 179–180
high occupancy vehicle (HOV), 177. See also HOV lane
definition of, 10, 14, 15
excess capacity and, 180f
GP and, 179
HOT and, 180
ML and, 179–180
person occupancy of, 187
Highway Capacity Manual (HCM), 13, 32, 57, 385, 464
bicycles and, 240
calibration of inputs, 223–227
control delay and, 98, 100
drive and, 182
freeways and, 178, 184f
“Intersection Control Delay Worksheet” from, 100, 101f
LOS and, 185, 240
PCE and, 185
service measure and, 227
Highway Performance and Monitoring System (HPMS), 294t
Highway Safety Information System (HSIS), 353
Highway Safety Manual (HSM), 13
EB and, 368
HIL. See hardware-in-the-loop
histogram, 518
for spot speed, 90f, 91f, 518t
history in before-and-after test, 489, 491
comparison and, 494
MOE and, 489
HOT. See high occupancy and toll facility
HOV. See high occupancy vehicle
HOV lane
compliance with, 186
concurrent flow, 10, 180
congestion and, 179
definition of, 14
GP and, 180
occupancy in, 179, 219
HPMS. See Highway Performance and Monitoring System
HSIS. See Highway Safety Information System
HSM. See Highway Safety Manual
hydrofluorocarbons (HFCs), 457
hypothetical questions, 508
impact, 463–483
impact score, 13, 270
incidents
definition of, 14
freeways and, 190
index, in written reports, 552
indirect measurements, of speed, 79
individual vehicle selection method, for data collection, 79–84
inferential statistics, 92, 528–535
estimation in, 528–529
with experiments, 486–487
nonparametric tests in, 533–535
proportions in, 531
samples and, 528–531
significance testing in, 532–533
informative changes, principle of, 27
inputs, 205
calibration of, 223–227
simulation and, 228t
in-road sensors, 62, 63–64
for gaps, 186
for headways, 186
sensors for, 64f
for spot speed, 86–87, 87f
Institute of Transportation Engineers (ITE), 13, 119, 464
intelligent transportation systems (ITS)
APC and, 281
AVL and, 281
definition of, 14
driver behavior and, 223
simulation and, 210, 212, 223
interchanges
definition of, 14
design for, 203
diverging diamond, 49
expressways and, 419
overpasses and, 194
single-point urban, 49
weaving segments and, 192
intermediate areas, 420
internal studies, for transportation planning, 446–448
intrarrater reliability, 13, 254
intersections. See also Michigan U-turn intersection; signalized intersections; unsignalized intersections
approaches to, 28, 210, 488
condition diagram for, 313f
conflict at, 391f–394f, 398t
continuous flow, 49
delay and, 98–104
driveways and, 97–115
flow diagram for, 71, 72f
saturation flow rate for, 225
traffic conflicts at, 391, 391f–394f, 398t
“Intersection Control Delay Worksheet,” from HCM, 100, 101f
intersection counts, 44–49
arrival volumes and, 45, 45f
bicycle and, 46
departure volumes and, 45, 45f
for Michigan U-turns, 47
at signalized intersections, 44–45
for superstreets, 47
at unsignalized intersections, 44

intersection sight distance (ISD), 112–115
AASHTO and, 115
measurements for, 113f
STOP signs and, 114–115
TCD and, 135
time gaps and, 114–115
YIELD signs and, 114

interviews
    dwelling-unit, 447
    for parking, 336–339, 338f
    surveys and, 510
    training for, 510
    for transportation planning, 438–440
    for TTD, 171–172
    at workplaces, 447–448

in-vehicle counting technology, 62

inventories, 309–321
    access to, 317
    classification of, 316
    data collection for, 318–320
    for land use, 432–434
    location systems for, 316
    maintenance of, 320–321
    parking, 325–332
    retrieval of, 317
    storage of, 317
    for transportation planning, 432–437
    updates for, 321

inverse sampling, 400

involvements, collisions and, 358

ISD. See intersection sight distance

ITE. See Institute of Transportation Engineers

iteration, 13, 229

ITS. See intelligent transportation systems

K
KABCO, 351–352
    collision severity and, 15
key counts, 55

L
lag, 15, 110

land use, inventories for, 432–434

lane-changing, 225–226
    algorithms for, 15, 225
    definition of, 15
    traffic conflicts and, 394

laptop computers, 60
    for bicycles, 239
    for gaps, 110
    intersections and, 98
    for pedestrians, 239
    for saturation flow, 105
    for TCD compliance, 146
    for test vehicles, 162

lasers
    calibration for, 85
    cosine error for, 80, 81t
    definition of, 15
    Doppler effect and, 79–82
    ISD and, 112
    round off error for, 80
    for spot speed, 84–86

