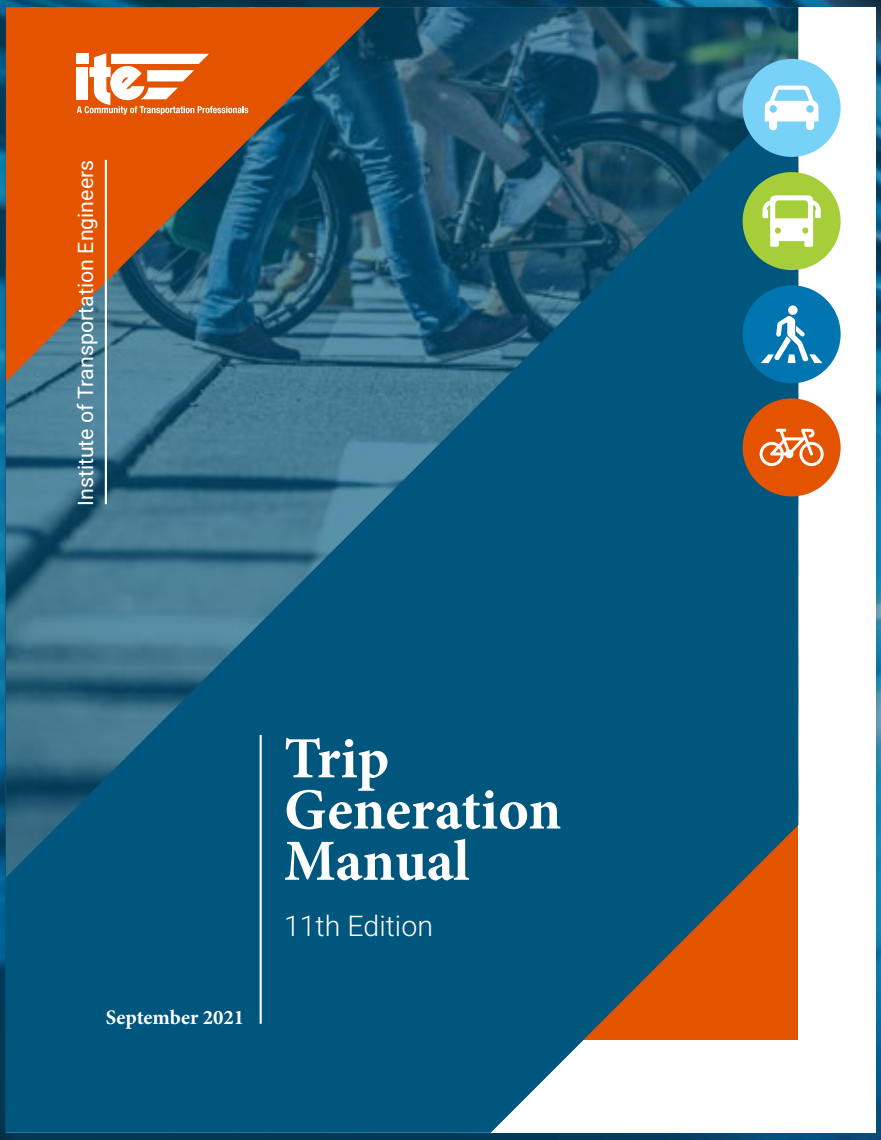
OCTOBER 2021

ite journal

A COMMUNITY OF TRANSPORTATION PROFESSIONALS



Trip Generation

Advanced Traffic Controller

Cobalt® powered by EOS,™ Econolite's revolutionary traffic controller software, with deliveries exceeding 50,000, for agencies looking to increase intersection safety and improve mobility. Transportation agencies rely on Cobalt, **because every moment matters!**

ECONOLITE

Saving Lives Through Improved Mobility®

Institute of Transportation Engineers
1627 Eye Street, NW, Suite 600, Washington, DC 20006 USA
Telephone: +1 202-785-0060 | Fax: +1 202-785-0609
www.ite.org

On the Road Again

ALYSSA A. RODRIGUEZ, P.E., PTOE (F)
ITE International President

I used to be a pro at packing. My laptop backpack stood ready at all times, filled with the accoutrements necessary for time on a plane or in an airport. I could plan a multi-day wardrobe for a carry-on bag without using the expander zipper. Today is a different story. I've packed too many clothing items and can't find the cord. Ready or not, however, travel is upon us. Over the past few months, I've had the privilege to attend two in-person ITE events: a one-day conference in the Florida-Puerto Rico District and a multi-day event in the Great Lakes District.

With hugs all around, Florida-Puerto Rico felt like a long-overdue family reunion. Filled with excitement and anticipation, Great Lakes was a successful kick-off event for the newly reorganized district. Attendees want to know: Are we ready to brave the freezing rooms and the banquet food? To which, in short, I give a hearty yes.

As a speaker, the live events are a joy. During a live event, I can make eye contact and assess the crowd's engagement. Sensing distractions, I can pivot on the topic or change my cadence and tone. I can call for physical audience participation or call out the students who have chosen to sit at the same table. Via Zoom, the screen is flat.

Webinars are orderly, and in-person meetings are less so. Aside from the occasional tech interruption, virtual presentations progress through a fairly predictable progression of slides and submitted questions. The format is efficient and straightforward. In real life, the process is somewhat messier. Attendees move in and out of the room, the presenter can gain cues from the audience, and the content can spark audible group groans or laughs. In addition, the questions can come from any direction, and there is no typed warning or prescreening. Afterward, the speakers can spend some time talking to each other and build networks.

Impromptu meetings at these live events are so valuable. From the chats in the elevator where you identify a fellow attendee from their badge to the casual lunch association, the unplanned conversations offer so much insight and connection. You receive unscripted reactions and impressions from members that you might not receive in a more rigid format. Further, the unstructured communication over a hockey match or a round of bocce at the social events enriches the links to colleagues to build lasting friendships.

The distractions are the same but different. Do I check my email during live presentations? Of course; we all do it. However, during a webinar it's much easier to completely tune out a presentation for a spreadsheet update or a coworker visit. And I certainly feel less guilty about it when the speaker can't see me.

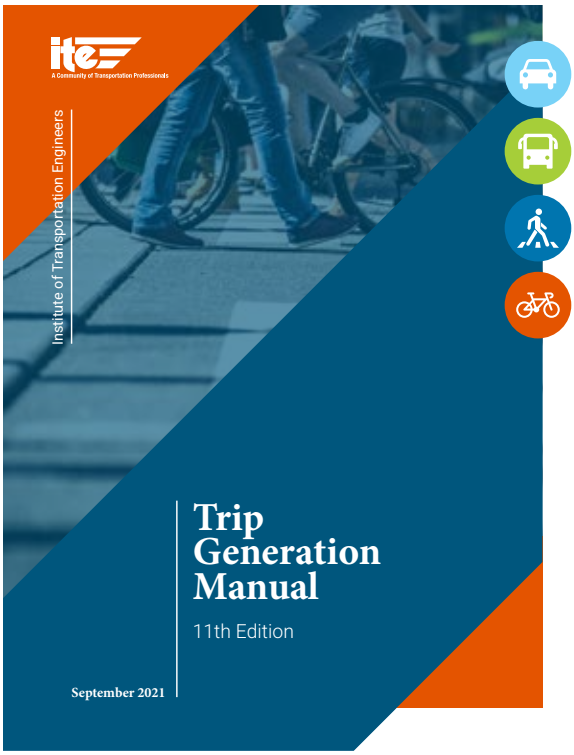
Perhaps the best part of traveling again is spending time with my colleagues, Beverly and Rosana. We've known each other for years, but we're in new roles on the Board since the pandemic started and have traversed all of our ITE work virtually. It's such a pleasure to meet and collaborate in person. I'll figure out how to pack again; it's worth it.

Alyssa A. Rodriguez, P.E., PTOE (F)
ITE International President

contents

ite journal
A COMMUNITY OF TRANSPORTATION PROFESSIONALS

OCTOBER 2021
volume 91 • number 10



Trip Generation

departments

inside ite

inside the industry

advertisers

1627 Eye Street, NW, Suite 600, Washington, DC 20006 USA • Telephone: +1 202-785-0060 • Fax: +1 202-785-0609 • www.ite.org

director's message

ITE TripGen11

Last month ITE released the 11th Edition of our signature technical product, the *Trip Generation Manual* (TGM). First issued in 1976, TGM is the go-to resource for conducting traffic impact assessments (TIA) throughout the United States. The TGM has evolved and grown throughout its history. Beginning with a modest 200 pages covering 50 land uses, the 11th Edition, if completely printed, would consist of more than 4,500 pages and cover 179 land uses.

Fortunately, starting with the 10th Edition, through our partnership with Transoft Solutions, we have developed the ITETripGen web-based app to provide digital access to the trip generation land use plots. We have taken this a step further with the 11th Edition, creating a single source for all your trip generation resources. In addition to digital access to all land use plots and descriptions, TripGen11 provides an electronic copy of the TGM Desk Reference and the *ITE Trip Generation Handbook*. You can find more information and purchase TripGen11 through the ITE Bookstore.

In this edition of the TGM we have extended the effort started with the 10th Edition to integrate urban, multi-modal, and person-based trips, including fully incorporating all the multimodal data brought forward in the 10th Edition Supplement. Responding to user feedback, we have added and reclassified a number of land uses to improve the applicability of the TGM. As examples, TripGen11 separates shopping plazas into those with and without supermarkets and medical-dental office buildings into those that are standalone and those within or near a hospital campus. The TripGen11 app also provides the user with the ability to filter the ITE data set so that the most accurate estimates can be produced.

ITE TripGen11 remains a single-user license product. While we understand some users would prefer a network version, we have not been able to find a distribution method that provides convenient user access while protecting ITE's intellectual property. However, we are providing deep discounts on multi-user purchases, including a new "office bundle" providing five TripGen11 user licenses and a TGM hard copy to make it affordable to share access within an office.

A lot goes into creating each new edition of the TGM. I want to recognize ITE staff Kevin Hooper, Lisa Fontana Tierney, and Deborah Rouse for their hard work in building this new edition. I also want to thank Transoft Solutions for their partnership and support for TripGen11 as well as the many volunteers who served as expert advisors and reviewers. Last, but certainly not least, thanks to all who have contributed data to the ITE trip generation database. We rely on your contributions to continue to update and evolve our data sets.

ITE is committed to continuing to grow our traffic impact assessment products and tools. Our recently developed, blended-learning TIA certificate course has proved to be very popular, and later this year we will be issuing a new draft Multi-Modal TIA Recommended Practice. If you have new data or ideas on how we enhance our offerings, don't hesitate to reach out to Lisa Fontana Tierney (lfontana@ite.org). As always, you can reach me on the ITE e-community or on Twitter: @JPaniatiITE.

Jeffrey F. Paniati, P.E. (F)
Executive Director and Chief Executive Officer

Volume 91 | Issue 10

ITE Journal (ISSN 0162-8178) is written by and for transportation engineers, transportation planners, and others responsible for the safe and efficient movement of people and goods on our surface transportation system. Published monthly by the Institute of Transportation Engineers, 1627 Eye Street, NW, Suite 600, Washington, DC 20006 USA.

Periodicals-Class postage paid at Washington, DC, and additional mailing offices. **Rates:** Single copy, $5. One-year subscription, $100 in the United States, Canada and Mexico; $150 elsewhere. Annual subscription rate for ITE members is $35, which is included in member dues. **Postmaster:** Send address changes to Subscription Department, ITE, 1627 Eye Street, NW, Suite 100, Washington, DC 20006 USA. GST Registration Number R 130 188 667.

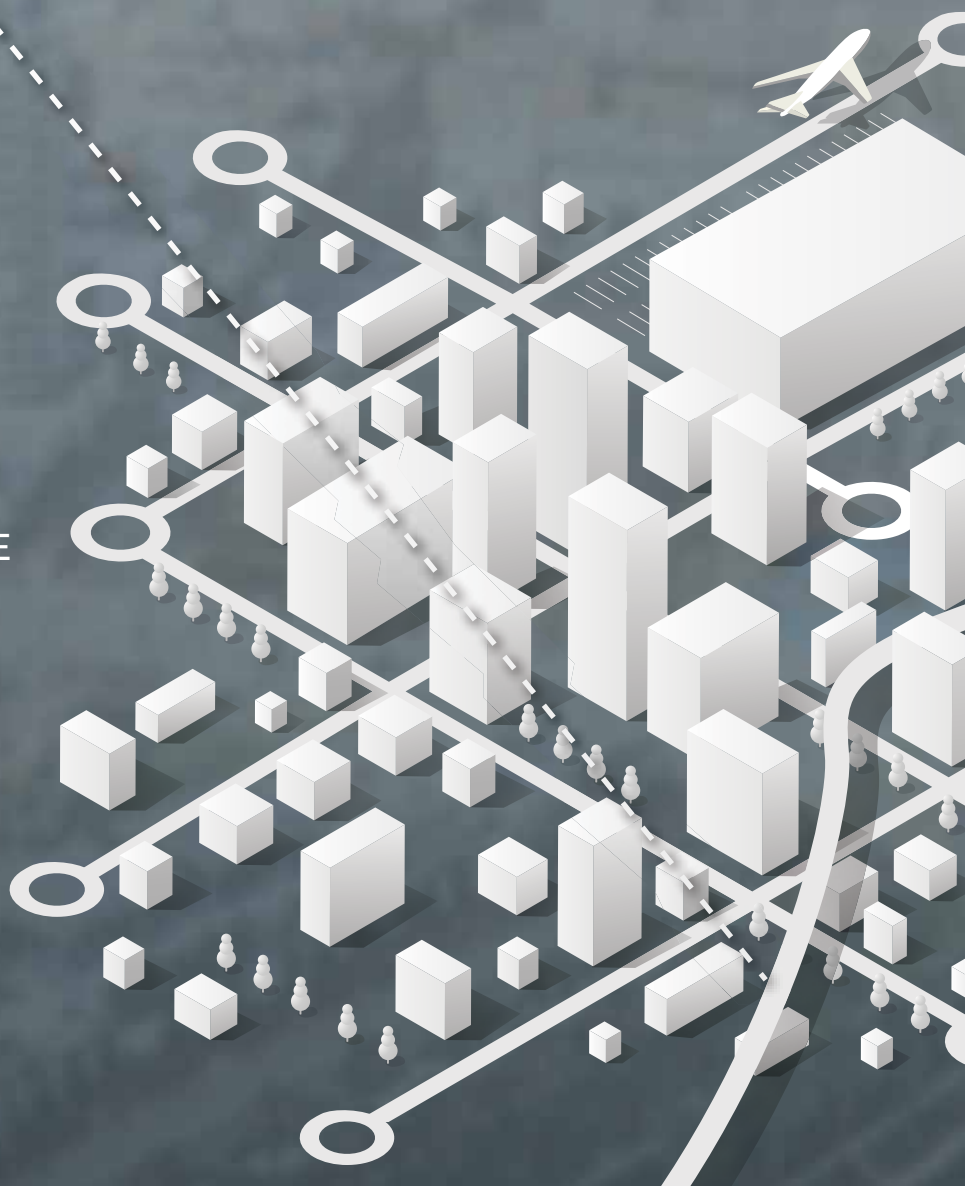
Article Submittals: All articles submitted for publication undergo peer review to determine suitability for publication and to ensure technical accuracy and credibility; before submitting manuscript, request a copy of "Information for Authors" from the editor. **Indexed in:** Engineering Index, Applied Science and Technology Index, Highway Research Information Service Abstracts, Environment Abstracts, Journal of Planning Literature, Sage Urban Studies Abstracts and TRID. **Disclaimer:** Opinions expressed herein are those of the authors and do not reflect official ITE or magazine policy unless so stated. Publication of advertising does not constitute official ITE endorsement of products or services. **Microfilm Copies:** Available from NA Publishing, P.O. Box 998, Ann Arbor, MI 48106-0998 USA; 800-420-6272; info@napubco.com.

McCain®
A SWARCO Company

TRANSPARITY® ADAPTIVE SOFTWARE

IMPROVE CONDITIONS & REDUCE EMISSIONS

Transparity® Adaptive utilizes a suite of synchronization strategies to improve operations. Empowering traffic engineers with autonomous signal timing optimization not only dramatically reduces emissions, but also the costs affiliated with traditional signal retiming efforts, making it a smart solution that's green in more ways than one.



SMART SOLUTIONS FOR SMART CITIES

- DYNAMIC MESSAGE SIGNS
- PARKING GUIDANCE & WAYFINDING
- SIGNAL PERFORMANCE MEASURES/ANALYTICS
- **INTERSECTION CONTROL SOFTWARE**
- ATC CABINETS

#SmartCities #Transparity
#AdaptiveSignalControl
www.mccain-inc.com

PEOPLE IN THE PROFESSION

Obituaries

ITE recently learned of the passing of the following members. We recognize them for their contributions to ITE and the profession, and send condolences to their families.

Aaron C. Fayish, P.E., PTOE (M) of Canonsburg, PA, USA, passed away on September 15, 2020.

Janet M. Barlow (M), Mobility Specialist and Researcher, who founded Accessible Design For The Blind, passed away quietly on Sunday, August 1, 2021. Janet was a tireless advocate for ADA compliance on streets and making transportation systems more accessible for the visually impaired. Janet assisted ITE as a passionate member on various ITE products, *ITE Journal* articles, and would always lend her voice as an accessibility advocate and researcher when called upon by ITE.

Most ITE members may know Janet from her years of advocacy within the National Committee on Uniform Traffic Control Devices (NCUTCD), always offering a strong voice for accessibility considerations when recommending standards for traffic control devices. Janet always floated between technical committees at the NCUTCD, working on everything from markings to signals. Janet positively impacted the transportation profession by both conducting research, site visits, as well as trainings on accessible design to many transportation professionals. **itej**

New Members

ITE welcomes the following new members who recently joined our community of transportation professionals.

Canadian
Pierre Barrieau, M.Urb., Ph.D.
Brian Patterson, RSP1
Kelly Yili Tang
Charlene Wilcock

Florida Puerto Rico
Alexandra Marie Boggs
Randy Larry Daniel
Joaquin Mojica
Esther Murray
Lori Palaio
Kelly Palframan
Peter Pellerito

Global
Ameer Anwer Hadi
Abid Hussain

Mid Colonial
Glen Colin Hebel
Qiang Li, P.E., PTOE
Edward A. Patton
Eloisa Thring

Missouri Valley
Daniel Cornelius Murphy, IV
Scott C. Parker
Chris Poole
Matthew J. Shimerdla

Mountain
Kelli Baker, P.E.
Massoud Javid, P.E.
Jesse Lassandro
Lindsay Merz, P.E.
Elle Miller
Asami Ototani, P.E.
Martha Rios
Tracy Shearer
Jessica Stemley
Troy Torgerson
Merle Van Houten

Northeastern
Sarah Carroll
Bruno Chede Cunha
William McNulty
Chris James Mukkadan
Jordan David Pike

Southern
Justin R. Bonifacio
David Miranda
Laura Olle
Amin Salman
James Stewart
Kaitlyn Stewart
Ian Woods

Texas
Breanne Alsobrook
Ruth Anne Gallup
Lance Knox, PTP
Steven Thomas Saltos Kochvar

Western
Divya Gandhi
Sonia Hernandez
Anna L. Le
Quang Nguyen, P.E., CPD
Soo Ho Park
Ryan Shea, PTP
Mitchell Smith, P.E.

Letters in parentheses after individuals' names indicate ITE membership status: S - Student Member; IA - Institute; M - Member; F - Fellow; R - Retired Member; and H - Honorary Member. Information reported here is based on news releases, and other sources. If you have news of yourself or the profession that you would like considered for publication, please send it to Holly Stowell, hstowell@ite.org.

ITE Talks Transportation Podcast

Deployment of MaaS/MOD Strategies

Carol Schweiger, President at Schweiger Consulting LLC

This month, Bernie Wagenblast talks with Carol Schweiger, President at Schweiger Consulting LLC and Co-Chair of TRB Committee on Innovative Public Transportation Services and Technologies. Carol has more than 40 years of experience in transportation consulting. During this conversation, Carol talks about the deployment of MaaS/MOD strategies, reflecting on how the pandemic impacted implementation, pilots in the U.S. and internationally, and the wide range of factors that need to be considered.

All episodes available at www.ite.org/learninghub/podcast.asp | Subscribe for free via iTunes at http://apple.co/2hOUz8t

2021 EVENTS

CO/WY ITE SECTION: COLORADO TRANSPORTATION SYMPOSIUM
October 11 | Denver, CO, USA

ITS NJ 2020 ANNUAL MEETING / COLLABORATION WITH ITE MET SECTION
October 22 | Location TBD

MET SECTION: 28TH ANNUAL MEETING AND TECHNOLOGY EXHIBITION
October 28–29 | Location TBD

IOWA SECTION ANNUAL MEETING
November 16, 2021 | Ames, IA (USA)

WASHINGTON DC (USA) SECTION ANNUAL MEETING
November 17-18 | Virtual

CONGRATULATIONS TO THE NEWEST TPCB CERTIFICANTS!

The Transportation Professional Certification Board, Inc. (TPCB) and ITE congratulate the following 78 new Professional Traffic Operations Engineers (PTOEs), 17 Professional Transportation Planners (PTPs), 65 Road Safety Professionals–Level 1 (RSP1s), and 21 Road Safety Professionals–Level 2 (RSP2s, Behavioral or Infrastructure) who passed certification exams in the June 2021 exam period. To learn more about these certifications and how to apply, visit www.tpcb.org. The next application deadline for the February 2022 exam period is December 1, 2021.

PTOE

Emmanuel Ake
Dawood Alani
Steven Alpert
S M Aftatul Aman
Sebastian A. Arias
Ravi Arora
Gloria Bansah
Anne M. Beauvillier
LaDarien C. Beene
Danielle M. Booms
Jeffery Branham
Jeffrey E. Brugge
John Ryan Carr
Benjamin Chavez, Jr.
PilJin Chun
John Joshua Coburn
Joshua Alexander Coulson
William Charles Cowan
Jonathan C. Crisafi
Ryan Davis
Kellie Dean
Alicia M. Dougherty
Evan G. Drew
Eric John Dudkowski
Andre F. Fillastre
Erin Littleton Filler
John Fitzpatrick
Mallori Linnea Fitzpatrick
Xueyu Gao
Nicholaus Matthew Grage
Shashad Bhaskar Gujaran
George Fekadu Gurara
Amelia (Millie) Hayes
Curtis Hefner
Ryan E. Henderson
Benjamin A. Hucker
Seth Daniel Jenison
Nicholas Junqueira Hevia
Martin Bruno Kaczmarek
Sherry J. Kim
Michael J. Kling
Kevin M. Konzelman
Tyler Craig Laing
Michelle Li
Molly D. Long
Craig A. MacPhee
Katherine Anne Masetti
Brendan S. May
Trevor Grant McGahey
Pierce-Jon McKelvey
Saleh R. Mousa
Subba Reddy Munagala, Sr.
Umer Hammad Nadeem
Michael O'Donnell
Carl Scott Olson
Scott E. Ornitz
Sahadev Parajuli
Amal Pazhanilam Chacko
Ben Pierce
Daniel Harold Masao Rawlings
Andrew A. Rowell
Jason A. Saliba
Hari P. Salkapuram
Md Imran Shah
Yoseph Shifare
Michael Shomion
Roshan Eric Singh
Sarvjeet Singh
Stacia B. Slowey
Ricardo Palma Solis
Celina Matthes Sumrall
Derek Sweeney
Christopher B. Tiesler
David Tompkins
Thomas James Wamser
Mengqing Wang
Zhibo Zhang
Uladzimir Zhuromski

PTP

Melanie Bishop
Kelly Blynn
Vinod Kumar Cherakara, Sr.
Mark Feldman
Steven Gaskill
Ruochang Huang
Lance Knox
Susie Lai
Yelena Onnen
Michael John Palomba
Michael A. Perrotta
Andrew Gordon Robertson
John C. Swartz
Thomas Valdriz
Matthew VanSlyke
Hua (Tony) Wang
Mengqing Wang

RSP1

Max Aguirre
Deanna Almond
Payton Donald Arens
Sandeep Aysola
Matthew Baldino
Sara M. Beresheim
Collene Byrne
Christopher S. Chahil
Austin P. Chapman
Kerry Perrillo Childress
Tavia Chow
Ryan J. Cunningham
Michael Lance Decuir
Emmeth D. Duran
Arpita Guha
Kristen D. Haas
Kelly K. Hardy
Curtis Hefner
Mark Herman
Robin Hernandez
Travis Hills
Michael C. Holden
Yuwen Hou
Phillip T. Jackson
Alireza Jafari Anarkooli
Michael Joyner
Felipe Ladron De Guevara
Tom Leung
Kevin Lipnicky
Emad E. Makarious
Daniel James Malsom
Katherine Anne Masetti
John Bradley Meyer
Kelly Misner
Gopikrishna Narla
Boniface M. Njoroge
Walter Okitsu
Lauren T. Picou
Ernie L. Pierce, III
Sergio C. Quevedo
Mohammed N. Rajani
Jeffrey Kent Roberts
Soroush Salek Moghaddam
Joy Sengupta
Anmol Shrivastava
Roma Garg Stevens
Audrey Stoltzfus
Veronica Sullivan
Emmanuel Ali Takyi
Ramana Vadarevu
Phillip Joseph Verville, III
Jianhong Wang
Oliver Wiesner
Kerry T. Wilcoxon
Lee Williams
Joshua Wolfgram
Qiong Wu
Ruiman Yang
Steven K. Younkin

RSP1 Saudi Arabia

Ibrahim Hussain Abuhulayqah
Abdullah Fahad Aleid
Mohamed Bakry Ali
Hassan Salem Alsaihati
Abdulmajeed Saleh Alsharari
Samir El Hage

RSP2 Behavioral

Priyanka Alluri
Michael D. Colety
Darryl A. DePencier
Kelly K. Hardy
John Calvin Milton

RSP2 Infrastructure

Priyanka Alluri
Muhammad Arif
Ryan T. Eckenrode
Malaika D. Faciane
Lei Fang
Kelly K. Hardy
James Kleen
Lee-Yung Koprowski
Meghan F. Mitman
Walter Okitsu
Yanira Rivera
Joseph A. Robertson
Susan Muench Ruinen
Lindsay S. Saner
Gaurav Vasisht
Conglong Yu

ITE NEWS

Go Green with *ITE Journal*

Not in the office to get your mail, or would you like to be more "green?" You can choose to stop the mailed delivery of *ITE Journal* by completing a quick online survey at http://bit.ly/ITEJGoGreen. You will still get the emailed version of *ITE Journal* that goes out on the first or second of each month and have full access to the digital edition.

WHERE IN THE WORLD?

Can you guess the location of the "Where in the World?" photo in this issue? The answer is on page 50. Feel free to send in your own photos to hstowell@ite.org. Good luck! **itej**

ITE to Release Call for Abstracts for #ITENOLA2022

ite New Orleans 22
Annual Meeting and Exhibition
July 31–August 3

Are you interested in presenting at the ITE International Annual Meeting and Exhibition next summer? Then circle October 12 on your calendar! ITE will be releasing its call for abstracts and you don't want to miss submitting. We have routinely received more submissions than presentation spots so take the time now to put together a well-thought out presentation topic. **itej**


Kevin Ruck / Shutterstock

Call for Abstracts

ite New Orleans 22
Annual Meeting and Exhibition
July 31–August 3

July 31-August 3 | New Orleans, LA, USA

Abstract submissions open on **October 12.**

A Career Dedicated to ITE

Erik O. Ruehr, P.E., PTOE (F)
Director of Traffic Engineering
VRPA Technologies
San Diego, CA, USA

Education
University of Michigan, Ann Arbor (USA)
Master of Science in
Engineering (Civil Engineering)
Bachelor of Science in
Engineering (Civil Engineering)

Erik with his wife, Pam, and daughter, Amelia.

ITE JOURNAL: **You joined ITE as a student member at the University of Michigan (USA). What are the benefits of being involved with an industry association for the length of a 42-year career?**

ERIK O. RUEHR: When I first heard that there was a society of transportation engineers and planners, I immediately wanted to be a part of it. There was no student chapter at the University of Michigan, so we filled out the paperwork to create a chapter, and I became the president. We invited local professionals to come and speak to us about their projects, and that was my first introduction to "real-world" ITE members. I am still in contact with the student member who was the vice president and one other member of the student chapter.

For me, ITE is about learning and networking. As a young member, I had much to learn about the profession. I was curious and learned as much as I could about every aspect of transportation, even topics that weren't directly related to my current work. As I grew, my career went in several different directions, and I found that a little knowledge of a technical topic was a big help when trying to get started in a new area of work. There is still a lot to learn as the profession and our society in general continue to change at a very rapid pace. Whether it is through online courses, in-person conferences, publications, or through direct connections with members, ITE has always provided me ample opportunities to continue learning.

Networking is the second aspect of ITE. I have made many friends through ITE, and being a member has opened up ways to trade information with other members. Whatever question or problem you are struggling with, it is almost certain that someone else out there has struggled with a similar issue. Those who know me know that I am willing to help share the knowledge that I have gained, and I am not shy about asking others for help.

ITEJ: **In this issue, we feature the 11th Edition of the *ITE Trip Generation Manual*. Would you please explain the importance of this tool and the task of industry professionals to keep it updated?**

RUEHR: Planning for the future and the ability to understand the potential effects of changes on the transportation system are key to our profession and to the service we provide to the communities where we practice. One important aspect of this work is the ability to accommodate traffic increases created by land development projects. The *ITE Trip Generation Manual* provides information on how to estimate the trips added to the roadway system by a wide variety of land uses.

There is a continuing need to update the Manual. In the time I have been in the profession, trip generation for some land uses has changed dramatically (elementary schools and middle schools), new land uses have come into existence (high-cube warehouses and parcel hubs), and some land uses have come and gone (anyone remember video stores?). In the near future when the current pandemic recedes, land uses that have had consistent trip generation factors for decades may change (offices and residential).

ITEJ: **What have been some of your most memorable projects and why?**

RUEHR: There have been many, but I will mention three projects.

When I moved to the Twin Cities, MN, USA, and took a job in a consulting firm, one of my first assignments was to propose a new roadway circulation system for the Minneapolis-St. Paul International Airport. After several weeks of exploring various options, the team was ready to present our work to the Airport Commission. Since I was primarily responsible for the new circulation plan, I was elected to make the presentation. Afterward, I never got a chance to ask the team whether they wanted me to do the presentation so they could run for

cover if the ideas weren't well received. When I was done with my presentation, the executive director of the Airports Commission had a question: "How soon can you build this?" The plan was built, and it worked well. Following completion of the construction, I saw for myself on the Sunday after Thanksgiving (busiest day of the year for airport traffic). I went to the top of a nearby parking structure and watched as traffic flowed smoothly. In case you're curious, this was decades ago, and the airport roadway system has been completely updated.

Later, in San Diego, CA, USA, I was given the assignment of leading the transportation analysis on a project to build the middle portion of State Route 56 (SR 56) freeway. This project would fill a significant gap in San Diego's freeway system. I was involved in this project from the early planning stages to final design. We worked through all the details required to plan and design a major freeway segment. One step in the process was selecting the final route for the freeway mainline. This was thought to be merely a formality as the planned route had been "known" for many years, even shown on many commercially available maps. However, as it was studied in more detail, objections were raised as the planned route ran through a sensitive natural canyon area. A new route was formed during a project meeting when a stakeholder in the process, a member of the Sierra Club, drew a new line on the map avoiding the canyon, and that is where SR 56 was built. Today, you can see clearly see the "bump" to the north on any map of SR 56 midway between I-5 and I-15. I noticed that many San Diego City Council members of that time mentioned the completion of SR 56 as one of their main accomplishments while in office.

One of my more recent efforts has been the ongoing process of working on the implementation of Senate Bill 743 (SB 743), California's level of service to VMT legislation. I got involved in this process in the early stages as a task force chair for the Western District of ITE. While I knew that taking a leading role in a high-profile situation would be a lot of work, I did not want our profession to be left out of the discussion. As it turned out, ITE did have a voice in the process and final implementation guidelines reflect some (though certainly not all) of ITE's recommendations. The story of SB 743 is too long to be told here, but you can read some of the details in the ITE Guide to SB 743 available on the Northern California website at www.norcalite.org, or by reading the ITE Informational Report on page 18.

ITEJ: **You have worked for both public and private sector companies. What was your biggest learning opportunity/takeaway from each part of your career?**

RUEHR: My time in the public sector was brief, but my first job as a transportation engineer was with the Toledo (OH, USA) Metropolitan Area Council of Governments (TMACOG). I did my best to learn as much as I could. We were closer to the political structure than I have been as a consultant, and many of my older colleagues complained that their job was more political than technical. My immediate supervisor did not let the politics bother him. He worked hard and was known as someone who got things done. I didn't experience this at TMACOG, but I learned later that one of the advantages of working in the public sector is the ability to see projects proceed to completion and watch a community or region grow over time.

I have been a consultant for most of my career, and it has suited me well. My work has covered a wide variety of technical disciplines in locations all over the United States. I never know where my next project will be or what technical knowledge will be needed. I do enjoy the variety of work. The challenging part of consulting is acquiring a constant flow of work for yourself and your employees (not too much and not too little). Downturns in the economy are hard, although I have survived several and have always been employed. Consulting has a business side, and some of your effort needs to be spent on taking care of business. This is just not true for the owners of the company. Project managers in consulting firms need to understand the business in order to be successful. **itej**

Erik has been playing recreational hockey for many years and is shown here celebrating with the rest of his team (lower row, second from the right).

ITE Awards and Experience

ITE Fellow 2007-present
Member 1992-2007
Associate Member 1981-1992
Student Member 1979-1981
President, California Border Section, 1999-2000
Vice President, California Border Section, 1998-1999
Treasurer, California Border Section, 1997-1998
Secretary, California Border Section, 1996-1997
ITE Western District Chair of California, Senate Bill (SB 743) Task Force 2014-2019
Technical Program Chair, ITE District 4 Annual Meeting, Minneapolis, 1990
Transportation Research Board, Associate Member 1989-present
San Diego Regional Transportation Technology Alliance, Member 1993-2001; Board of Directors 1996-2001; President 1998-1999
Member, San Diego Highway Development Association, 1991-present
Member, WTS, 1987-2015
Member, Southwest Region Transportation Model Users Group, 1991-present

Fun Fact

I enjoy spending time with my family, traveling, playing hockey, hiking, and spending time at the ocean.

A Professional Family

While the ITE Puerto Rico Section's membership roster may not include a long list of names, having a smaller group has many advantages.

The members all know each other, and proudly boast that they are like an extended family because many of the members work at the same company or even on the same projects. The time together provides for a closer environment for transportation professionals to help promote each other. On a relatively small island, the Section tries to regularly meet in the San Juan metropolitan area to stay connected and network.

That closeness trickles into PRITE's relationship with ITE International, a relationship that has grown over the last 20 years and that in 2022 will include **Rosana Correa, P.E. (F)** a graduate of the University of Puerto Rico, being elected as the ITE International Vice President. She will assume the ITE Presidency in 2023.

The Puerto Rico Section is very proud of its colleague and friend. Correa was key to the reinstatement of the Puerto Rico Section in 2011, and she has been a continuing supporter of the Section since. Correa has been committed to ITE since she was a student; she was a founding member of the ITE Student Chapter of the University of Puerto Rico at Mayagüez, the first student chapter in Puerto Rico. The Section congratulates her and encourages her as she continues her journey supporting the transportation profession and professionals worldwide.

The Section holds at least two technical conferences per year, typically in spring and fall. These events are open to the public, with an average attendance of 60 participants, including planners, architects, students, and other transportation professionals.

These activities provide a unique opportunity to connect and network with the transportation professionals around the island since PRITE is the only professional group that focuses on transportation topics. Students participate in poster presentations that provide an opportunity to network with local professionals.

Puerto Rico 2018 Annual Meeting and Technical Conference at the College of Engineers and Surveyors of Puerto Rico.

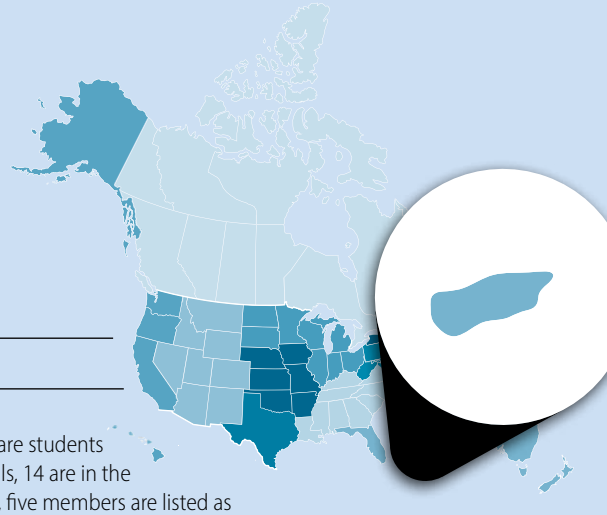
Field visit at the Traffic Management Center at Caguas, Puerto Rico, at the 2019 Florida Puerto Rico District Annual Meeting.

Topics discussed in the meetings respond to the needs of the transportation professionals, and new technologies and applications, among others. These meetings normally are conducted at the headquarters of the College of Engineers and Surveyors of Puerto Rico.