Latin square, 496

learning effect, 210

letter of transmittal, on written reports, 551

level, 15

level of service (LOS), 32
    bicycles and, 240
    control delay and, 102
    definition of, 15
    density and, 187, 188f
    HCM and, 185, 240
    ML and, 198

license-plate matching
    by checkers, 334
    for parking, 332–336, 333f
    for path-based counts, 48

for transportation planning, 441–444, 442f, 445f
for TTD, 171–172

lighting, 413–426
    before-and-after test for, 415
    benefit-cost ratio for, 425–426, 425t
    collisions and, 420–423
    collision reports and, 421
    collision severity and, 420
    crime and, 426
    data collection for, 415–424
    data reduction and analysis for, 424–426
    dilemma zone and, 370
    inventories of, 415
    pedestrians and, 417t, 426
    pollution from, 292
    recommendations for, 416t–417t
    volume and, 423–424

lights-on studies, 446

Likert scale, 507

line graphs, 27t, 30–31, 30f

Livable Streets, 482

load, 266t, 267t
    definition of, 15
    public transportation and, 278

loading, trucking and, 299–302

local roadways, 419

location systems, for inventories, 316

long-range transportation plans (LRTP), 431

LOS. See level of service

lost time, 105–109
    field procedures for, 108–109

LRTP. See long-range transportation plans

M
macroscopic models, 202–203
    definition of, 15
    for queue length, 105

magnitude, of noise, 452–453
Maintaining Traffic Sign Retroreflectivity, 137

major street, 419
definition of, 15
parking on, 331
peak hour warrant and, 127
warrants and, 132

managed lanes (ML), 177–198
collisions and, 191
definition of, 15
LOS and, 198
measures for, 198
types of, 179–180
VMT and, 179

Managed Motorways, 179

manual counts
for bicycles, 238–242
data reduction from, 67
for pedestrians, 238–242
periods for, 69
for public transportation, 273–281
for test vehicles, 162–165
for TTD study, 161
for volume data collection, 58–62

Manual on Uniform Traffic Control Devices (MUTCD), 16
pedestrians and, 238
signs and, 132
TCD and, 117–118, 144
warrants and, 123, 124

manual speed traps, 85–86

maps, 27t. See also online mapping tools; spot maps
for bicycles, 259f
collisions and, 354
for curb parking, 328, 328f
statistical, 546, 546f
with street classifications, 312f
for TCD, 312f
time-contour, 161, 167f
for traffic count, 71, 74f
for traffic flow, 71, 73f

maritime cargo, 293

maturation
in before-and-after test, 489, 491
comparison and, 494
MOE and, 489

Maximum-Car Technique, 161
mean, 91
arithmetic, 523–524
central tendency and, 522
definition of, 15
MOE and, 492
public transportation and, 288
stratified random sampling and, 502
means test, for factorial design, 495t

measures of effectiveness (MOE), 486
for bicycles, 253–254
definition of, 15
history and, 489
maturation and, 489
mean and, 492
for pedestrians, 253–254
person occupancy and, 187
regression to the mean and, 490
TCQSM and, 266t–277t
median, 91, 524
median U-turn. See Michigan U-turn intersection

medium-term planning, 430
mesoscopic models, 15, 202
method of sampling, 528
metropolitan planning organizations (MPOs), 429, 457

Michigan U-turn intersection counts for, 47
definition of, 15
layout of, 48f
microscopic model, 202, 207f
algorithms for, 202
definition of, 15
Microsoft Excel, 536
middle ordinate
for curve radii, 408–410
definition of, 15
midlock, 50

minor street
approaches of, 125
definition of, 15
peak hour warrant and, 127

misery index, 197
mitigation measures, 464
ML. See managed lanes
MMIRE. See Model Minimum Inventory of Roadway Elements
MOBILE6, 459
mobility
averages, 197
classification for, 435t
modal split, 476–477
mode, 91, 524
Model Minimum Inventory of Roadway Elements (MMIRE), 353
models, 205. See also specific models or model types
definition of, 15
for simulation, 219–220
3D, 24
modified binomial test, for Poisson-distribution, 492, 492f
MOE. See measures of effectiveness
Motorist Compliance with Standard Traffic Control Devices (FHWA), 143
MPOs. See metropolitan planning organizations
multiple panels, 27t
multiple threat
conflict and, 252
definition of, 15
multistage random sampling, 504
multi-use paths, data collection for, 241f
multiway stop control signs, warrants for, 133
MUTCD. See Manual on Uniform Traffic Control Devices

N

NAICS. See North American Industry Classification System
National Cooperative Highway Research Program (NCHRP), 16, 208, 375, 452
National Highway Planning Network (NHPN), 294t
National Highway Traffic Safety Administration (NHTSA), 353
National Transit Database (NTD), 264
National Transportation Atlas Database (NTAD), 294t
National Transportation Statistics, 295t
NCHRP. See National Cooperative Highway Research Program
N/D. See ratio of rates
near collisions, 215
nearly stopped, 149
nested designs, 496
networks, 205
bicycles and, 252–253
definition of, 16
measures of, 223
pedestrians and, 252–253
screening of, 359–369
simulation and, 220f
warrants for, 132
Next Generation Microsimulation (NGSIM), 204, 204f
algorithm, 204, 204f
NGSIM. See Next Generation Microsimulation
NHPN. See National Highway Planning Network
NHTSA. See National Highway Traffic Safety Administration
night percentage, for collisions, 424
node-aggregated data, 223
noise, 452–457
abatement criteria for, 454t
contours, 456, 457f
determination of existing levels, 454–455
FHWA and, 453
frequency of, 453
magnitude of, 452–453
during peak hour, 455
pollution from, 292
predictions about, 456
samples for, 455t
temporal distribution of, 453
time variance of, 453
no-left-turn, compliance with, 150, 150f
nonattainment area
air quality and, 457
definition of, 16
noncoverage, 514
nonparametric tests, in inferential statistics, 533–535
nonrandom sampling, 504–505
convenience, 504
expert, 504–505
judgment, 504–505
quota, 505
snowball, 505
nonresponse, in surveys, 513–514
nonsite traffic forecasts, 477–478, 477t
North American Industry Classification System (NAICS), 297
North American Transportation Statistics, 295
no stop, 149
not-at-home, 514
NTAD. See National Transportation Atlas Database
NTD. See National Transit Database
Nth name selection technique, 504
null hypothesis, 486
number of approaches, 316
O
occupancy
definition of, 16
density and, 187
freeways and, 184–185
in HOV lane, 179, 219
parking and, 330, 332, 340f
O-D. See origin-destination
one-time solution, 210, 212
one-way analysis of variance (ANOVA), 487
factorial design and, 494–495, 495t
online mapping tools, 61, 162
definition of, 16
for parking, 326
on-site circulation, 480
open questions, 506
operating speed
algorithm for, 227
definition of, 16
simulation and, 227
validation and, 227
optimization
algorithm, 16
definition of, 16
simulation and, 208
steady-state, 210
oral presentations, 555
ordinal scale, 507
organization charts, 547, 547f
origin-destination (O-D)
cordon count and, 50
data expansion for, 443t
definition of, 16
field sheet for, 440f
parking and, 326
path-based counts and, 47–48
peak hour and, 47
screen-line counts and, 54, 449f
simulation and, 212
surveys, 437–438
TAZs and, 432f
transportation planning and, 437, 448–449
ortho-rectification
definition of, 16
with video-base counts, 65
outputs, 205
simulation and, 228
validation for, 227–228
overpasses, interchanges and, 194

pace speed, 16, 91
paired comparison, in experiments, 488, 488t
paratransit, 16, 264
parking, 323–343
accumulation studies of, 330–332, 332f
block and curb face numbering system for, 326f
for CBD, 325
congestion and, 325, 331
curb, 326–327
data collection for, 332–339
data reduction and analysis for, 339–340
data tabulation form for, 341f–343f
duration summary sheet for, 335f
generation studies of, 330–332
interviews for, 336–339, 338f
inventories, 325–332
license-plate matching for, 332–336, 333f
O-D and, 326
on major street, 331
occupancy and, 330, 332, 340f
pedestrians, 237–259
accelerometers for, 242
accessibility for, 238, 252
automatic counts for, 242–245
before-and-after test for, 255
behavior of, 250–258
classification for, 419
collision and, 144, 154–155, 154f, 252
critique and, 251–252
critical gap for, 247, 249
crosswalk and, 239f
data collection for, 253–256
definition of, 17
delay and, 249
gaps and, 246–250, 248f
GPS for, 242
handheld count boards for, 239
interception counts and, 46
manual counts for, 238–242
MOE for, 253–254
MUTCD and, 238
networks and, 252–253
platoon and, 228
percentile