In both meetings, the PRITE Board aims to invite the heads of government agencies with relevance to transportation in an effort to create networking opportunities between transportation professionals and those in the decision-making positions. This type of meeting is convenient to these governmental leaders because they will look for the best professionals who have expertise and experience with transportation issues.

Student involvement is also important to the Section. Puerto Rico has two student chapters: one at the University of Puerto Rico at Mayagüez (UPRM), and the second at the Polytechnic University of Puerto Rico. Both are prestigious universities with great professors, advisors, and students. Every year the PRITE Section participates at conferences and on-campus meetings to promote the advantages and benefits of being part of ITE. Annually, the PRITE Section provides a sponsorship to the Traffic Bowl Team at the UPRM. Additionally, the Section provides technical advice to students who are working on research projects.

Puerto Rico Section of ITE



Florida Puerto Rico District

Members

The PRITE Section has 80 members, where 37 are students and 33 are professionals. Of the 33 professionals, 14 are in the public sector and 19 in the private sector. Also, five members are listed as young professionals and five members as fellow ITE members.

Board Members

President – **Wilfredo Cordero, EIT, MECE, RSP1 (M)**
Vice President and PRITE Section representative for the Florida Puerto Rico District– **Ashley Vargas, P.E., MEM (M)**
Secretary – **Bryan Ruiz, EIT, MSCE (M)**
Treasurer – **Migdalia Carrión, EIT, MSCE (M)**
Past President – **Zaida Rico, P.E., Ph.D. (M)**

Committee Members

Budget committee – **Joangelli Gonzalez (M), Migdalia Carrión (M)**
Communications Committee – **Armando González (M), Bryan Ruiz (M)**

Past Presidents

2020 – **Lynnette Alicea, EIT, MSCE (M)**
2018-19 – **Zaida Rico, P.E., Ph.D. (M)**
2016-17 – **Ivelisse Gorbea (M)**
2015 – **Miguel Vescovacci, P.E., PTP, PTOE (M)**
2014 – **Alexis Nevarez, P.E., MSCE**
2013 – **Vanessa Amado, P.E., Ph.D. (F)**
2012 – **Francisco Martínez, P.E., MSCE**
2010-11 – **Alberto Figueroa, P.E., Ph.D. (M)**, former Executive Director of the Puerto Rico Integrated Transportation Authority
1993 – **Benjamín Colucci, P.E., Ph.D. (F)**, Founding Member

Members of Note

Dr. Benjamín Colucci Ríos

- 2019 Wilbur S. Smith Distinguished Transportation Educator Award
- 2021 Wilbur S. Smith Award – ASCE

Eng. Carlos Contreras

- Past PRITE board member
- 2016-2020 Secretary of the Puerto Rico Department of Transportation and Public Works (PRDTPW)

Awards

PRITE gives two annual awards: Distinguished Transportation Professional and Outstanding Transportation Student. As of today, PRITE has granted seven of each award.

Hosting the 2019 Florida Puerto Rico District Annual Meeting

This event was an incredible experience for the Section's members. It provided a great opportunity for PRITE Section members who had never participated in ITE activities outside of Puerto Rico to engage with other section members. Likewise, members from Florida Puerto Rico District enjoyed cultural activities and exquisite food in the Caribbean atmosphere.

In addition, members outside of Puerto Rico had the opportunity to visit transportation projects that were developed on the island. The feedback received from the visitors was positive and encouraging, pointing out the effectiveness of the system and overall organization of traffic projects that were relatively new on the island.

The student chapters are important to PRITE because they are the next in line of succession to continue the Section's work. The professionals at the PRITE Section are always looking forward to connecting with the students, and vice versa, in the Spring Meetings and Annual Meetings every year. This is very important to professionals because these students have become their employees or co-workers, often because of their academic performances on specific transportation issues.

The Section also enjoys social "Peak Hours" where transportation professionals can meet and share technical and casual conversations at a local restaurant or bar while waiting for the traffic congestion to drop. Additional social activities include:

Annual Meeting. This meeting is held by the end of the year and is exclusively for members. The Annual Meeting provides a forum for the Board to present its annual report and to swear in the new Board for the upcoming year.

Evening Talk with PRITE. This new activity was included during the COVID-19 pandemic to keep PRITE members engaged. This virtual meeting provided a dynamic interaction between the participants and the speaker. The Evening Talk with PRITE is held as a relaxed meeting afterhours among colleagues and friends. **itej**

ITE Guide to California's Level of Service to Vehicle Miles Traveled Legislation (SB 743)

An ITE Informational Report

By Erik Ruehr, P.E., PTOE (F), Director of Traffic Engineering, VRPA Technologies, Inc.

In the fall of 2013, the Legislature in California, USA, passed a bill that caused extensive changes in the practice of transportation engineering and planning in America's most populous state. Senate Bill 743 (SB 743), was signed into law by Governor Jerry Brown in September 2013 initiating a lengthy guideline-writing process culminating in the implementation of SB 743 statewide in July 2020.

Through legislative initiative, SB 743 changed the performance measure to be used for transportation evaluations under the California Environmental Quality Act (CEQA), a state environmental policy similar to the National Environmental Policy Act (NEPA). SB 743 prohibited the use of automobile level of service and delay, and required that a different performance measure be used that supported the goals of reduction of greenhouse gas emissions, the development of multimodal transportation networks, and a supporting a diversity of land uses. Through discussions occurring after SB 743 was passed, a consensus opinion has formed that vehicle miles traveled (VMT) is the performance measure best suited to the implementation of SB 743.

While the use of level of service and delay is prohibited as a performance measure in conducting environmental studies under CEQA, there are no restrictions placed on the use of level of service and delay for any other purposes, and these measures continue to be used in California for operational analysis of roadways, planning future roadway networks, traffic impact analysis, and a variety of other studies. In addition, level of service and delay continues to be used as the traditional performance measure for NEPA. Therefore, projects that require both a state and federal environmental clearance now include both a CEQA transportation analysis focused on VMT and a NEPA transportation analysis focused on level of service and delay.

In terms of policy, the net impact of SB 743 is to discourage land development and transportation projects that would increase VMT by requiring that they analyze and consider mitigation measures that would reduce their VMT increases. SB 743 also provides a more streamlined environmental process for land development and transportation projects that would have adverse effects on level of service and delay. These projects no longer have a requirement under CEQA to analyze and consider mitigation measures for significant level of service and delay issues they would cause. It is important to note that lead agencies can still require projects to provide transportation improvements that would improve level of service and delay. The change under SB 743 is that any conditions of approval related to level of service and delay now occur outside the state's environmental process.

For transportation engineers and planners, the implementation of SB 743 requires acquisition of a new skill set to analyze and mitigate VMT increases caused by land development and transportation projects. Although VMT has traditionally been used as a performance measure at the regional level, analysis of VMT at the project level is a new challenge.

ITE Guide to SB 743

The ITE Guide to SB 743 is an unpublished white paper prepared by the California ITE SB 743 Task Force, a joint task force of the seven ITE Sections in California. It can be found at the Northern California ITE website (www.norcalite.org) under the SB 743 section. This guide was written to provide California transportation engineers and planners information on implementing SB 743.

The ITE Guide to SB 743 includes information on the following topics:

- History and background of SB 743
- VMT analysis and mitigation for various types of projects
- Recommendations for VMT analysis in rural and suburban areas
- Implementation steps for lead agencies
- Summary of Caltrans' role in implementing SB 743
- Resources and website for additional information
- One-page summary of SB 743 suitable for distribution to interested stakeholders outside the transportation engineering and transportation planning professions

Use of VMT as a Project-Level Performance Measure Outside California

Many agencies throughout the United States and in other parts of the world share the goals of SB 743 as stated in the legislation:

- Reduction of greenhouse gas emissions
- Development of multimodal transportation networks
- Supporting a diversity of land uses

Therefore, it is reasonable to ask whether initiatives similar to SB 743 could be of interest in other regions or states within the U.S or in other countries. In other words, would project-level VMT analysis and mitigation help other jurisdictions outside California achieve the above-stated goals?

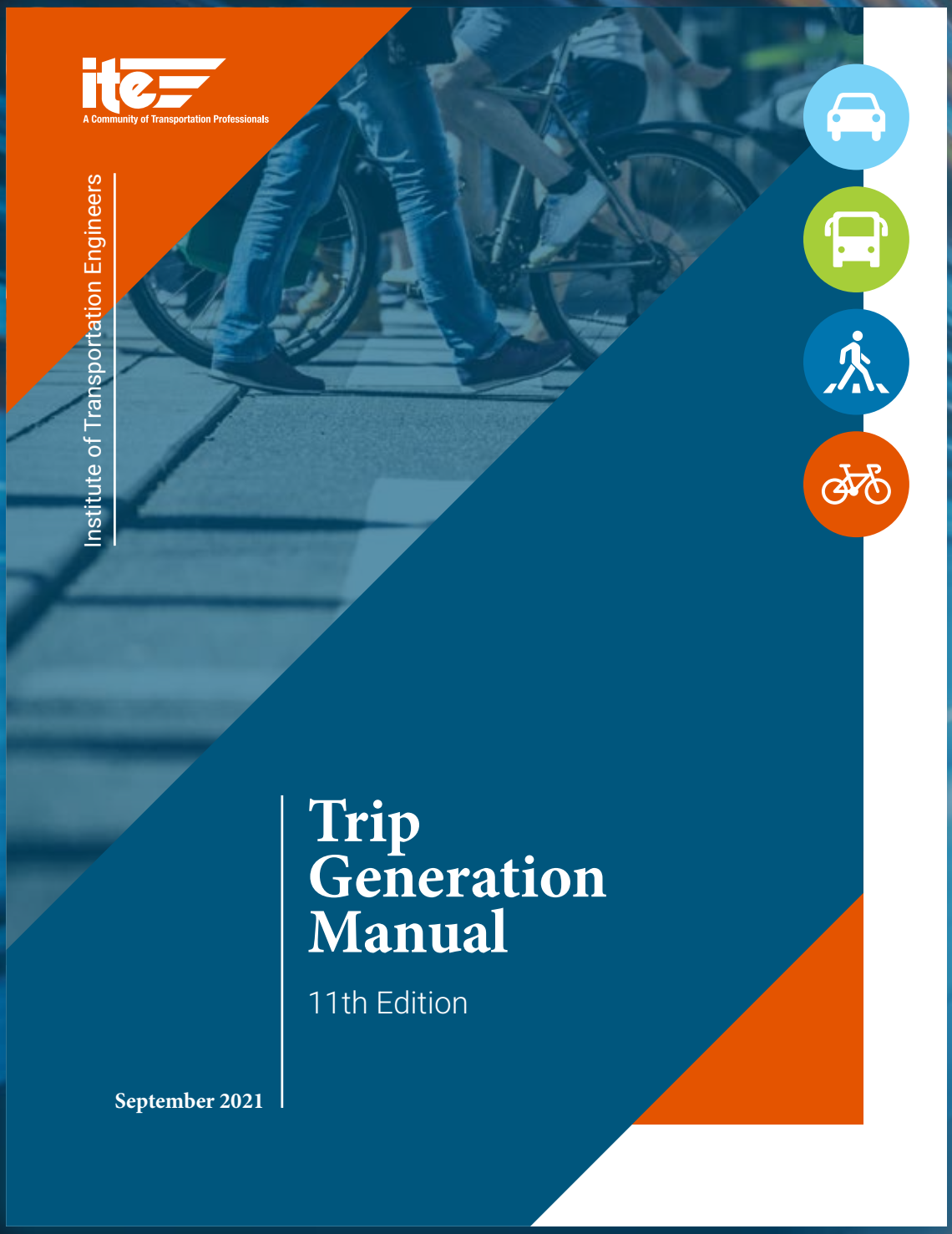
Although there has been considerable interest in understanding California's LOS to VMT initiative, the California ITE SB 743 Task Force is not aware of implementation of any similar initiatives enacted outside California.

Publication of the ITE Guide to SB 743 as an ITE Informational Report

Due to the level of interest in California's SB 743 initiative, ITE has announced its intent to publish the ITE Guide to SB 743 as an ITE Informational Report. While it remains unknown whether similar initiatives will be implemented outside California, it is considered important that ITE members have the technical knowledge and information necessary to consider and respond to questions regarding available tools and resources relating to the transportation profession. Publication as an ITE Informational Report will allow ITE members around the world to have easier access to events in California. When questioned about whether an initiative like SB 743 could be successful in other locations, ITE members will be able to review the relevant information and provide an informed response. **itej**

Learn More

The ITE Guide to SB 743 resource, prepared by the California ITE SB 743 Task Force, can be found at the Northern California ITE website (www.norcalite.org) under the SB 743 section.



Shutterstock/Pozdeyev Vitaly

Updates to the Trip Generation Manual, 11th Edition

In September 2021, ITE released the 11th Edition of the transportation profession's leading source of trip generation information—*Trip Generation Manual* (TGM). This new edition updates and enhances the 10th Edition by providing the latest multimodal trip generation data for urban, suburban, and rural locations.

Trip Generation Manual contains text, tables, data plots, and statistics that describe current state-of-the-practice understanding of the relationship between walk, bicycle, transit, motor vehicle, and truck trip generation and characteristics associated with an individual development site or land use. TGM also presents land use descriptions and data plots for combinations of available land uses, time periods, independent variables, and settings contained in the ITE database.

The 11th Edition of TGM has undergone numerous changes in content and format when compared to the 10th Edition. The significant improvements described in this article are due largely to the efforts, attention, and diligence of the Trip Generation Review Panel.

TGM Format and Organization Changes

The primary means for accessing the 11th Edition is through the ITETripGen web app. The web app provides immediate access to integrated digital copies of all related land use definitions, plots, and supporting materials (including the desk reference, pass-by trip generation information, *Trip Generation Handbook*, truck trip generation, hourly distribution data, and supplemental plots). The entire PDF version of the 11th Edition is now accessible through the web app.

Trip Generation Manual, 11th Edition is also offered in five hard copy volumes. The first volume (Desk Reference) includes the chapter content that establishes the format, framework, and content of the overall 11th Edition (same as for the 10th Edition).

Volume 2 includes the land use description pages and data plots for the 43 land uses with sites in either a dense multi-use urban setting or center city core setting. If data are available, plots are provided for vehicle, person, walk, bicycle, transit, and walk+bicycle+transit trips.

Volumes 3 through 5 contain the land use description pages and data plots for the 177 land uses with sites in either a suburban or rural setting. Data plots are provided for vehicle and walk+bicycle+transit trips.

Further, the 11th Edition includes over 900 supplemental data plots accessible through the ITETripGen web app or through access to a protected ITE website for hard copy users. These supplemental plots include truck trip plots for all land uses for which data are available and individual modal and person trip plots for suburban and rural settings.

ITETripGen Web App Updates

The menu order on the ITETripGen Graph Look Up page has been changed to allow selection of the site setting immediately after selection of a land use code. The default site setting is General Urban/Suburban. By promoting this selection to earlier in the web app data plot definition process, the analyst can see what independent variable and time period combinations have data plots available in their site setting. This early definition also minimizes potential errors in the mixing of urban and suburban data plots.

For the 10th Edition, upon selection of a land use, the app provided a "Click for more details" link that pulled up a PDF of the

Land Use Description page for the specified land use. For the 11th Edition, the link pulls up a PDF of the Land Use Description page plus all data plots associated with that land use. The PDF format enables the analyst/user to print individual pages or to copy/paste selected data plots into reports as desired.

The Technical Support button on the left banner of the Graph Look Up page has been expanded by adding three buttons:

- TGM Desk Reference–includes all nine chapters of the 11th Edition Desk Reference (e.g., definitions of terms, list of data sources)
- TGM Appendices–includes tables with time-of-day distributions, tables with pass-by trips (previously available only in *Trip Generation Handbook*), modal data plots for sites in suburban settings, truck data plots for all land uses, and modal and truck percentages for all land uses
- Supporting Trip Generation Documents–includes *Trip Generation Handbook* 3rd Edition and other ITE resources that also reside on the ITE Trip Generation Resource Page

Trip Generation Land Use Description/Data Updates

Industrial Land Uses (100s)

The 10th Edition Supplement introduced the use of land use subcategories for High-Cube Fulfillment Center Warehouse (Land Use 155) with sort and non-sort subcategories. These subcategories provide, in essence, additional land uses as subsets of the current Land Use 155.

Marijuana Cultivation and Processing Facility (Land Use 190) has been added as a new land use.

Residential Land Uses (200s)

Single-Family Attached Housing (Land Use 215) has been added as a new land use. Sites included in this land use are any single-family housing unit that shares a wall with an adjoining dwelling unit, whether the walls are for living space, a vehicle garage, or storage space. The database includes duplexes, townhouses, and row houses.

The number-of-floors threshold between Multifamily Housing (Low-Rise) (Land Use 220) and Multifamily Housing (Mid-Rise) (Land Use 221) has been revised. Low-rise sites are now defined as having three or fewer floors, and mid-rise sites have between four and 10 floors.

The proximity of a residential site to a rail transit station has been added as a factor to consider when using any of the multifamily housing land uses (Land Uses 220, 221, and 222). The default land use subcategory selection in the web app (and the initial set of data plots in the PDF and hard-copy versions) is that the site is not located close to a rail transit station. If the study site is located within a half-mile walk of a rail transit station, the land use subcategory "Close to Rail Transit" is the appropriate selection.

The 10th Edition Supplement introduced the use of land use subcategories for Affordable Housing (Land Use 223) with Income Limits and Senior as its two land use subcategories. The 11th Edition has added a third subcategory for affordable housing for special needs residents (which can include persons with physical and mental impairments, single mothers, recovering addicts, and others).

Off-Campus Student Apartments are now divided into low-rise, mid-rise, and high-rise land uses (Land Uses 225, 226, and 227).

The proximity of an off-campus student apartment to a college campus was added with the 10th Edition Supplement as a factor to consider when using any of the off-campus student apartment land uses (Land Uses 225, 226, and 227). The default land use subcategory selection in the web app (and the initial set of data plots in the PDF and hard copy versions) is named/titled "Adjacent to Campus." If the study site is located more than a half-mile walk of the college campus, the land use subcategory "Over 1/2 Mile from Campus" is the appropriate selection.

Multifamily Residential with 1st-Floor Commercial land uses (Land Uses 231 and 232) have been renamed Multifamily Residential with Ground-Floor Commercial, and have been split into Low-Rise, Mid-Rise, and High-Rise (Land Uses 230, 231, and 232) using the same number-of-floors thresholds as Land Uses 220, 221, and 222.

For the Multifamily Residential with Ground-Floor Commercial land uses (230, 231, and 232), the amount of gross floor area (GFA) designated for commercial use is used as a factor when estimating site trip generation. The default land use subcategory selection in the web app (and the initial set of data plots in the PDF and hard copy versions) is named/titled "GFA (1-25k)" which indicates the commercial GFA is between 1,000 and 25,000 square feet. The other commercial GFA choice provided is "GFA (25-65k)."