definition of, 17
gaps and, 110
of speed, 520
for spot speeds, 523f
percentile speed, 85th, 84, 84t, 91–92, 520
definition of, 17
peak hour warrant and, 127
YIELD signs and, 133
percent of congested travel, 197
percent variation, 197
Perception, Identification, Emotion, and Volition (PIEV), 134
perceptual organization, principle of, 26
perfluorocarbons (PFCs), 457
performance measures, 17. See also specific performance measures
permissive turn
definition of, 17
at signalized intersections, 45
permitted error, 83
person-hours per year, 197
person injury, in collisions, 351–352
person occupancy, 184
of HOV, 187
MOE and, 187
PFCs. See perfluorocarbons
pedal-associated factors, 331
pedestrians, 175
pedestrian–automobile conflict, 331
pedestrian–bicycle conflict, 331
pedestrian–pedestrian conflict, 331
pedestrians and noise, 455
pedestrian–vehicle conflict, 331
pedestrian-priority intersections, 383
parking
availability and, 328
access and, 328
availability for, 328
behavior and, 328
non-parking, 328
parking access and, 328
pedestrians and, 328
vehicle access and, 328
pedestrians and bicycle accidents, 334
per capita

definition of, 17
load

load

load

load

load

load

load

load

load
PHF. See peak hour factor
photographs, 27t. See also time-lapse photography
pictograms, 545, 545f
pictorial elements, 27t
picture-in-picture (PIP), 255
pie graph, 27t, 29, 29f
PIEV. See Perception, Identification, Emotion, and Volition
PIP. See picture-in-picture
platoon
  coordinated signal system warrant and, 131
definition of, 17
pedestrians and, 228
for TTD, 172
podium presentations, 38–40
point and ride checks, 271, 274–281
point data collection, 221–222, 227
point delays, simulation and, 227
Poisson-distribution, 491
  modified binomial test for, 492, 492f
  rejection criteria for, 492f
Policy on Geometric Design of Highways and Streets (AASHTO), 385
population, 501
  descriptive statistics and, 522
  stratified random sampling and, 502
postcards, 440, 441f
  for parking, 336–337
  for transportation planning, 440–441, 441f
posted speed
  definition of, 17
  peak hour warrant and, 127
posters, 40–41
  visualization and, 40
preface, on written reports, 551
presentations, 554–559
  checklists for, 558–559
  for communication, 37–41
  oral, 555
  organization of, 557
  podium presentations, 38–40
  with posters, 40–41
  questions in, 557–558
  for volume counts, 70–71
  Web sites, 41
pretests, for surveys, 510
probable amount of error, 528
probe vehicle, 123
  cellular phone observation method and, 174
  GPS and, 174
  for TTD, 173–174
problem areas, 420
A Program for School Crossing Protection, 128
project progress charts, 549, 549f
prompt list
  definition of, 17
  RSA and, 386, 387t
property damage only (PDO), 352, 356, 360, 420
proportions, in inferential statistics, 531
protected turn, 17
public transportation, 263–288
  accessibility for, 270
  automatic counts for, 281–283
  BRT and, 264
  checkers for, 280
  data collection for, 272–285, 273f
  delay and, 279f
  load and, 278
  manual counts for, 273–281
  mean and, 288
  performance measures for, 265–266
  problems with, 265
  QOS for, 265
  routes and, 266
  samples for, 285–288
  statistical analysis for, 285–288
  surveys for, 283–284
  systems and, 266
  visualization for, 280f
Q
QOS. See quality of service
quality of service (QOS), 250
  bicycle lane and, 253
  crosswalks and, 253
  definition of, 17
  for public transportation, 265
  user perception, 252, 253, 255–256
questions
  in presentations, 557–558
  for surveys, 505–508
queues
  congestion and, 189
  control delay and, 100
  definition of, 17
  on freeways, 189
  ramp metering and, 189
queue length, 104–105
  definition of, 17
  on freeways, 189
  macroscopic models for, 105
  simulation and, 228
quota sampling, 505
R
radar
  calibration for, 85
  cosine error for, 80, 81f, 81t
  definition of, 17
  Doppler effect and, 79–82
  round off error for, 80
  for spot speed, 84–86
railroad (RR), 136, 292–293
Railroad-Highway Grade Crossings, 294t
raised reflective pavement marker
centerline markings and, 139
  definition of, 17
ramp metering, 181, 182f
  definition of, 17
queues and, 189
Ramsey and Routledge method, 111, 111t–112t
  accepted gap and, 111t
random assignment
  in experiments, 487
  in factorial design, 496, 496t
random number speed. See iteration
random sampling
  cluster, 502–504
  multistage, 504
  replacement and, 502
  simple, 502, 503t
  stratified, 502
  for surveys, 501–504
  systematic, 504
range, 526
ranking scale, 507
rate quality control (RQC), 364
ratio of rates (N/D), for collisions, 424–425
references, in written reports, 552
Regional Economic Accounts, 295t
regression to the mean, 489–490
  comparison and, 494
  MOE and, 490
  overcoming, 491–492
regulatory sign, 118
  definition of, 17
  warrants for, 132–134
rejected gap, 17, 110, 250
rejected lag, 17, 110
relative frequency distribution, 518
Relative Severity Index (RSI)
  collision severity and, 362–363
  definition of, 17
relevance, principle of, 26
reliability
  definition of, 17
  measures, 197
  as service measure, 267t
replacement, random sampling and, 502
replication
  definition of, 18
  samples and, 486–487
  units and, 486
reports. See written reports
residential area, 420, 481–482
Residential Street Design and Traffic Control, 481–482
retroreflectivity
  of pavement marking, 139–140, 139t
  of signs, 137–139
retroreflectometer
  for pavement marking, 139f
  for signs, 138, 138f
reversible lanes, 181, 181f
  definition of, 18
  ITS and, 18
right of way
  definition of, 18
  traffic signals and, 124
  at unsignalized intersections, 398
  width of, 471
  YIELD signs and, 133
right-turn-on-red (RTOR), 136, 144
  compliance with, 152–153, 152f
Road Safety Audit (RSA), 252, 383–389
  collision reports and, 384
  data collection for, 385–388
  data reduction and analysis for, 388–389
  definition of, 18
  driver behavior and, 384
  for pedestrians, 387t
  prompt list and, 386, 387t
  risk category method for, 389t
  SPF and, 384
roadside counting technology, 62, 64, 65f
RoadSoft GIS, 320
road surfaces
  classifications for, 418t
  collisions and, 370
road-user compliance studies, 136
roadways. See streets
roundabouts
  approaches and, 46
  definition of, 18
  path expansion for, 46
round off error, 80
routes
  average speed summary along, 166f
  definition of, 18
  guide signs for, 134–135
  public transportation and, 266
  for trucking, 298
  by vehicle, 219
RQC. See rate quality control
RR. See railroad
RSA. See Road Safety Audit
RSEC. See collision rate for section
RSI. See Relative Severity Index
RSP. See collision rate for spot
RTOR. See right-turn-on-red run. See iteration
S
safety, 347–348
  alternatives for, 383–412
  congestion and, 191
  with data collection, 7–8
  freeways and, 190
  simulation and, 215–216
  spot speed and, 78
  TCD and, 137
SAFETYNET, 353
safety performance function (SPF)
  collisions and, 368
  crash frequency and, 18, 368
  definition of, 18
  RSA and, 384
salience, principle of, 26
samples
  for advisory speed, 408
  control counts and, 69
  count expansion and, 69
  coverage counts and, 69
definition of, 18
descriptive statistics and, 522
inferential statistics and, 528–531
for noise, 455t
for path-based counts, 47–48, 49t
for public transportation, 285–288
random, 503–504
reliability of, 528–531
replication and, 486–487
in surveys, 501–505
for TCD compliance, 147–148
for test vehicles, 162, 163t, 164f
for traffic conflicts, 397–400
for TTD, 162, 163t, 164f
random, 503–504
reliability of, 528–531
replication and, 486–487
in surveys, 501–505
for TCD compliance, 147–148
for test vehicles, 162, 163t, 164f
for traffic conflicts, 397–400
for TTD, 162, 163t, 164f
sampling error, 513
sampling units, 501
saturation flow rate, 105–109
data collection form for, 107f
field procedures for, 106–108
for intersections, 225
signal phase and, 107
scales, in surveys, 506–507
scatter plots, 27t
school crossings
compliance with, 144
warrants for, 128–129, 130t, 131t
screen-line counts, 54f
calibration from, 54
definition of, 18
O-D and, 54, 449f
seasonal factors, in control counts, 55–56, 56t
seeding period, for simulation, 221
segment studies, for freeways, 187–190, 195–196
segment travel times, simulation and, 227
sensitivity analysis
CF and, 206
definition of, 18
simulation and, 206–208, 207f
sensors. See also in-road sensors
for bicycles, 242
simple random sampling, 502
formulas for, 503t
simulation, 201–233
algorithm for, 19, 205, 218
analysis levels for, 203f
cycle length and, 202
data collection for, 218–228
data reduction and analysis for, 229–233
definition of, 19
documentation for, 232
driver behavior and, 210–212, 225–227
DTA and, 211
emergency scenario models and, 212–214, 213f
environment and, 217–218, 217f
evacuation and, 212–214
evaluating alternatives with, 208–210, 209f
inputs and, 228t
input calibration for, 223–227
ITS and, 210, 212, 223
measures for, 221–223
models for, 219–220
model types for, 202–203
networks and, 220f
number of runs for, 229–230
O-D and, 212
operating speed and, 227
optimization and, 208
outputs and, 228t
output validation for, 227–228
predicting behavior with, 210–212
queue length and, 228