Senior Adult Housing–Detached (Land Use 251) and Senior Adult Housing–Attached (Land Use 252) have been combined into a new Senior Adult Housing–Single-Family (Land Use 251) that includes both detached and attached housing. New data have been used to create a new land use, Senior Adult Housing–Multifamily (Land Use 252).

The 11th Edition removes occupied dwelling units as an independent variable for the residential land uses in the 200s: (Land Uses 210 through 223, 230 through 252, and 260 through 270). The total number of dwelling units is considered a more accurate and reliable independent variable and has been retained.

The 11th Edition removes occupied beds as an independent variable for land uses that include at least some elements of group quarters living: Affordable Housing (Land Use 223), Assisted Living (Land Use 254), and Congregate Care Retirement Community (Land Use 255). The total number of beds is considered a more accurate and reliable independent variable and has been retained.

Recreational Land Uses (400s)

Movie Theater (Land Use 444) and Multiplex Movie Theater (Land Use 445) have been combined into a single land use Movie Theater (Land Use 445) that now contains all movie theater data.

Arena (Land Use 450) has been removed as a land use after reexamination of the single study site in the database indicated the site may not conform to the land use description.

The primary independent variable for Snow Ski Area (Land Use 466) has been changed to the number of lifts.

Casino/Video Lottery Establishment (Land Use 473) has been renamed Casino (Land Use 473) because the database now includes full-service casinos as well as the smaller video lottery establishments.

Institutional Land Uses (500s)

Primary and secondary school land uses have been reorganized to provide a more logical numbering sequence.

- Public school land uses are now assigned within the 520-528 range–Elementary School (Land Use 520), Middle/Junior High School (Land Use 522), and High School (renumbered as Land Use 525). Because School District Office consists entirely of facilities for public schools, it has been recoded as Land Use 528.
- Private school land uses are now assigned within the 530-534 range–Private School (K-8) (renumbered as Land Use 530), Private School (K-12) (renumbered as Land Use 532), and Private High School (added as Land Use 534).
- Charter school land uses are now assigned within the 536-538 range–Charter Elementary School (renumbered as Land Use 536) and Charter School (K-12) (added as Land Use 538).

Prison (Land Use 571) has been renamed Adult Detention Facility because the database includes both jails and prisons.

The 11th Edition removes occupied beds as an independent variable for Adult Detention Facility (Land Use 571). The total number of beds is considered a more accurate and reliable independent variable and has been retained.

Medical Land Uses (600s)

The 11th Edition removes occupied beds as an independent variable for Nursing Home (Land Use 620). The total number of beds is considered a more accurate and reliable independent variable and has been retained.

Office Land Uses (700s)

The description of a Small Office Building (Land Use 712) has been changed to be a single-tenant office with less than or equal to 10,000 square feet of GFA. The description for General Office Building (Land Use 710) has been adjusted accordingly.

Trip Generation Manual, 11th Edition, Review Panel

Justin Barrett (M), JCB Engineering
Paul Basha (M), Summit Land Management
Gina Bonyani, FDOT
Chris Brehmer (M), Kittelson & Associates
Kenneth Cram (F), Bayside Engineering
Debbie Dantin (M), Dantin Consulting
Brian Dempsey (F), Provident Design Engineering
Alison Felix, Metropolitan Area Planning Council
John Gard (M), Fehr & Peers
Wes Guckert (F), The Traffic Group
Dan Hardy (M), Renaissance Planning Group
Randy McCourt (F), ITE Past President Retired
Nadereh Moini (M), New Jersey Sports and Exposition Authority
Cole Piechotta (M), City of Calgary
Fede Puscar (M), Bunt & Associates
Lisa Schletzbaum (M), MassDOT
Peter Terry (F), Benchmark Civil Engineering
Eric Tripi (M), GHD
Paul Villaluz (F), Westwood Professional Services
Tony Voigt (M), Voigt Associates
Mike Workosky (M), Wells and Associates
Brad Yarger, Yarger Engineering, Inc.
Darlene Danehy Yellowhair (M), Psomas
Diane Zimmerman (M), Zimmerman Traffic Engineering

The proximity of a Medical-Dental Office Building to a hospital has been added as a factor to consider for Land Use 720. The default land use subcategory selection in the web app (and the initial set of data plots in the PDF and hard copy versions) is that the site is stand-alone and is not adjacent to or within a hospital campus. If the study site is located within or near a hospital campus, the land use subcategory "Within/Near Hospital Campus" is the appropriate selection.

Government Office Complex (Land Use 733) has been removed because its single data point consists of a mixed-use site and not a single land use. The data is of limited value due to the uniqueness of the site.

The 11th Edition removes occupied GFA as an independent variable for all office land uses. Total GFA is considered a more accurate and reliable independent variable and has been retained.

Retail Land Uses (800s)

Shopping Center (Land Use 820) has been divided into three separate land use codes:

- Shopping Center (>150k) (Land Use Code 820) for sites with more than 150,000 square feet of gross leasable area (GLA)
- Shopping Plaza (40-150k) (Land Use Code 821) for sites between 40,000 and 150,000 square feet GLA
- Strip Retail Plaza (<40k) (Land Use 822) for sites with less than 40,000 square feet GLA

Whether or not a Shopping Plaza includes a supermarket has been added as a factor to consider for Land Use 821. The default land use subcategory selection in the web app (and the initial set of data plots in the PDF and hard copy versions) is that the shopping plaza includes a supermarket. If the study site does not include a supermarket, the land use subcategory "Supermarket - No" is the appropriate selection.

Convenience Market (Land Use 851) has been renamed Convenience Store (Land Use 851).

The data from the existing Discount Supermarket (Land Use 854) have been reclassified. The large discount supermarkets have been merged into the overall Supermarket (Land Use 850) and Land Use 854 has been removed as a land use.

Services Land Uses (900s)

Quality Restaurant (Land Use 931) has been renamed Fine Dining Restaurant (Land Use 931).

Gross floor area (GFA) has been removed as an independent variable and replaced by the number of drive-through lanes for two land uses:

- Fast-Food Restaurant with Drive-Through Window and No Indoor Seating (Land Use 935)
- Coffee/Donut Shop with Drive-Through Window and No Indoor Seating (Land Use 938)

Examination of the study sites that comprise Bread/Donut/Bagel Shop without Drive-Through Window (Land Use 939) and Bread/Donut/Bagel Shop with Drive-Through Window (Land Use 940) revealed that the sites included in these land uses fit the definition and trip generation characteristics of the existing coffee/donut shop land uses. Therefore, land uses 939 and 940 have been removed and the study sites reassigned to the appropriate coffee/donut shop land uses (Land Uses 936 and 937).

Convenience Market with Gasoline Pumps (Land Use 853), Gasoline/Service Station with Convenience Market (Land Use 945), and Super Convenience Market/Gas Station (Land Use 960) have been reassigned to a single new land use Convenience Store/Gas Station (Land Use 945). Land Uses 853 and 960 have been removed.

Multiple land use subcategories have been added to Land Use 945 to allow for a multi-variable evaluation of sites with single-variable data plots. All study sites are assigned to one of three subcategories, based on the number of vehicle fueling positions (VFP) at the site:

- Between 2 and 8 VFP
- Between 9 and 15 VFP, and
- Between 16 and 24 VFP

For each VFP range subcategory, Land Use 945 data plots are presented with GFA as the independent variable for all available time periods and trip types. The use of both GFA and VFP (as the independent variable and land use subcategory, respectively) provides a significant improvement in the reliability of a trip generation estimate when compared to the single-variable data plots in prior editions of *Trip Generation Manual*. Further, the study sites are also assigned to one of three other subcategories, based on the convenience store GFA at the site:

- Between 2,000 and 4,000 square feet
- Between 4,000 and 5,500 square feet, and
- Between 5,500 and 10,000 square feet

For each GFA subcategory range, Land Use 945 data plots are presented with VFP as the independent variable for all available time periods and trip types. The use of both VFP and GFA (as the independent variable and land use subcategory, respectively) provides a significant improvement in the reliability of a trip generation estimate. Each combination of GFA and VFP values for a convenience store/gas station, the two sets of data plots produce two estimates of site-generated trips.

The trips recorded for Truck Stop (Land Use 950) have been modified to include only truck trips. Data plots now use the commercial VFP as the independent variable rather than general use VFP or site GFA.

Three service land uses with a focus on the consumption of alcoholic beverages are now grouped in the 970s. Wine Tasting Room (Land Use 970) has been renamed to better reflect the data contained in this land use. Brewery Tap Room (Land Use 971) has been added as a new land use. Drinking Place has been renumbered as Land Use 975.

Long-Term Effects of COVID Pandemic on Trip Generation

The COVID-19 pandemic has had immediate and significant impacts on the North American economy and on many elements of personal and business trip-making. Some of these effects, still ongoing as of this writing, are expected to be long lasting. The extent to which these impacts will have long-term impacts on ITE Trip Generation rates remains unknown.

All data plots and statistics presented in *Trip Generation Manual* (TGM) are based on data collected prior to the pandemic. ITE recognizes that some TGM data plots and statistics may need to be updated once post-pandemic conditions stabilize. ITE does not know with certainty which data plots and statistics will need to be updated until future study site data are collected and analyzed. Nevertheless, *Trip Generation Manual* identifies and discusses several land uses for which measurable changes in trip generation characteristics may occur. **itej**

Resources

For additional guidance on impacts of COVID-19 on travel demand, ITE has developed a COVID-19 resource web page that presents a wide variety of technical resource material to help provide an understanding of anticipated short- and longer-term impacts of COVID-19 on the transportation system and trip making characteristics.

See **www.ite.org/about-ite/covid-19-resources** for more information. Of particular relevance is the ITE report titled "What a Transportation Professional Needs to Know about Counts and Studies during a Pandemic." The report can be accessed through the ITE website: **https://ecommerce.ite.org/IMIS/ItemDetail?iProductCode=IR-148-E.**

Shutterstock/Vitaliy Andreev

Study Area Trip Distribution Method for Traffic Analyses

By Grant G. Schultz, Ph.D., P.E., PTOE (F) and Michael L. Adamson

The purpose of this article is to provide a resource to explain the study area trip distribution method for traffic impact analyses. Based on the Institute of Transportation Engineers' (ITE) *Transportation and Land Development*, 2nd Edition, trip distribution is defined as "the percentage of directional distribution of the total site traffic onto the major approach routes to the proposed study site," while the analogy method "uses the directional distribution of traffic generated by another similar development in the immediate vicinity of the site under study" to create a trip distribution for use in the traffic impact analysis.[1]

The analogy method uses developments or land uses that are analogous to the given project site. The study area trip distribution method applies this concept on a study area level, based on the assumption that the study site will have a similar trip distribution to the surrounding roadways within which the site is contained. As such, this method evaluates the turning movement counts for intersections that provide access into and out of the study area to determine the directional distribution for the study area that then can be applied to the study site.

Literature Review

Trip distribution is a topic that has been heavily studied since the 1950s. The purpose of these studies has been to find ways of predicting the distribution of vehicles traveling to a given destination from a variety of origins. As a result, several methods have been developed to determine directional distribution including the analogy method, the area of influence method (including the gravity model), and the origin-destination method.[1]

The gravity model has been a particular focus of many researchers, as its applications within the realm of trip distribution are widespread. Wilson provides an in-depth explanation of this model and some of its applications.[2] Since the publication of that article in 1970, a variety of studies have been performed to develop more efficient applications of the gravity model, such as developing a doubly constrained trip distribution model,[3] which combines the origin (emissiveness) and destination (attractiveness) effects to develop a more accurate trip distribution.[4] The gravity model can be complicated as it allows for several parameters to be identified and used to better represent and estimate driver behavior. Because of this, some researchers have also focused on developing more efficient methods for determining the parameters within the gravity model.[5]

Due to the large amount of data needed to apply the gravity model, it can at times be less ideal for traffic impact analyses that focus on smaller developments. As such, it is beneficial to consider simpler methods of trip distribution for these cases. Looking at the impacts and analogous behaviors of like land uses (the analogy method) can yield accurate directional distributions more efficiently for smaller developments than other methods. As stated by Alan Vorhees, "Any theory that attempts to explain the origin and destination of various types of trips in urban areas must reflect the competitive factors of similar types."[6] Studying similar land uses and their effects on each other near the site can represent the driver behaviors present, particularly at smaller scales.

Regardless of the method used, it is important to note that engineering judgment must be applied in conjunction with state and local standards to ensure that any traffic forecast and distribution applied is neither overly conservative nor overly limited.[7] The point of any trip distribution model is to ensure that driver behavior is being well represented by the directional distribution, thus allowing for a more accurate representation of traffic impact.

Explanation of Study Area Trip Distribution Method

This section will explain applications of the study area trip distribution method for traffic impact analyses. To do this, an example study area was developed for illustration of the methodology, and three possible applications of the study area trip distribution method were applied: assuming all movements (Application 1), assuming study site entering and exiting movements only (Application 2), and assuming entering and exiting movements only with separate distributions for entering and exiting traffic (Application 3).

First the format of the example study area will be explained, followed by an explanation of each application as well as a comparison of the directional distributions found. Note that this example is for illustration purposes only. The study area boundaries for each specific application are based on state and local standards as determined from a pre-application meeting for the study.[8] The analyst would need to adapt the methodology to local circumstances based on the actual makeup of the study area and utilizing the concepts outlined.

Format of Example Study Area

To perform the study area trip distribution method, an example study area was created, consisting of Roadways A, B, and C. Roadway A runs north to south, and will be considered the major roadway of the example study area, while Roadway B and C run east to west. The study area consists of two intersections, with the example site assumed to be located between these intersections:

- Roadway A / Roadway B
- Roadway A / Roadway C

The example study area is shown in Figure 1. This study area was designed with six "entrances" to the study area. Each entrance is a leg of one of the two intersections within the study area, excluding the two legs that connect the two intersections (considered legs that are internal to the study area). These six legs are considered entrances to the study area because they allow external traffic to enter the study area and provide opportunity for internal traffic to exit the study area. The entrances to the example study area are as follows:

- North (N): Southbound leg of the Roadway A / Roadway B intersection
- Northwest (NW): Eastbound leg of the Roadway A / Roadway B intersection
- Northeast (NE): Westbound leg of the Roadway A / Roadway B intersection
- South (S): Northbound leg of the Roadway A / Roadway C intersection

- Southwest (SW): Eastbound leg of the Roadway A / Roadway C intersection
- Southeast (SE): Westbound leg of the Roadway A / Roadway C intersection

To find the percentage of the directional distribution corresponding to each entrance to the study area, the turning movements interacting with the entrances were identified, summed, and then divided by the total volume considered for the directional distribution of the study area. This yielded the percentage of volume expected to enter and exit the study area. However, determining which turning movements at the intersections are pertinent to the study area directional distribution and which are not can vary from one study area to another contingent upon local conditions, the needs of the project site under review, and engineering judgment. The following subsections will give examples of different applications of the turning movement counts used to adjust the directional distribution of the study area trip distribution method.

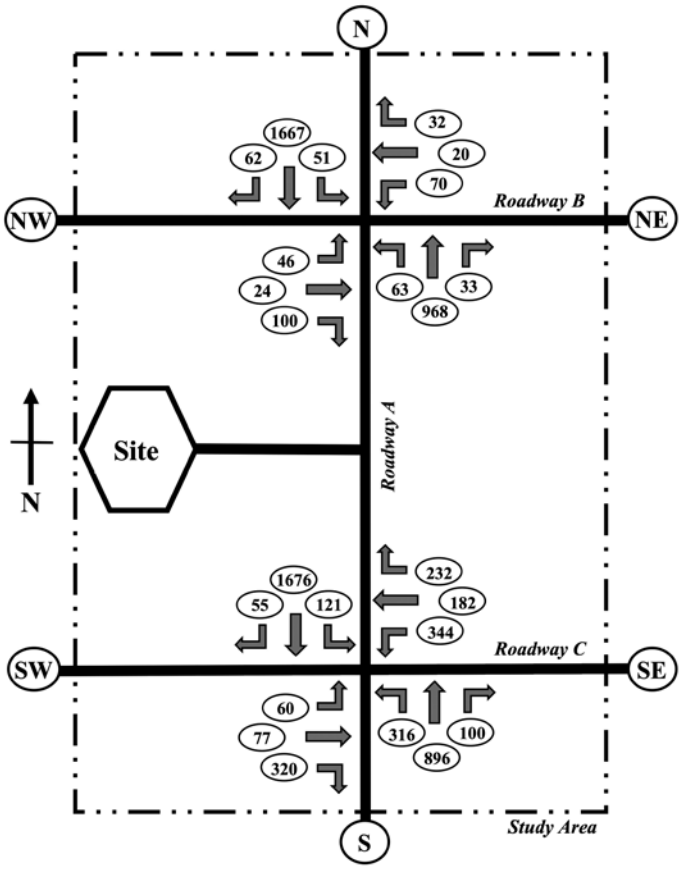
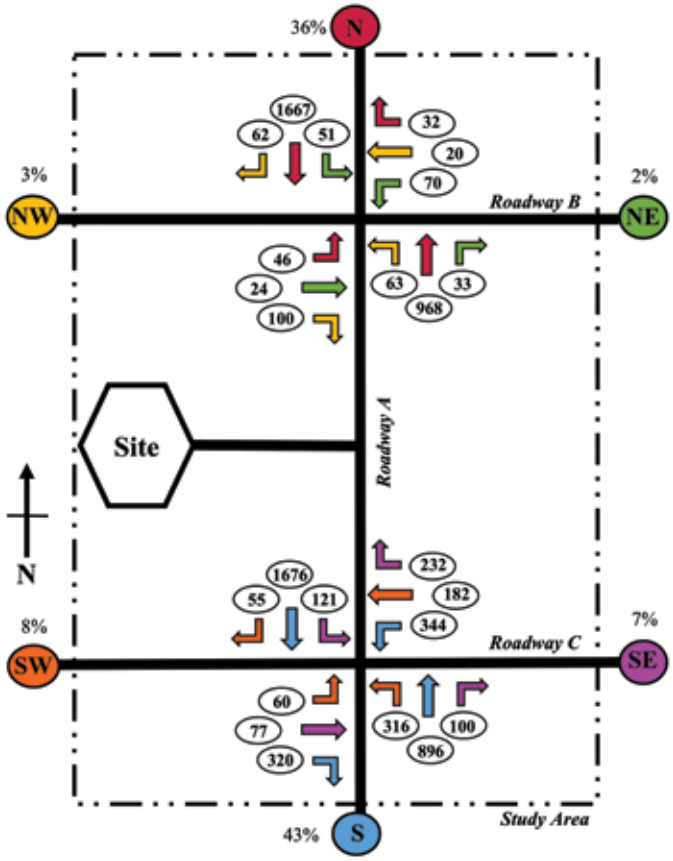


Figure 1. Turning movement counts for example study area.

Application 1

One application of the turning movement counts to define a directional distribution is to assume all movements at the pertinent intersections contribute to the overall distribution. A visual representation of this process for the sample study area is shown in Figure 2. From this figure, four movements correspond to each entrance point when all turning movements are assumed, including one entering movement and three exiting movements. The corresponding directional distribution for each entrance point is given in the table contained within the figure.

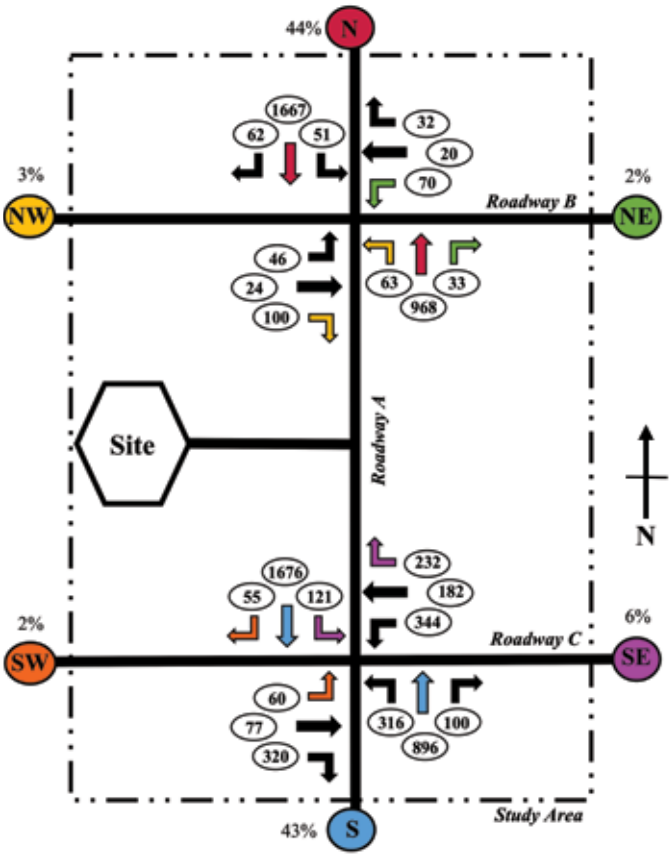


Direction	Volume			Percentage
	Enter	*Exit*	*Total*	
N	1667	1046	2713	36%
NW	100	145	245	3%
NE	70	108	178	3%
S	896	2340	3236	43%
SW	60	553	613	8%
SE	232	298	530	7%
Total	3025	4490	7515	100%

Figure 2. Directional distribution with all turning movements included (Application 1), marked according to direction.

Application 2

Another way to approach the study area trip distribution method would be to consider only traffic entering and exiting the study area. Referring to Figure 2, some movements only 'skim' the study area without ever entering or exiting to/from the study site, such as the southbound left- and right-turn movements at the Roadway A / Roadway B intersection. These movements skimming the study area are not considered in this application. Additionally, traffic internal to the study area that does not enter or exit at any of the defined entrance points would not be considered. An illustration of this approach is shown in Figure 3.



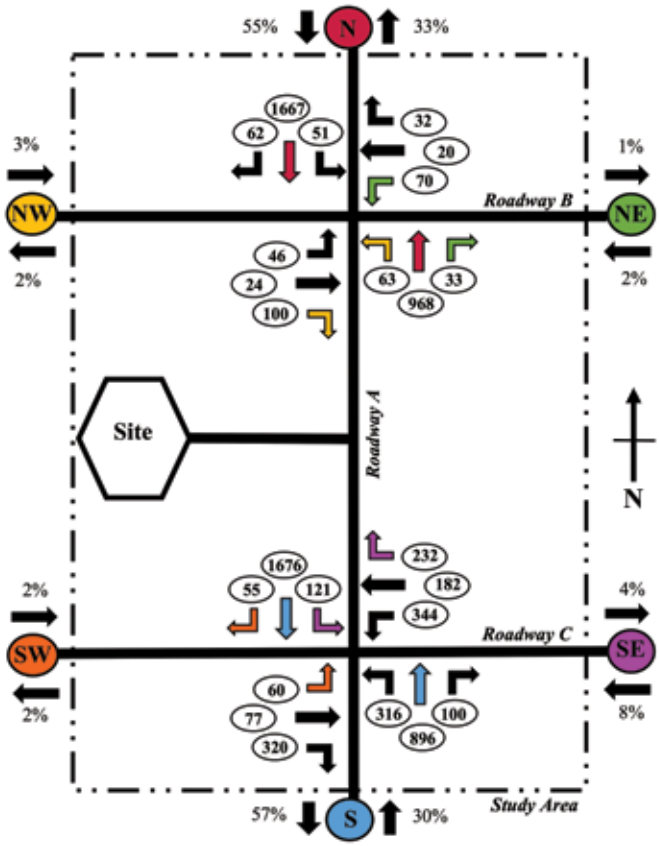
Direction	Volume			Percentage
	Enter	*Exit*	*Total*	
N	1667	968	2635	44%
NW	100	63	163	3%
NE	70	33	103	2%
S	896	1676	2572	43%
SW	60	55	115	2%
SE	232	121	353	6%
Total	3025	2916	5941	100%

[Movement Not Used]

Figure 3. Directional distribution after limiting to entering and exiting movements only (Application 2), marked according to direction.

Application 3

There are some instances where it might be logical to assume separate distributions for both the entering and exiting trips, such as heavy commuter volume entering in the morning peak hour that likely will exit during the evening peak hour. To illustrate, the directional distribution from Figure 3 was split into two separate distributions, one for entering and one for exiting traffic. This is shown in Figure 4.



Direction	Volume		Percentage	
	Enter	*Exit*	*Enter*	*Exit*
N	1667	968	55%	33%
NW	100	63	3%	2%
NE	70	33	2%	1%
S	896	1676	30%	58%
SW	60	55	2%	2%
SE	232	121	8%	4%
Total	3025	2916	100%	100%

[Movement Not Used]

Figure 4. Separate directional distributions after limiting to entering and exiting movements only (Application 3), marked according to direction.

Comparison of Distributions

The directional distributions resulting from the different turning movement applications within the study area trip distribution method are shown in Table 1. In comparing these directional distributions, the variation between each is relatively minor. This is logical, due to differences in engineering judgment and variable circumstances made for each case.

Table 1. Comparison of directional distributions.

Case	Enter/ Exit	Percentage of Distribution					
		N	NW	NE	S	SW	SE
All Movements	**Both**	36%	3%	3%	43%	8%	7%
Enter/Exit Movements	**Both**	44%	3%	2%	43%	2%	6%
Enter/Exit Separate	**Enter**	55%	3%	2%	30%	2%	8%
	Exit	33%	2%	1%	58%	2%	4%

Conclusion

The purpose of this article is to provide a resource to explain the study area trip distribution method as a viable method to determine the directional distribution of trips for a given study area. The analogy method assumes that a study site will have a trip distribution that is analogous to the given project site. The study area trip distribution method applies this assumption at the study area level, assuming that the study area will have a similar distribution to the surrounding roadways within which the site is contained.

To illustrate this method and its variability of application, three applications of the study area turning movement counts were used to develop directional distributions, including all movements, entering/exiting movements only, and assuming different distributions for entering versus exiting trips. In comparing the directional distributions found using the three assumptions, it was noted that variability in the directional distributions likely will occur due to differences in judgment and application. In the example presented in this article, Application 2 provides the most realistic estimation based on the fact that it includes only those trips that could potentially enter/exit the study site. This could vary depending on individual circumstances.

The study area trip distribution method allows engineers and developers to use the driving behaviors of a given study area to develop a trip distribution for the study site. However, it is important to note that the assumptions used, particularly when it comes to which volumes to include and which not to, could affect the directional distribution found. As such, it is important that all assumptions and applications be clearly documented to ensure that they are logical and fit the behaviors observed within the study area. **itej**

References

1. Stover, V.G. and F.J. Koepke. *Transportation and Land Development. 2nd Edition*. Washington, DC, USA: Institute of Transportation Engineers, 2006.
2. Wilson, A.G. "Advances and Problems in Distribution Modelling." Transportation Research, Vol. 4, 1970, pp. 1-18.
3. Arrowsmith, G. "A Behavioral Approach to Obtaining a Doubly Constrained Trip Distribution Model." *Operational Research Quarterly*, Vol. 24, No. 1, 1973, pp. 101-111.
4. Cesario, F.J. "A Generalized Trip Distribution Model." *Journal of Regional Science*, Vol. 13, No. 2, 1973, pp. 233-247.
5. Kadas, S.A. and E. Klafszky. "Estimation of the Parameters in the Gravity Model for Trip Distribution: A New Method and Solution Algorithm." *Regional Science and Urban Economics*, Vol. 6, 1976, pp. 439-457.
6. Vorhees, A.M. "A General Theory of Traffic Movement–The 1995 ITE Past Presidents' Award Paper." Transportation, Vol. 40, No. 1, 2013, pp. 1105-1116.
7. Abu-Eisheh, S.A. and F.L. Mannering. "Traffic Forecasting for Small- and Medium-Sized Urban Areas." *ITE Journal*, 1986, pp. 37-42.
8. Institute of Transportation Engineers (ITE). *Transportation Impact Analyses for Site Development*. Washington, DC, USA, 2010.

Dr. Grant Schultz, P.E., PTOE (F) *is a professor of civil engineering at Brigham Young University. He holds bachelor of science and master of science degrees in civil engineering from BYU, and a Ph.D. in civil engineering from Texas A&M University. In addition to teaching the Introduction to Transportation Engineering course, Dr. Schultz teaches courses in traffic engineering, transportation site planning, and global leadership, and has taught study abroad courses in China and Europe. He conducts research in the areas of traffic operations, traffic safety, incident management, connected vehicle technologies, and access management. He is the past Chair of the ITE Transportation Education Council, is a member of the TRB Standing Committee on Safety Performance and Analysis, and is Chair of the TRB Standing Committee on Access Management.*

Michael L. Adamson *is a transportation engineer for Fehr & Peers in its Tacoma, WA, USA, office. He emphasizes in traffic impact analysis, long-range multimodal transportation planning and forecasting, impact fee program development, and geospatial traffic safety analysis. He is passionate about helping clients plan transportation systems that best meet the complex preferences and needs of their diverse range of users.*

Upcoming Live Webinars

Pavement Markings - What, Where, Why, When and Liability Concerns 1.5 PDH
Thursday, October 7, 2:00 – 3:30 p.m. EDT
This webinar is led by the Traffic Engineering Council.

Strategies to Attract and Retain Female Talent in Transportation
Tuesday, October 12, 2:00 – 3:00 p.m. EDT
This webinar is led by the Consultants Council.

FREE for ITE Members
The Relationship between Freight Movements and Land Use in Urban Areas
Thursday, October 14, 2:00 – 3:00 p.m. EDT
This webinar is led by the Transportation Planning Council.

FREE
An Overview of ITE's Micromobility Facility Design Practitioners Guide
Wednesday, October 20, 2:00 - 3:00 PM EDT

On-Demand Webinars Available!

Missed a webinar? No problem!
Take a look at the webinars still available to view on-demand on the ITE Learning Hub at www.pathlms.com/ite/events/.

ITE Offers Preparatory Material for the PTP, PTOE, RSP1, and RSP2 Certification Exams!

ITE Educational Foundation offers the following certification preparatory resources in the ITE Learning Hub (www.ite.org/learninghub):

- PTOE Online Practice Exam
- PTOE Refresher Online Course
- PTP Online Practice Exam
- PTP Refresher Online Course
- Road Safety Professional Level 1 (RSP1) Online Practice Exam - Revised in June 2021
- Road Safety Professional (RSP) Refresher Online Course - Revised June 2021
- Road Safety Professional Level 2 (RSP2) Behavioral Online Practice Exam
- Road Safety Professional Level 2 (RSP2) Behavioral Specialty Refresher Course
- Road Safety Professional Level 2 (RSP2) Infrastructure Specialty Online Practice Exam
- Road Safety Professional Level 2 (RSP2) Infrastructure Specialty Refresher Course

If you have questions about accessing these resources, please contact Kellyanne Broom at kbroom@ite.org. If you have questions about the PTOE, PTP, RSP1, or RSP2 exams, please contact Ann O'Neill at certification@tpcb.org.

Coming Soon!

New Partnership to Benefit Transportation Industry!
A Technician and Installer Credential program, co-developed by ITE and The NEXT Education.

Intelligent Transportation Credential (ITC)
Level1 Traffic Signal Technician & Transportation
This credential offers traffic signal technicians and transportation professionals a condensed yet flexible approach to begin their journey into Intelligent Transportation Systems (ITS).

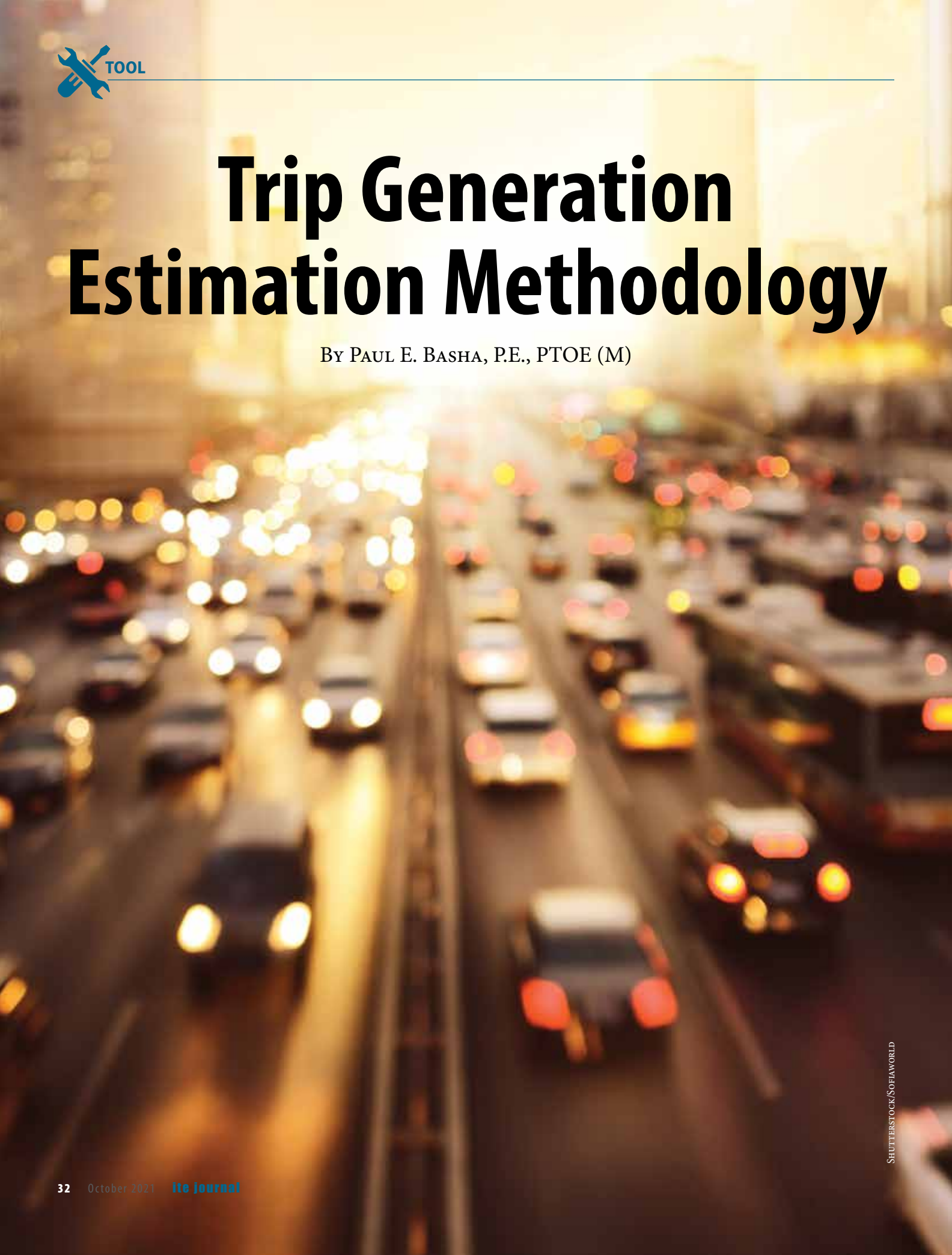
This course will familiarize participants with the ecosystem, components, functions, and the ITS Architecture as applied to traffic signal systems.

This series of courses transform analog technicians into digital workers for ITS. Our curriculum covers the specific in-demand skills for workers engaging in the new connected economy. All instructors are subject matter experts, equipped with real-world field experience, ready to prepare participants with a solid foundation in infrastructure basics and supporting systems technologies.

For more information: https://www.thenexted.com/courses/intelligent-transportation-credentialing-itc-level-1-traffic-signal-technician/

Trip Generation Estimation Methodology

By Paul E. Basha, P.E., PTOE (M)



Shutterstock/Sofiaworld

The *Trip Generation Manual* methodologies estimate future traffic volumes, not accurate calculations. Two foundational assumptions exist. One is that trip generation is exclusively dependent on one independent variable. (While some land uses have data for multiple independent variables, they are usually considered unilaterally.) Two identical land uses with identical independent variable sizes may have very different traffic counts. Other variables are potentially relevant, such as daily fluctuation, tenant characteristics, parking availability, or proximity to other similar or complementary or different land uses.

The second foundational assumption is that the proxy data are representative of the trip generation propensity of a specific proposed development. We hope this assumption is valid, but it will not be precise. The actual traffic volume will occur after the proposed development is operational, when the inaccuracy consequences will be difficult to correct.

The *Trip Generation Manual* provides proxy data that are aggregated into average, minimum, and maximum trip rates, and standard deviations. When sufficient data exists, fitted curves with correlation coefficients are also provided.

New with the 10th Edition of the *Trip Generation Manual* is a data-filtering capability that allows selected dependent variable ranges. As an example for weekday at shopping center, code 820, selected ranges were examined: 0 to 150, 151 to 300, and 301 to 1510 thousand square feet. Table 1 provides filtered trip generation rate statistics.

Table 1. Trip Generation Manual*, 10th Edition, filtered proxy data statistics.*

Building Area Range	Number	Minimum	Average	Maximum	Standard Deviation
1 to 1,510	147	7.42	37.75	207.98	16.41
1 to 150	29	38.45	83.82	207.98	30.08
151 to 300	17	30.79	51.51	81.53	14.49
301 to 1,510	101	7.42	35.52	74.35	13.28

Figure 1 superimposes the average trip generation rates for the filtered building area ranges upon the standard *Trip Generation Manual* plot of trips versus independent variable.