reporting results for, 231, 232t
resolution of, 221
safety and, 215–216
seeding period for, 221
segment travel times and, 227
sensitivity analysis and, 206–208, 207f
significantly different at, 242
signpost-based transponders, 173, 283
SIL. See software-in-the-loop
simulation run. See iteration
single-point urban interchanges, 49
site diagrams, 372, 372t
Sites with Promise (SWP),
collisions and, 365–368, 366t, 367t
site traffic forecasts, 473–477
SLM. See sound level meter
slow-vehicle, same-direction, traffic
conflicts and, 394
SMS. See space-mean speed
snowball sampling, 505
software-driven communication,
25–26
software-in-the-loop (SIL), 224
sound. See noise
sound level meter (SLM), 455
space-mean speed (SMS), 78
analysis for, 171
definition of, 19
equation for, 78t, 166
freeways and, 183
speed-flow-density and, 78
spatial distribution, 521–522, 522f
GIS and, 522
speed. See also specific speed types
at approaches, 79, 98, 115, 401
definition of, 19
direct measurements of, 79
flow and, 183
indirect measurements of, 79
percentile of, 520
simulation and, 224
speed distributions, 219
for speed limits, 121
speed-flow-density
on freeways, 184f, 191
macroscopic model and, 15
SMS and, 78
speed limits
definition of, 19
distribution for, 121
warrants for, 134
speed traps, 19, 79, 82, 85–86
speed zone inventory map, 314f
SPF. See safety performance
function
spot crash location maps, 119
spot maps, 119
for collisions, 359
definition of, 19
spot speed, 77–94
all-vehicle sampling for, 86–88,
136–137
average for, 523f
confidence level for, 92, 92t
cumulative frequency distribution
of, 520t
data collection for, 84–89
data reduction for, 88–93, 89t
definition of, 19
descriptive statistics for, 91–92
frequency distribution table for, 90t
histogram for, 90f, 91f, 518t
in-road sensors for, 86–87, 87f
laser for, 84–86
percentile for, 523f
radar for, 84–86
results of, 122f
safety and, 78
spatial location of observer for, 85f
standard deviation of, 83t
summary calculations for, 525t
TCD and, 121, 136–137
SSAM. See Surrogate Safety
Assessment Methodology
stacked bar graph, 29, 29f
standard deviation, 91–92, 526–527
definition of, 19
of spot speeds, 83t
standard error, 19, 155, 527
startup lost time, 105, 109
statistical analysis, 515–537
for advisory speed, 409–412
calculation aids for, 536
engineering study and, 515
for freeways, 195–198
for lighting, 424–426
for parking, 339–340
reports for, 536–537
for RSA, 388–389
for simulation, 229–233
for traffic conflicts, 405–406
for transportation planning,
448–450
for TTD, 165–166
statistical inference. See inferential
statistics
statistical maps, 546, 546f
statutory speed, definition of, 19
steady-state
congestion and, 212
definition of, 19
optimization, 210
step graphs, 27t
stochastic, 205. See also model
simulation and, 229, 229f
stopped-time delay, 123
stopping sight distances, design
speed and, 114t
STOP signs, 44
compliance with, 149, 149f,
155–156
departure sight triangle and, 114
engineering judgment and, 132
ISD and, 114–115
peak hour warrant and, 127
traffic control signal and, 133
warrants for, 132–133
strategy optimization, 208
stratified random sampling, 502
streets. See also major street;
minor street; superstreets
classification of, 312f, 418f, 419,
435, 436f
study area, 469, 470f
study horizons, 467, 467t
subjects. See units
subunits, 502
sulfur hexafluoride (SF₆), 457
summary, in written reports, 552
sunrise and sunset times, 421, 422t
superelevation, 408–409
definition of, 19
superstreets
definition of, 20
intersection counts for, 47
layout of, 48f
turning movements for, 103f
supergate data, 475
Surrogate Safety Assessment Methodology (SSAM), 19
simulation and, 215, 215f
surveys, 271
administration of, 510–512
by checkers, 284
data collection for, 500–501
design of, 499–514
errors in, 512–514
example of, 508–509
incentives for, 438
interviews and, 510
methods for, 500–501, 501t
O-D, 437–438
for parking, 337–338, 337f
pretests for, 510
protecting respondents in, 509
for public transportation, 283–284
questions for, 505–508
random sampling for, 501–504
samples in, 501–505
scales in, 506–507
for taxis, 448
for transportation planning, 438–446
for trucking, 448
SWP. See Sites with Promise
synchronization, 20, 320
systematic sampling, 504
systems, 205. See also specific systems and system types
definition of, 20
public transportation and, 266
tables, 516
design of, 542–543
organizing data in, 543
at intersections, 391, 391f–394f, 398t
lane-changing and, 394
samples for, 397–400
slow-vehicle, same-direction and, 394
summary form for, 403f
time period form for, 402f
training for, 395–397, 396t