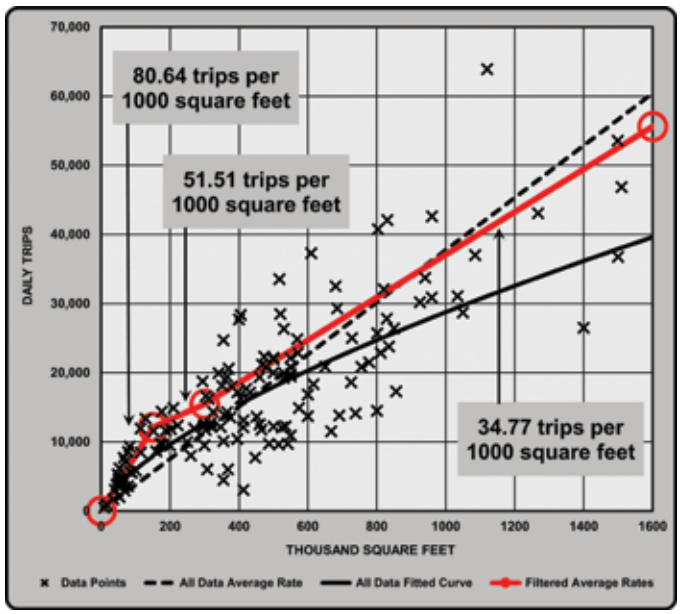


Figure 1. Trip Generation–Shopping center weekday with varying average trip rates.

The *Trip Generation Handbook*, 3rd Edition, Appendix J, pages 243-246, explains that the *Trip Generation Manual*'s reported average rates and standard deviations are not direct traditional calculations. Recognizing that the simple mathematical mean and standard deviation may not validly define the proxy data, weighted average and weighted standard deviation are utilized. The purpose of the weighted values instead of the typical values is to minimize the influence of outlier data.

Appendix J provides an example calculation of weighted average and standard deviation. The weighted average is provided as 1.21, while the unweighted average for these data would be 1.32.

The weighted standard deviation is provided as 0.67, while the unweighted standard deviation for these data would be 0.75.

In addition to weighted average trip generation rates for the proxy data, the *Trip Generation Manual* provides a fitted curve (regression equation) for the proxy data if four or more data points are provided, and the correlation coefficient equals or exceeds 0.50.

For shopping center land use code 820, weekday, the entire proxy data set regression equation is provided as LN (T) = 0.68 * LN(X) + 5.57 with correlation coefficient 0.76.

For the proxy data filtered for only building areas less than or equal to 150,000 square feet, the regression equation is provided as LN (T) = 0.97 * LN(X) + 4.48 with correlation coefficient 0.74.

No regression equation is provided for proxy data with building area of 150,000 to 300,000 square feet.

For the proxy data filtered for only building areas of 300,000 to 1,510,000 square feet, the regression equation is provided as T = 27.05 * X + 5,068.10 with correlation coefficient 0.50.

The traffic professional must use judgment to determine the most appropriate calculation for the particular proposed development. Often, both average rate and fitted curve are calculated, and the largest value is utilized. This results in a conservative estimate of traffic volume that may or may not correspond closely to the actual future traffic volume for a particular development.

In addition to weighted average rates and regression equations for the entire and filtered proxy data, the *Trip Generation Manual,* 10th Edition, website provides data useful for other techniques to predict proposed development future traffic volume. The purpose of predicting future trip generation is to ensure that the future transportation system properly accommodates the future traffic volumes. The practitioner must select proxy data that has a high probability of valid trip generation prediction for the proposed development.

The *Trip Generation Manual* web-based data allows determination of the independent variable size and trip value coordinates, and thereby the calculation of the individual trip generation rate, for each proxy data point.

The proxy data coordinates for land use code 820, shopping center, weekday, were determined from the web-based *Trip Generation Manual,* 10th Edition. The individual trip rates for each proxy data point were calculated, then plotted. Figure 2 depicts the daily trip generation rate versus building area. This graph reveals that the individual proxy data trip rates are very dispersed. Two proxy data values are apparently outliers.

Only one of the 29 proxy data points below 150,000 square feet is close to the average rate of 37.75 daily vehicles per 1,000 square feet. At a building area of 53,000 square feet, the counted trip generation rate was 38.43 daily vehicles per 1,000 square feet.

While the two outlying data points represent existing shopping centers of known building area and actual traffic counts, their trip generation rates are apparently different from the remainder of

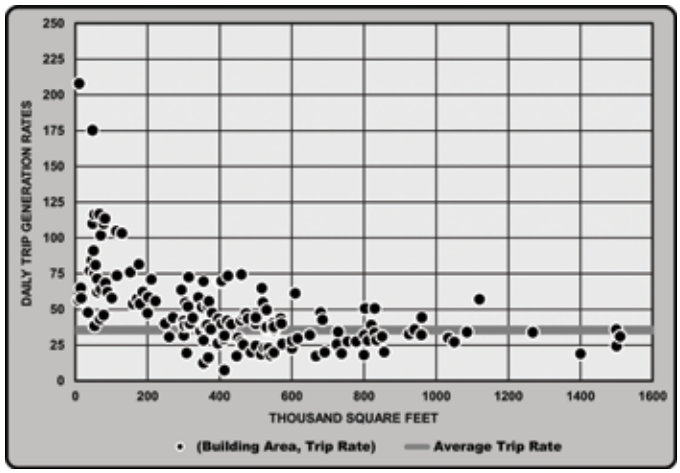


Figure 2. Trip generation rate versus shopping center size.

the data. Potentially, these outlying data are so different from the remainder of the data set that their inclusion within the proxy data average rate or fitted curve are invalid.

The mathematically reasonable response is to remove the dissimilar data from the data set. A common statistical evaluation is to compare the average rate less twice the standard deviation to the minimum rate(s), and compare the average rate plus twice the standard deviation to the maximum rate(s). If the lowest or highest rates are greater than twice the standard deviation from the average rate, these data points can be defined as dissimilar to the remaining data.

Therefore, these data can be removed from the analysis. This determination is more likely to be valid than the assumption that the proposed facility is similar to all of the counted facilities within the entire dataset with the outliers included.

Once the atypical data are deleted from the data set, the new weighted average and standard deviation must be calculated adhering to the methodology described in Appendix J of the *Trip Generation Handbook*. This calculation requires determining the building area, trip number, and trip rate for each proxy data point. If necessary, the process is then repeated until all rates are within twice the standard deviation from the average rate.

One of the foundational assumptions of the trip generation estimation process is that trip generation is exclusively dependent on one independent variable. This implies that traffic counts would be equal for all identical independent variables.

For this example of shopping center, the selected independent variable is building area. The proxy data for weekday shopping center includes two circumstances with four identical building areas, two circumstances with three identical building areas, and six circumstances with two identical building areas. Within the data, three building areas have 53,000 square feet with traffic counts of 2,038, 3,970, and 6,161; for respective trip generation rates of

38.45, 74.91, and 116.25. These proxy trip generation rates are very different though they have the same building area. These differences reveal that some proxy data have dissimilar traffic volume attributes to other proxy data, and therefore, also are potentially atypical from the subject proposed development. It is incumbent on the traffic professional to consider the possibility of proxy data with incompatible trip generation. Understanding the reasons for the differences may or may not be possible or relevant. Meaningfully, the purpose of the *Trip Generation Manual* is traffic volume.

Discovering statistically inconsistent proxy data was accomplished for each of the data ranges for the shopping center weekday data. The building area range of 151 to 300,00 square feet exhibited statistical consistency of all trip generation rates within two standard deviations of the average rate. The building area ranges of equal to or less than 150,000 square feet and of greater than 300,000 square feet included proxy data rates more than two standard deviations from the average rate.

Table 2 provides the building size ranges that were statistically inconsistent by having trip rates outside twice the standard deviation from the average rate.

Table 2. Initially statistically inconsistent data modified to be consistent.

Statistically Inconsistent Data

Building Area Range	Number	Minimum	Average	Maximum	Standard Deviation
1 to 150	29	38.45	83.82	207.98	30.08
301 to 1,510	101	7.42	35.53	74.35	16.56

Statistically Inconsistent Data Modified to be Statistically Consistent

Building Area Range	Number	Minimum	Average	Maximum	Standard Deviation
1 to 150	27	38.45	80.64	116.58	24.49
301 to 1,510	98	7.42	34.77	70.00	17.91

The building area range of 1 to 150,000 square feet suggested two very high trip rates be removed to become statistically consistent. The weighted average rate reduced by approximately 4 percent from 83.82 to 80.64.

The building size range of 301,000 to 1,510,000 square feet suggested three high trip rates be removed to become statistically consistent. The weighted average rate reduced by approximately 2 percent from 35.53 to 34.77.

While the percentage difference is small, the predicted traffic volume potentially could be consequential. These modified filtered average trip rates should also be considered in addition to the entire proxy data average rate and fitted curve, and the filtered data average rate and fitted curve.

Consequently, there are five different trip generation rate techniques for the building areas equal to or less than 150,000 square feet, and for the building areas greater than 300,000 square feet. There are three different trip generation rate techniques for building areas between 150,000 square feet and 300,000 square feet. Table 3 summarizes the different predicted traffic volumes for 10 selected building areas.

Table 3. Selected estimated trip generation summary.

	Entire Proxy Data		Filtered Proxy Data		Modified Filtered
Building Area	Curve	Average	Curve	Average	Average
50	3,752	1,888	3,923	4,191	4,032
100	6,012	3,775	7,685	8,382	8,064
150	7,921	5,663	11,388	12,573	12,096
200	9,632	7,550		10,302	
250	11,210	9,438		12,878	
300	12,690	11,326		15,454	
400	15,432	15,101	15,888	14,212	13,907
800	24,724	30,202	26,708	28,424	27,815
1,200	32,572	45,303	37,528	42,636	41,722
1,600	39,612	60,404	48,348	56,848	55,630

Examining the entire proxy data, large discrepancies exist between the fitted curve regression equations and the average rates. For comparatively small building areas, the fitted curve estimates larger traffic volumes than the average rate. For comparatively large building areas, the fitted curve estimates smaller traffic volumes than the average rate.

Examining the filtered proxy data, smaller discrepancies exist between the fitted curve regression equations and the average rates. For all building areas, the fitted curve estimates smaller traffic volumes than the average rate (with one exception).

Comparing the modified filtered proxy data to the filtered proxy data, the modified filtered data estimates larger traffic volumes than the fitted curve and smaller traffic volumes than the average rate (with one exception).

Comparing the modified filtered proxy data to the entire proxy data, for small building areas, the modified filtered data estimates larger traffic volumes than the entire proxy data for both regression equation and average rate. For large building areas, the modified

filtered data estimates traffic volumes between the traffic volumes estimated by the entire proxy data fitted curve and average rate (with one exception).

The differences between the lowest and highest traffic volume estimates are significant in terms of potential street system recommendations. For comparatively small building areas, the highest traffic volume estimate was approximately 120 percent greater than the smallest traffic volume estimate. For building areas between 150,000 and 300,000 square feet, the highest traffic volume estimate was approximately 36 percent greater than the smallest traffic volume estimate. For comparatively large building areas, the highest traffic volume estimate varied from approximately 15 percent to 50 percent greater than the smallest traffic volume estimate.

Critically, the traffic volume difference between the highest and lowest estimates for a particular building area varied from approximately 2,000 to 21,000 daily vehicles. Recognizing that a generally accepted street capacity is 8,000 daily vehicles per lane, these discrepancies are potentially very consequential.

Importantly, all daily traffic estimates are based upon actual traffic counts at existing shopping centers. The traffic engineer or planner must exercise professional judgment in selecting the appropriate traffic volume prediction for a particular proposed development, evaluating several possible methodologies, and thoughtfully selecting the traffic volume that best corresponds to the situation. The *Trip Generation Handbook*, pages 23 through 31, provides guidance for these professional judgments.

The provided analysis is merely an example. The selection of independent variable size ranges for proxy data filtering is conditional to the specific proposed development. The filtered ranges within this analysis would be acceptable for building areas of 75,000 or 225,000 or 900,000 square feet. However, these filtered ranges would not be acceptable for building areas of 150,000 or 300,000 square feet. A potential filtering range for 150,000 square feet would be 100,000 to 200,000 square feet; and for 300,000 square feet would be 200,000 to 400,000 square feet. The subject development independent variable should be approximately equidistant from the lowest and highest range limits. The proxy data should be scrutinized to establish range limits that do not bifurcate a proxy data cluster. Also, the range limits should be adjusted to minimize the number of outlier values.

In my experience, both clients and reviewing agencies usually accept the results of these professionally prepared, comprehensive, and detailed analyses. One reviewing agency resisted using a filtered average rate less than the full proxy data average rate, though two other agencies reviewing the same traffic study readily accepted the lower average rate. Developer clients have always accepted my use of higher average rates than the full proxy data average rate, as their stated interest is to ensure that the traffic circulation both within and adjacent to their development functions properly.

A traffic impact analysis estimates future traffic volumes and recommends corresponding transportation improvements. Simplistic calculations should be avoided. Traffic engineers and planners are professionally obligated to consider as much data, information, and scientific methodology as possible to ensure assumptions for trip generation estimations are valid and applicable for the specific analysis. **itej**

Acknowledgements

The author wishes to acknowledge Carl Butke for his vision to create the first *Trip Generation Manual* in the mid-1970s. Paul also wishes to thank Christopher Brown of Bellevue, WA, USA, who in the early 1980s encouraged investigating trip generation data beyond the summary numbers.

References

1. Institute of Transportation Engineers, *Trip Generation Manual,* 10th Edition, September 2017.
2. Institute of Transportation Engineers, *Trip Generation Handbook,* 3rd Edition, September 2017.

Paul Basha, P.E., PTOE (M) *has 47 years of traffic engineering and transportation planning experience, with approximately half as consultant and half as public servant. He also has been a faculty associate at Arizona State University for 25 years. More than 70 current members of the Arizona Section of the Institute of Transportation Engineers have studied traffic engineering under Paul's direction. Paul served on the Evaluation Committees for the* Trip Generation Handbook, *3rd Edition; the* Parking Generation Manual, *5th Edition; the* Trip Generation Manual, *10th and 11th editions; and the ITE Warehouse Trip Generation Expert Panel.*

Estimating Modal Trip Generation

By Paige Glassman

Transit oriented developments (TODs), while defined differently throughout the country, are generally compact, mixed-use development near transit facilities that offer high-quality pedestrian and bicycle facilities. TODs are a relatively new concept in the United States; these developments are located in moderate to high density areas and can be new construction or redevelopment. Based on proximity to public transit, TODs often feature higher transit and non-automotive transportation. The most common land uses within TODs are residential, commercial, and office.

Shutterstock/Soran Shangapour

Out of the basic principles of smart growth, defined by The Smart Growth Network, TODs accomplish the following:

- Provide mixed land uses
- Create walkable neighborhoods
- Strengthen and direct development toward existing communities
- Provide a variety of transportation choices
- Take advantage of compact building design
- Foster distinctive, attractive communities with a strong sense of place
- Encourage community and stakeholder collaboration in development decisions
- Make development decisions predictable, fair, and cost-effective[1]

Throughout the country, the Institute of Transportation Engineers (ITE) publications *Trip Generation Manual*, *Parking Generation Manual*, and *Traffic Engineering Handbook* are used to determine the anticipated traffic and parking characteristics of a site. While ITE does provide internal capture rates for mixed developments, the calculation of modal splits is done on a case-by-case basis by using independent research, surveys, etc. Without specific data, many planning organizations default to the ITE publications, which are primarily based on data pertaining to suburban areas without transit. Additionally, municipalities are skeptical to accept less than the minimum parking as dictated by ordinances, which leads to an excess of parking provided.

Literature Review

A literature review of national publications published prior to COVID-19 was conducted to further understand the complexity of transit-oriented developments.

Benefits of TODs

Success of a development can be defined by several factors. TODs can revitalize declining neighborhoods, creating financial gains for joint development opportunities as nearby land and business owners can profit from increased activity near transit stops. TODs also increase transit ridership, increasing the revenue of the public transit system. Residents living near transit stations are two-to-five times more likely to travel via transit overall and five-to-six times more likely to use transit when commuting, depending on the convenience and quality of connecting transit service. For example, a TOD located near a transit station with frequent service to the downtown urban core has higher transit use rates than a TOD located near a transit station with less frequent service to the downtown urban core or needing a transfer to travel to the downtown urban core. TODs located near transit stations results in higher transit use rates than TODs located near bus hubs, as commuting via bus often yields similar or higher travel times than commuting via car.[2]

TODs also result in congestion relief, land conservation, improved air quality, reduced outlays for roads, and improved safety for pedestrians and cyclists. TODs reduce unnecessary travel, which causes reduced infrastructure expansion, energy consumption, and greenhouse gas/other emissions. With lower levels of traffic generated, infrastructure improvements aren't always necessary, which can allow for additional pedestrian and bicycle facilities and lower developer cost.[1]

Characteristics of TOD Residents

A variety of individuals live in TODs, but the majority of residents are young working professionals and empty nesters, as these two groups of individuals are most likely to not own a car. Living in a TOD enables these groups to live without the need for a vehicle. Residents of TODs are twice as likely to not own a car and have approximately 3.5 times more walking and cycling trips than non-TOD developments.[2] The top three reasons for living in a TOD, according to residents, are the housing and neighborhood design, housing cost, and proximity to transit. Streetscape design and local land use mix influences in which TOD a prospective resident will choose to live. After living in a TOD for over five years, transit use for all purposes (work and non-work) rose 12 percent compared to initial use. After moving from a non-TOD residential development, 68 percent of TOD residents drive less, 70 percent use transit more, and 47 percent walk more.[2]

Characteristics of TOD Workers

Individuals who work in TODs commuted to work via transit at a higher rate than those individuals who do not work in TODs. For office workers in California, USA, approximately 12 percent travel to work via rail when the office is close to transit. However, that number rises to 25 percent when the office buildings are in a downtown area with high density, regional accessibility, limited parking, and within a block of a rail station. Of hotel workers in California, 41 percent traveled to work via rail transit. A survey of California hotel patrons revealed little-to-no transit use to come to the hotel, but many guests used transit to travel during their stay.[2]

Keys to Successful TODs

Successful TODs are developments with the lowest vehicular traffic. Of the national studies conducted, there are a few items that are prevalent in all successful TODs.

Transit Frequency

Vehicular trips to/from TODs are reduced as the frequency of trains to the station increases. For the best results, transit headways should be approximately 10 minutes.[2] However, in some areas, such as Minnesota, high-frequency headways are considered to be

anything under a half hour during peak hours. Track mileage and number of transit stations has no impact on TOD ridership.[3]

Part of transit frequency is relative travel time. An extensive but slow transit system will attract fewer riders if highway congestion is not severe. Conversely, a fast rail corridor adjacent to a congested highway will attract high ridership.