traffic control devices (TCD), 2, 117–140. See also signs; TCD compliance
AASHTO and, 144
before-and-after test for, 136
bicycles and, 252
collision diagram and, 137
collision report and, 144
condition of, 137
definition of, 20
delay and, 123
effectiveness of, 135–137
engineering study and, 135
establishing need for, 123–135
gap and, 123
inventories, 123
map for, 312f
MUTCD and, 117–118, 144
pedestrians and, 120–121, 252
removal when unnecessary, 135
safety and, 137
sight distance and, 135
spot speed and, 121, 136–137
volume and, 119–121
warrant for, 120, 120f, 123

traffic control signals
definition of, 20
STOP signs and, 133
warrants for, 124, 128

traffic control strategy, 219

traffic control study, 20
traffic count map, 71, 74f
traffic demands, 219
Traffic Detector Handbook (FHWA), 192
Traffic Engineering Handbook (TEH), 119
traffic events, 394
traffic flow map, 71, 73f
Traffic Impact Analyses for Site Development (ITE), 464
traffic management center (TMC) definition of, 20
ITS and, 20
video-based counts and, 65
Traffic Noise Model (TNM), 456
traffic signals. See also traffic control signals
compliance with, 151, 151f
pedestrians and, 154–155, 154f
right of way and, 124
trail car studies, 271
trajectory, 215, 216
definition of, 20
Transit Capacity and Quality of Service Manual (TCQSM), 264
MOE and, 266t–267t
service measure and, 266
transit route passenger questionnaires, 448
transit signal priority (TSP), 21
transit stops, 266
transportation demand, 463, 481
transportation planning, 429–450
area, 477–478
data collection for, 438–448
data reduction and analysis for, 448–450
internal studies for, 446–448
interviews for, 438–440
inventories for, 432–437
license-plate matching for, 441–444, 442f, 445f
O-D and, 437, 448–449
parking and, 436–437
postcards for, 440–441, 441f
surveys for, 438–446
Transportation Planning Handbook (TPH), 119
Transportation Research Board (TRB), 13, 20, 385
transportation studies
checklist for, 6t
collecting, 6–7
data collection for, 4
development of, 4–5
guidelines for, 3
study techniques for, 4
transportation systems management (TSM), 430. See also intelligent transportation systems
teach paths, bicycles and, 252
thermal-time delay (TTD), 98, 123, 159–174
aerial surveys for, 172
automatic counts for, 165
CBD and, 161
cellular phone observation method for, 172
cycle length and, 99
data collection for, 161–165
data reduction and analysis for, 165–166
definition of, 12
extrapolation method for, 172
FFS and, 104
field procedures for, 103–104
on freeways, 188–189
GPS for, 161–162
interview method for, 171–172
license-plate matching for, 171–172
manual counts for, 162–165
peak hour and, 161
platoon matching for, 172
probe vehicle study for, 173–174
sample for, 162, 163t, 164f
study field sheet for, 168f
test vehicles for, 160–171
TIQD and, 99
vehicle observation study for,
171–174
vehicle signature matching method for, 172
travel time index, 197
definition of, 20
TRB. See Transportation Research Board
treatments, 20, 486
trends, 477–478

Index • 627
trip distribution, 475–476, 475f, 476f
trip generation, 473–474, 474t

**Trip Generation (ITE),** 119, 464

trucking, 292
CBD and, 300
loading and, 299–302
routes for, 298
surveys for, 448
unloading and, 299–302
weight and dimension limits for, 297t, 302–304
WIM and, 303–304, 303t

truck only toll (TOT), 177
definition of, 15, 20
ML and, 179–180

TSM. *See* transportation systems management
TSP. *See* transit signal priority
TTC. *See* time-to-collision

TTD. *See* travel-time delay
t-test, 488
type I error, 486
type II error, 486

**U**

UAVs. *See* unmanned aerial vehicles
unable to answer, 514

units
in before-and-after test, 489, 493
comparison and, 494
definition of, 21
replication and, 486
sampling, 501

universal design, 252

unloading, trucking and, 299–302

unmanned aerial vehicles (UAVs), 172
for density, 187

unpaired comparisons, in experiments, 487

unsignalized intersections, 43
crosswalks and, 252
gap and, 123
pedestrians and, 247–249
right of way at, 398
unwilling to answer, 514

Urban Transportation Planning Package, 450

U.S.-Canada border crossings, 294t
U.S. Census County Business Patterns, 295t
U.S. Department of Transportation (US DOT), 353
US DOT. *See* U.S. Department of Transportation
U.S. Economic Census, 295t
user perception
definition of, 21
QOS, 252, 253, 255–256

U.S.-Mexico border crossings, 294t

U.S. Ports and Waterways Facilities Database, 294t

V
validation, 205
definition of, 21
operating speed and, 227
for outputs, 227–228
variability, 526–528

v/c. *See* volume-to-capacity ratio
vehicles. *See also* probe vehicle; test vehicles
classification of, 185–186, 185f
conflict and, 251–252
definition of, 21
emissions from, 217–218, 217f
on freeways, 185–186, 185f
heavy, 185–186
pedestrians and, 251–252
routes by, 219
types of, 219
vehicle identification number (VIN), 352
vehicle intercept method, 446
vehicle miles traveled (VMT), 26, 192
ML and, 179
vehicle observation study, 123
for TTD, 171–174
vehicle owner mail questionnaires, 447
vehicle registrations, 446
vehicle signature matching method, for TTD, 172
vehicles per hour (vph), 119
video, 60–61, 65
at approaches, 65
for intersections, 98–99
for saturation flow, 105
signal phase and, 255
for speed determination, 82
for speed traps, 85–86
with test vehicles, 161
VIN. *See* vehicle identification number

virtual detectors, 65
virtual earth, definition of, 21
visual aids, in podium presentations, 38
visual analytics, 21, 40
visualization
with AVL, 282f
for bicycles, 258
definition of, 21
4D, 24, 39–40, 40f
for pedestrians, 258, 258f
posters and, 40
for public transportation, 280f
for simulation, 232–233, 233f
3D, 39–40
visual tables, 27t

visual weight, in graphics, 541f

VMT. *See* vehicle miles traveled
volume, 43–74
ADT and, 119
at approaches, 44, 47, 146t
arrival, 45, 45f
bicycles and, 238–245
collisions and, 354
count expansion for, 69, 70t
count periods for, 69
crosswalks and, 238
data collection for, 58–66
data presentation for, 70–71
DDHV, 12
definition of, 21
demand, 223–224
eight-hour vehicular volume warrant, 124–125, 125t
four-hour vehicular volume warrant, 125–127, 126t
on freeways, 196f
lighting and, 423–424
for peak hour, 473f
pedestrians and, 128, 238–245
samples and, 69
simulation and, 227
TCD and, 119–121
test vehicles and, 166–171, 169f, 170t
time series distribution of, 521t
TTD and, 166–171, 169f, 170t
volumes
DDHV, 57
departure, 45, 45f
volume-to-capacity ratio (v/c), 102
vph. See vehicles per hour

W
walkability checklists, 252, 257f
walking speed, by pedestrians, 246
walkways, for pedestrians, 252, 419
warm up period, in before-and-after test, 491
warning signs, 118
definition of, 21
placeemnt of, 134
warrants
for collision severity, 131
for coordinated signal system, 131
for crash, 131
definition of, 21
eight-hour vehicular volume, 124–125, 125t
engineering judgment and, 21, 123
four-hour vehicular volume, 125–127, 126t
major street and, 132
for multiway stop control signs, 133
MUTCD and, 123, 124
for network, 132
peak hour, 127, 127t
pedestrian volume and, 128
for regulatory sign, 132–134
for school crossings, 128–129, 130t, 131t
for speed limit, 134
for STOP signs, 132–133
for TCD, 120, 120f, 123
for traffic control signals, 124, 128
for YIELD signs, 133–134
waterborne commerce, 294t
weaving segments
freeways and, 183
interchanges and, 192
Web site design, 41
weigh-in-motion (WIM), 43, 173, 192, 193f
definition of, 21
scale technologies comparison, 303t
truckling and, 303–304, 303t
WIM. See weigh-in-motion
wireless technology method, for TTD, 172
Work Zone Operations Best Practices Guidelines (FHWA), 190
work zones, on freeways, 190
written reports, 550–554. See also collision reports
on air quality, 460, 460f
appendices in, 37
body of, 36–37, 552–554
communication with, 34–37
engineering study and, 513–554
exhibits for, 37
organization of, 550–552
sections of, 35
for statistical analysis, 536–537
target audience for, 35–36
writing style for, 35–36

Y
Yellow Book. See AASHTO Highway Safety Design and Operations Guide
YIELD signs, 44
design speed and, 114
engineering judgment and, 133
ISD and, 114
percentile speed, 85th and, 133
right of way and, 133
TTD and, 103
warrants for, 133–134