TOD Pass Programs

TOD pass programs are similar to other transit pass programs and can include reduced rates, high-frequency use credit, and/or local discounts for transit card members. When transit pass programs are implemented, commuter ridership will increase. In California, a TOD pass program was implemented and resulted in a 22 percent increase in transit for commuting purposes. When an employer assistance with transit costs program is implemented, workers are up to 50 percent more likely to use transit.[3]

Employment Location

Accessibility and location of employment can impact the success of a TOD. The proximity to rail stations is a stronger influence on transit use than land use mix or quality of a walking/biking environment. Higher development densities in close proximity to transit can increase TOD ridership. Employment density at trip ends has more influence on ridership than population densities at trip origins. If jobs are located near transit, more people will move into TODs.[4]

Southeastern Pennsylvania Transportation Authority's (SEPTA) Paoli-Thorndale Line runs from Center City Philadelphia, PA, USA, to Throndale, PA, USA, located 35.2 miles from Center City. In 2018, ridership on the Paoli-Thorndale line was the highest of all regional rail lines, with 1.5 million more annual riders than the next highest traveled rail line. Several stations along the rail line, including Narberth, Wynnewood, Ardmore, Haverford, and Thorndale are all within walking distance to several commercial and residential developments. Headways are similar for commuting toward and away from Philadelphia. SEPTA's Wilmington-Newark Line is longer than the Paoli-Thorndale Line (38.7 miles from Newark, DE, USA to Center City Philadelphia, PA, USA), but has less than half of the ridership as the Paoli-Thorndale Line, as more stations along the Wilmington-Newark Line are located in residential areas with little commercial developments.[5]

TOD Design

While employment access is a primary consideration, mixed uses, such as local restaurants and shopping, are important to attract residents and visitors to a TOD. Restaurants and shopping not only attract visitors to the area, but also enable residents to spend their money locally and benefit the economy where they live. Urban design treatments, such as pedestrian pathways, are important to attract residents and visitors to a TOD.[2] Wide sidewalks for strollers/wheelchairs, protected bike lanes, and bike parking allow for people to travel via non-automotive transportation while feeling safe. Longer walking distance to transit and/or a circuitous route to the nearest transit both lead to driving over transit.

Installing pedestrian and bicycle facilities, such as audible pedestrian countdown signals, bike lanes, and wide, shared sidewalks, are not a guarantee to attract more non-auto uses for travel. The Freemont, CA, USA, BART station has all of the afore-mentioned amenities, but the streets adjacent to the station are wide, and the blocks are 800-2,000 feet long. All of the nearby activities are far away, and large office and institutional buildings are nearby.

A study of two TODs near the BART station revealed how a better design leads to more transit use. Two large apartment complexes were studied. One, Alborada, dedicated two-thirds of the land to surface parking, and the other development, Archstone, put the parking beneath the buildings. Despite being within a half mile of BART, the quickest path for Alborada residents to walk to the station is over a mile long due to the community being gated, which leads to increase car usage. The Archstone development is not gated, which led to decreased parking demand rates.[6, 7]

Trip Generation for Transit-Oriented Developments

The *Trip Generation Manual* primarily is comprised of data from general urban/suburban areas. These areas often have little or no public transportation and incomplete sidewalk and bicycle networks. For sites located within pedestrian/bicycle friendly areas and/or near reliable public transportation, the anticipated trips can be adjusted to reflect the availability of non-vehicular and ridesharing travel modes (modal split). Because trip adjustments are generally conducted on a case-by-case basis, the methodology for modal splits needs justification and approval from the reviewers and municipalities.

Local Data Collection

Many municipalities collect data on how residents travel to and from work. As an example, Philadelphia, PA, USA, though the Center City District produces a yearly summary of how Philadelphia residents travel to and from work and how travel has changed over time. In the latest publication, which included data through 2019, 70 percent of all Greater Center City residents used non-automotive transportation for commuting to work in 2019, with biking and working from home having the largest increase in mode-share.[8]

In 2019, 61.5 percent of Washington, DC, USA, workers commuted via non-automotive transportation,[9] while 57.2 percent of Boston, MA, USA, residents used non-automotive transportation to get to and from work.[10] As of 2014, 15 percent of all work commutes in Boston were completed on foot, and 27 percent of inner-city work commutes in Boston were completed on foot.[11] In 2019, 75.9 percent of all workers in the United States drove alone to work.[12, 13]

Shutterstock/Aneta Waberska

Elfreth's Alley, located in historic Old City in Philadelphia, PA, USA is one of the neighborhoods in Greater Center City.

Delaware (USA) Valley Regional Planning commission (DVRPC) compared trip generation from 13 local residential TODs to the ITE rates for multifamily housing. Of the 13 local TODs, three were considered urban, and 10 were suburban, with three of the suburban TODs lacking significant public transportation options. During the morning peak hour, the urban TODs' average trip generation rates were 48.11 percent of the ITE rates, the suburban TODs within close proximity to transit average trip generation were 76.19 percent of the ITE rates, and the suburban TODs without public transit average trip generation rates were 101.59 percent of the ITE rates.[14]

Using Census Data

Where a proposed development is not located within a major metropolitan area, modal splits can be calculated by using census data from On the Map. On the Map provides traveling statistics for every census data tract including how workers travel (via car, carpool, public transportation, bike/walk, work from home), and to how many vehicles each worker has access. The modal split for a site planned within a certain census tract can be calculated by taking a weighted average of the data given for the surrounding census tracts.

Potential COVID 19 Impacts

The COVID-19 pandemic resulted in over one-third of United States' households working remotely at a higher rate than before the pandemic, including 61.7 percent of households that had a worker with at least a bachelor's degree.[15] In Boston, MA, USA, 7 percent of workers were fully remote prior to COVID-19, and 60 percent of workers were fully remote during the pandemic. While some Boston, MA, USA, workers plan to return to the office full time, 21 percent of workers plan on being fully remote, and 47 percent plan on working from home a couple days a week.[16]

Conclusions

As smart growth becomes more infused into the planning process, transit-oriented developments are becoming more popular. TODs are beneficial to communities, as they promote a healthy, walkable lifestyle with multiple land uses within one development. The proximity to transit revitalizes the area, increases ridership, and brings revenue to the transit system. Calculating the anticipated trip generation for these developments is complicated, as proximity to public transit often results in lower vehicular trips than what is presented in ITE's *Trip Generation Manual*. By using local data, the percentage of multi-modal splits can be determined. **itej**

References

1. Outwater, Maren, Smith, Colin, et al. Effect of Smart Growth Policies on Travel Demand. Strategic Highway Research Program, 2014.
2. Arrington, GB and Robert Cervero. "Effects of TOD on Housing, Parking, and Travel." Transit Cooperative Research Program. Report No. 128, 2008.
3. Ferrel, Christopher E, Appleyard, Bruce S. et al. "Livable Transit Corridors: Methods, Metrics, and Strategies." Transit Cooperative Research Program. Report No. 187, 2016.
4. "Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects." Transit Cooperative Research Program. Report No. 102, 2004.
5. https://planning.septa.org/
6. SANDAG. Parking Strategies for Smart Growth: Planning Tools for the San Diego Region. June, 1998.
7. Cervero, Robert, Adkins, Arlie and Cathleen Sullivan. "Are Suburban TODs Over-Parked?" *Journal of Public Transportation*, Vol. 13, 2010, pp. 47–70.
8. https://centercityphila.org/uploads/attachments/ckp4g4pzt1w2xfeqdsvc569lv-socc2021-transportation.pdf
9. Commute Mode | Bureau of Transportation Statistics (bts.gov)
10. www.boston/sites/default/files/document-file-03-2017/go_boston_2030_-_3_boston_today_spreads.pdf
11. https://data.census.gov/cedsci/table?q=boston%20commuting&tid=ACSST1Y2019.S0801&hidePreview=false
12. https://data.census.gov/cedsci/table?q=commuting%202019&tid=ACSST1Y2019.S0801&hidePreview=false
13. Microsoft PowerPoint - DY2019 Percent 60+ min 1113 (census.gov)
14. www.dvrpc.org/Reports/TR20006.pdf
15. Working From Home During the Pandemic (census.gov)
16. EF_Survey_Report_V8_Phase1.pdf (boston.gov)

Paige Glassman *is a transportation planning specialist at Traffic Planning and Design, Inc. located in Philadelphia, PA, USA. She graduated with a bachelor's degree in civil engineering from the University of Delaware in 2013, and received an master's degree in civil engineering from Villanova University in 2018.*

SHUTTERSTOCK/TRAVELVIEW

Automated Traffic Signal Performance Measures: A Survey to Fuel Innovation

JUSTIN R. EFFINGER, P.E. (M)

Automated Traffic Signal Performance Measures (ATSPMs) became more popular in the United States through the Every Day Counts – 4 Innovations.[1] ATSPMs consist of logging high-resolution data from modern traffic signal controllers utilizing the *Indiana Traffic Signal Hi Resolution Data Logger Enumerations* for data analysis and to proactively identify and correct any deficiencies if they exist.[2]

Some well-known benefits of an ATSPM program include:

1. Improving traffic signal operations
2. Quicker response time to citizen concerns
3. Evaluation of advanced traffic signal control technologies
4. Transportation Management Center (TMC) Operations
5. Planning selection process of improvement (modernization/expansion) projects

Since ATSPMs are more widely used, the next question that comes up is, "How can we fuel new innovation for ATSPMs?" The answer to this question should be driven by most of the users of the system. To accomplish this, a survey link was sent to ITE members along with known users of ATSPMs to address fundamental questions. Figure 1 shows the special distribution of the 35 respondents of the survey. It is important to note that the purpose of this survey is to be a targeted survey to provide good data points, not analysis of statistical significance, since there is widespread disparity across different jurisdictions.

Automated Traffic Signal Performance Measures Survey Results

The survey was designed to take less than five minutes to complete and provide insights to guide the future of ATSPMs. The five fundamental questions asked in the survey include:

1. What additions to ATSPMs do you want to see in the near future? (select top 3)
2. What performance measures do you use most? (select top 3)
3. What training format would be most beneficial to you?
4. What prohibits you from implementing or expanding ATSPMs? (select up to 2)

ATSPM advancements are being undertaken in both the open-sourced software, initially created by the Utah Department of Transportation, and vendor-based solutions using cloud-based data storage. Most of the items in question 1 (Figure 2) are items already being explored by multiple entities. Question 2 (Figure 3) looks into what performance measures are used more often to ask the following questions:

1. Are there targeted enhancements that can be done to existing performance measures?
2. Are there current flaws in the performance measures that are used more often?

Questions 3 and 4 (Figures 4 & 5) are more geared toward the business case in implementing ATSPMs. In order to properly implement ATSPMs, we must know the challenges that agencies face and how to improve the knowledge and interpretation of the performance measures themselves.

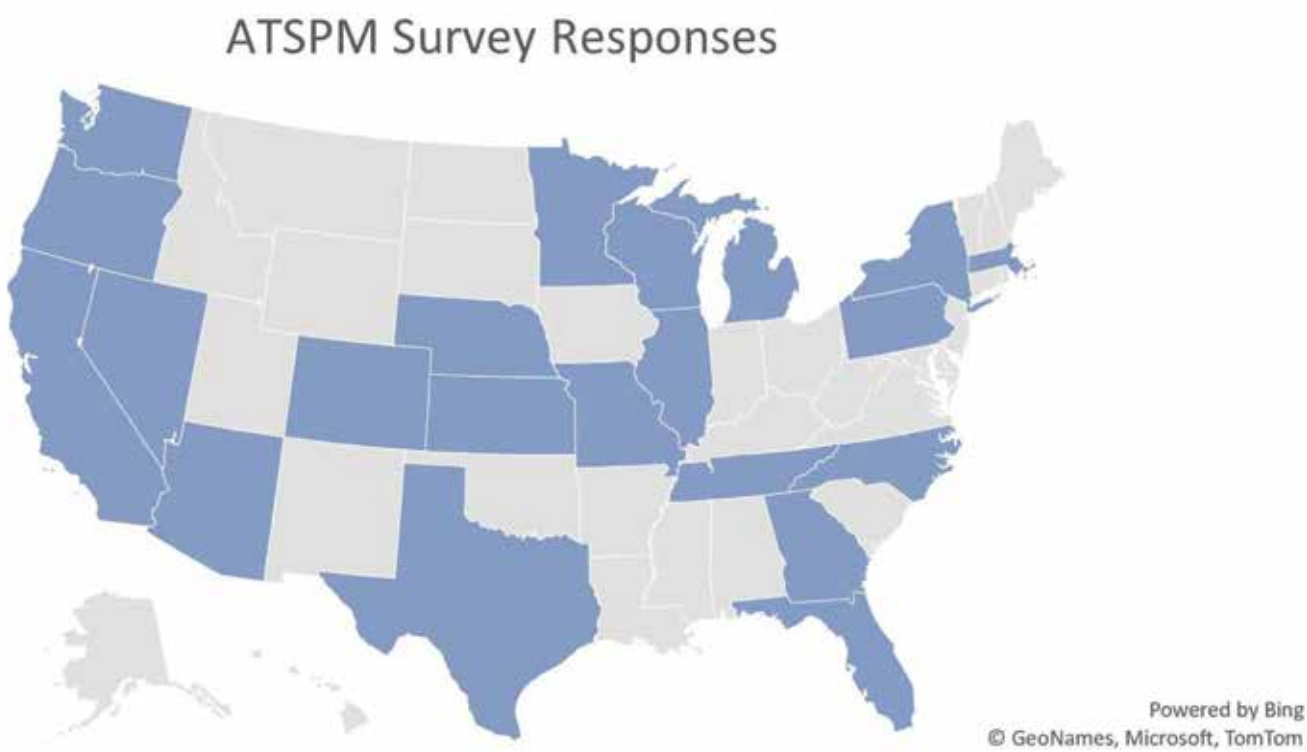


Figure 1. Map of the states that had at least one respondent of the ATSPM survey (indicated in blue).

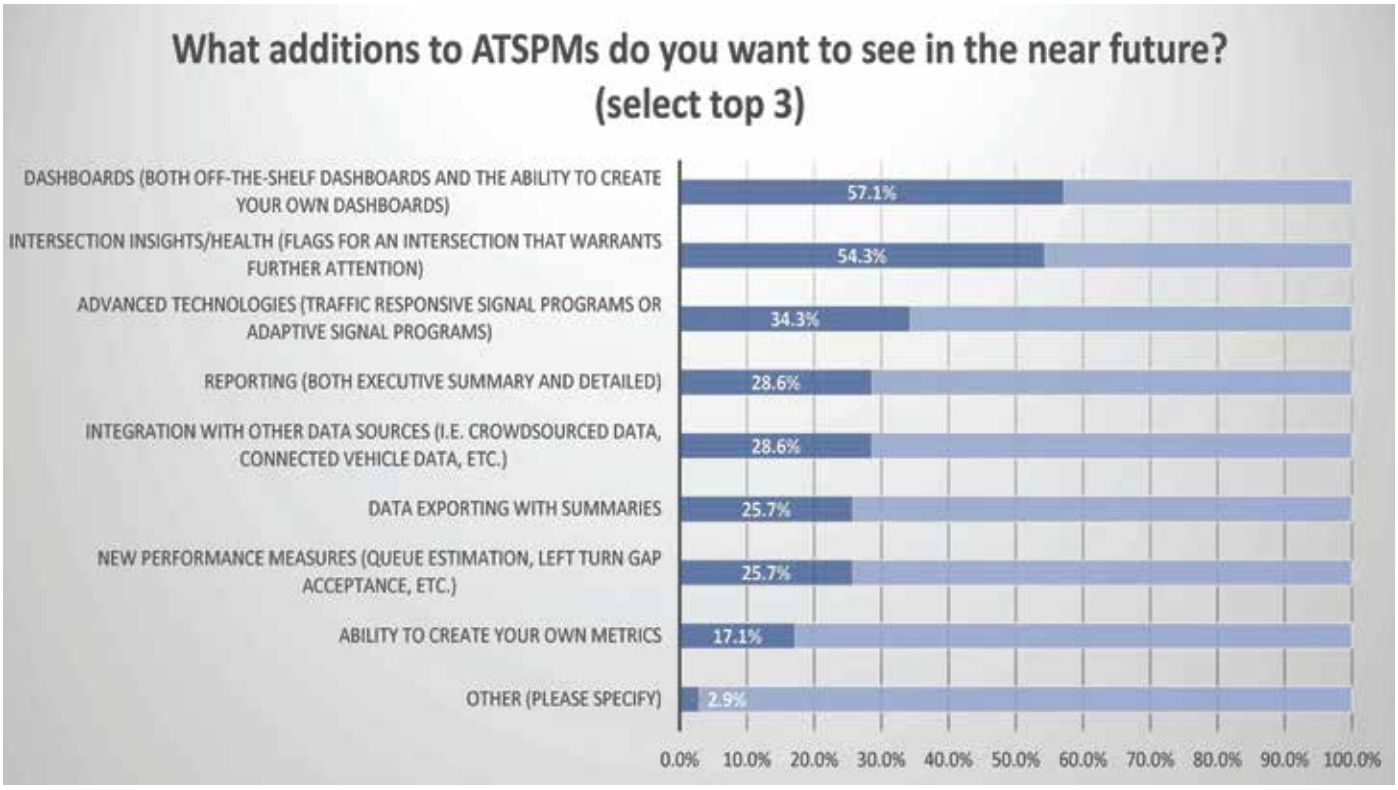


Figure 2. Results for Question 1 of the ATSPM survey.

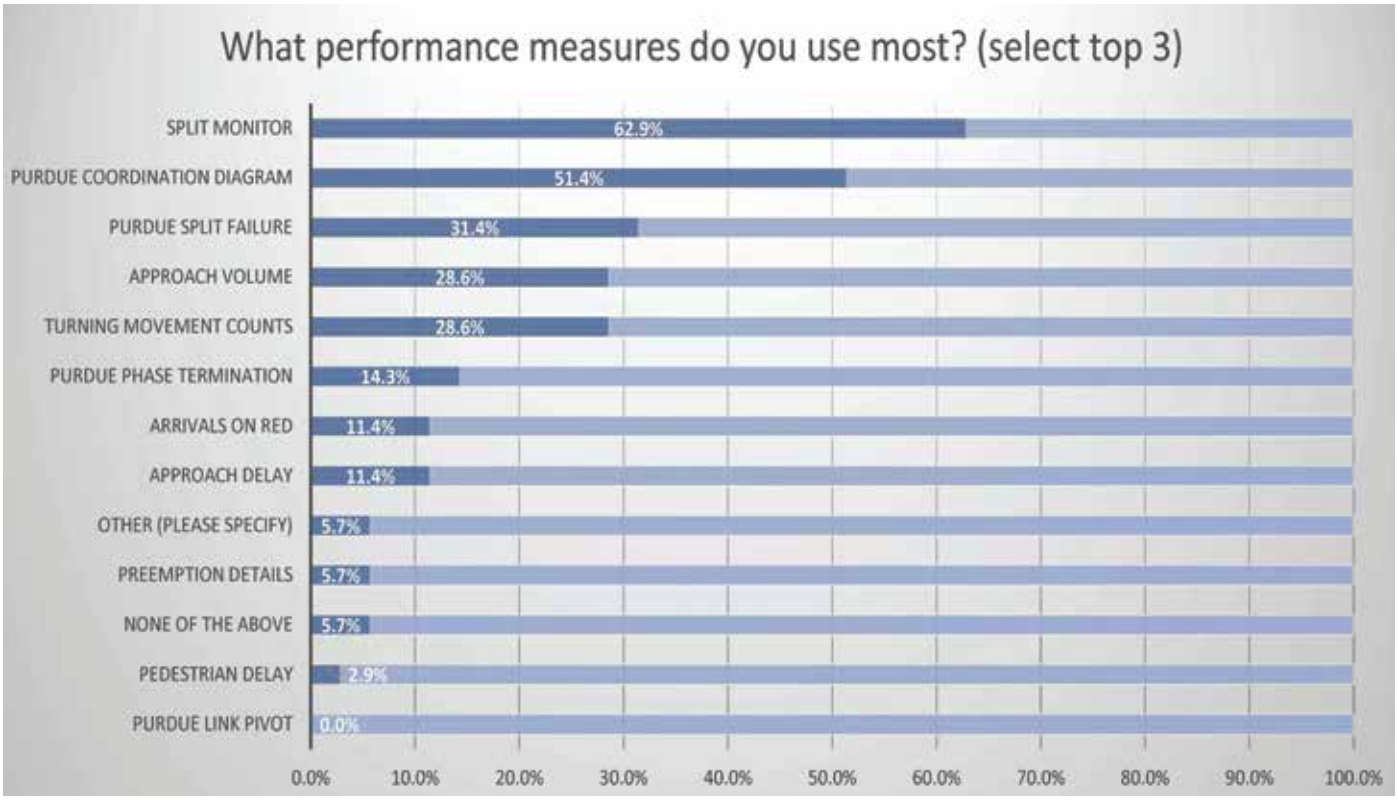


Figure 3. Results for Question 2 of the ATSPM survey.

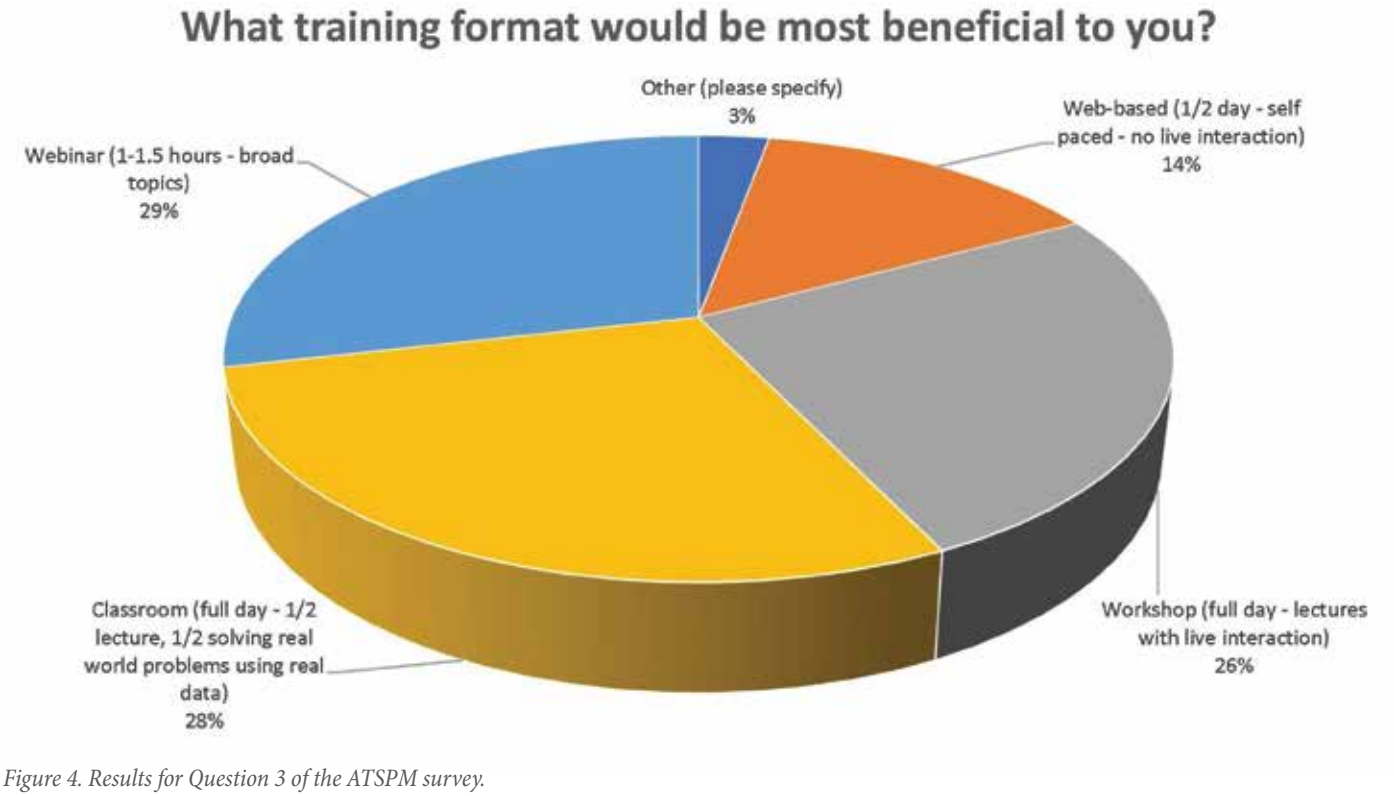


Figure 4. Results for Question 3 of the ATSPM survey.

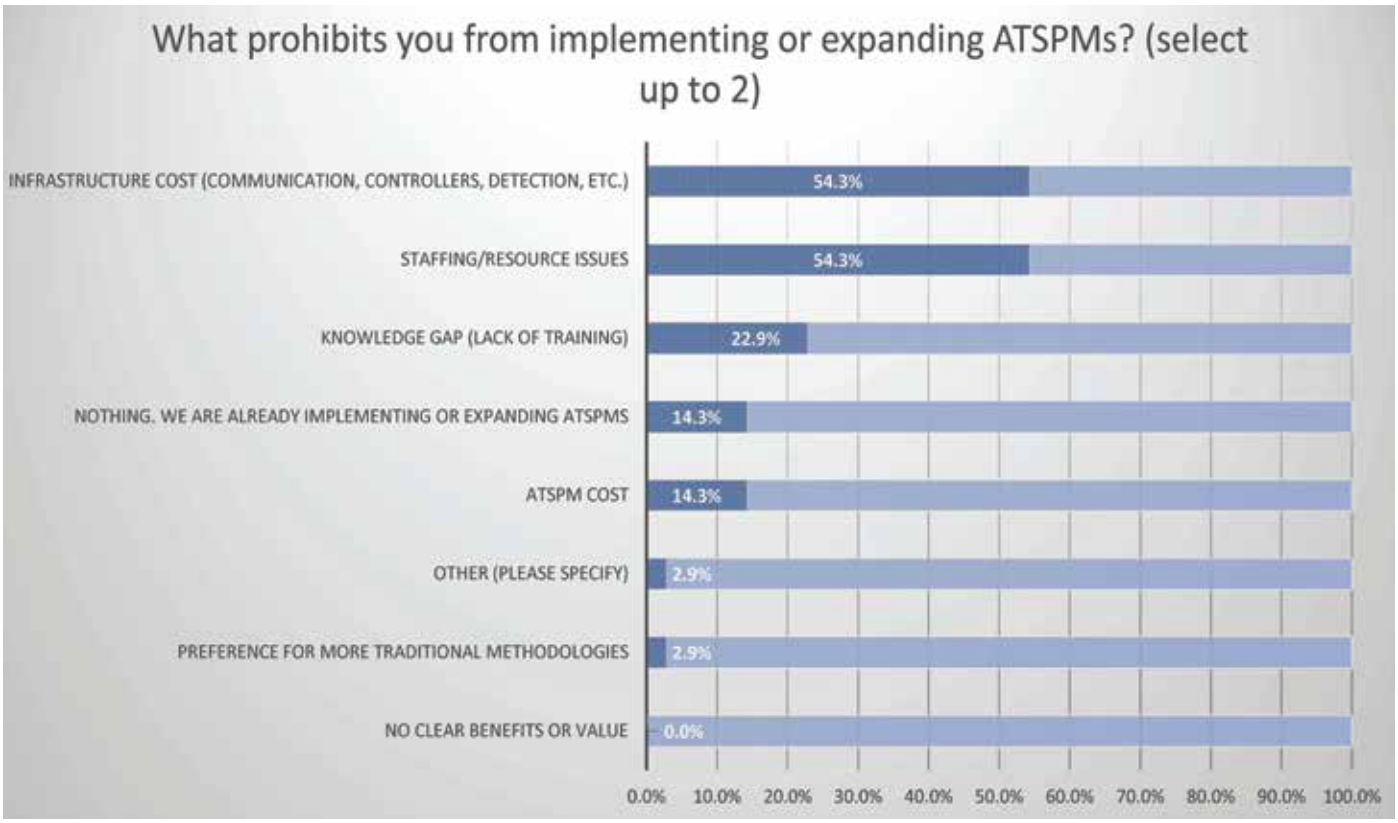


Figure 5. Results for Question 4 of the ATSPM survey.

Interpretation of the Results

For additions to ATSPMs, there are two clear front runners that more than half of the respondents wanted so see, which include dashboards and intersection insights and health. This is consistent with the overall questions, "How is my system operating?" and "Where do I need to focus my efforts?" The concept of big data is well received by most engineers, except it needs to be shown in a storytelling way. An example could be visually showing the following before and after results for a Signal Coordination and Timing (SCAT) study:

1. Travel time/average speed
2. Number of stops
3. Annual benefit
4. Benefit-to-cost ratio
5. Annual change in emissions (fuel consumption and CO_2)

The story being told to elected officials and the public is that we are actively making changes to coordinated traffic signal systems to improve in elements that the public can understand and value most. For intersection insights or health, it is known that many agencies have limited resources, so we need targeted areas of improvement to be proactive. An example would be traffic signal detection that has failed and is causing more delay than usual. The engineer wants a dashboard of this information rather than scrolling through multiple different performance measures to find the problem. The story to the public is that we are being proactive with traffic signal maintenance to minimize the duration of equipment issue impacts.

For existing performance measures used more than others, there are two that stand out, which are split monitor and Purdue Coordination Diagram (PCD). Most existing performance measures can be improved visually or by improving the methodology. For most coordinated systems, the split monitor can't tell the user if the coordinated phases are having issues or not, because they are naturally maxing out, in which a different performance measure should be used. A good example is using research to estimate the queue length using advanced and stopbar detectors.

PCD is a great tool to use in evaluating whether a coordinated traffic signal system is operating in harmony or if it needs offset adjustments based on vehicle arrivals. Two of the biggest concerns with PCD include:

1. How do we identify platoons of vehicles versus vehicles that are arriving more randomly?
2. What happens when the traffic signal becomes oversaturated?

Identifying platoons of vehicles can be done using existing research and analyzing the gap time between vehicles. The information can be visually represented by making those groups of vehicles stand out. When a traffic signal becomes oversaturated, the PCD will show a high arrival on green, which is shown in Figure 6. When looking at the Closed-Circuit Television (CCTV) camera (Figure 7), the queue length is not cleared during the split time and extends beyond the advanced detector. In this instance, traffic is backing up due to a shopping rise on Black Friday. If there is a performance measure that has queue lengths, it should be used, as the objective would be queue management. Another option would be visually showing if the queue was over the detector for a traffic signal cycle.

For increasing the knowledge base of ATSPMs, there is a close split between the formats of webinars, classroom, and workshop. This shows a need for a long-term training and knowledge program to keep ATSPMs a relevant technology. Most of the survey

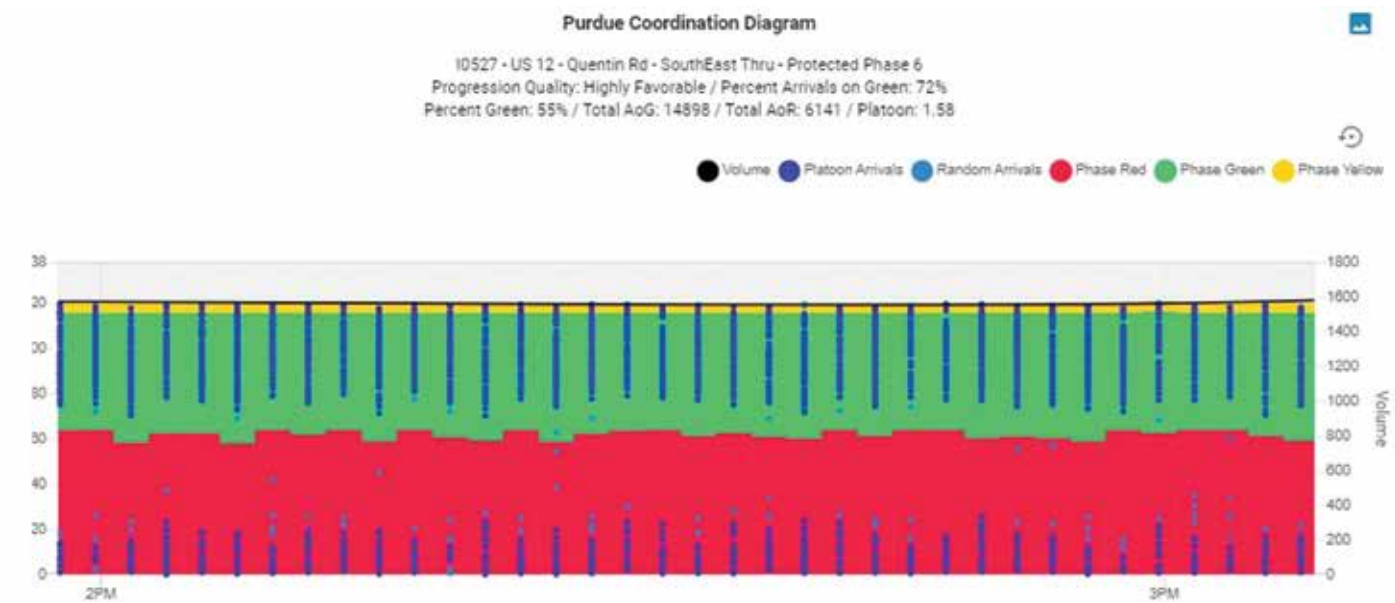


Figure 6. Purdue Coordination Diagram (PCD) of U.S .12 & Quentin.

respondents wanted a longer and more in-depth training with the classroom or workshop format. The biggest element missing in training today is the lack of solving traffic signal problems in a guided setting and the openness to allow users to find their own path. Typically, to truly diagnose a problem, multiple performance measures are needed, and different people may find different performance measures in diagnosing and solving those problems.

The last survey question was designed to give insights to what is causing agencies not to implement or expand ATSPMs. The two clear front runners, with over 50 percent of respondents selecting them, include infrastructure cost and staffing or resource issues. Infrastructure cost has been an issue for many government agencies, in which the highest costs include communication infrastructure. It would be beneficial for agencies to make long-range plans to include simple, lower-cost enhancements in resurfacing projects that can include traffic signal controller updates or traffic signal controller firmware updates.

It is a misconception that ATSPMs increase in the need for staffing from an operational perspective. As ATSPMs evolve over time, they are intended to change the culture of traffic signal operations, which is outlined in *NCHRP Report 954*,[3] and the result will be a more efficient way to evaluate traffic signal timings and handle concerns that occur. From a maintenance perspective, ATSPMs can increase staffing need because the agency is being more proactive and will be notified every time a maintenance issue surfaces. An example would be a detection issue that normally wouldn't surface until the engineer either travels to the intersection or a call comes in from the public. With ATSPMs, those issues can be shown in a day or less, and more maintenance tickets can be generated. The biggest benefit is much lower delay for the public and overall system reliability. More information on benefit to cost of ATSPMs are outlined in the document, *A Methodology and Case Study: Evaluating the Benefits and Costs of Implementing Automated Traffic Signal Performance*.[4]

Conclusion

ATSPMs have a bright future when new innovations and enhancements are drawn from the industry leaders using the system. This targeted survey has provided insights on exploration of additional items and how to improve existing performance measures as they relate to ATSPMs.

In the future, there is potential to include connected vehicle data and crowdsourced data in addition to ATSPM data to improve operations at traffic signals. Even though ATSPMs are less granular data than crowdsourced or connected vehicle data, it can fill in gaps to accommodate the lower hit rates. It is important to reevaluate and improve performance measure methodology and data validation to accomplish the next generation traffic signal technology.

Figure 7. Closed Circuit TV (CCTV) snapshot of U.S. 12 and Quentin at 2:49 p.m. on Nov. 29, 2019.

Lastly, the one thing that big data has shown us is the need to communicate to infrastructure is critical along with targeted dashboards to interpret the information as quickly as possible. The biggest advancement in recent months and years is the addition to summarize system reliability to reduce delay for the public. **itej**

Acknowledgment

The Lake County (IL) Division of Transportation has a robust ATSPM program that has been enhanced with knowledge from the Federal Highway Administration. ITE provided resources to communicate the survey link to members through the ITE e-community.

References

1. "Automated Traffic Signal Performance Measures (ATSPMs)," 2 January 2021. [Online]. Available: https://www.fhwa.dot.gov/innovation/everydaycounts/edc-4.cfm.
2. H. Li, A. M. Hainen, J. R. Sturdevant, T. Atkinson, S. Talukder, J. K. Mathew, D. M. Bullock, D. Nelson, D. M. Maas Jr., J. Fink and T. Stiles, "Indiana Traffic Signal Hi Resolution Data Logger Enumerations," Indiana Department of Transportation and Purdue University, West Lafayette, Indiana, 2020.
3. B. Nevers, T. Urbanik, K. Lee, B. Cesme, J. Musselman, L. Zhao, D. M. Bullock, H. Li, A. Tanaka, C. M. Day, L. Richardson, "Performance-Based Management of Traffic Signals" National Academies of Sciences, Engineering and Medicine, Washington, DC, 2020.
4. C. M. Day, P. O'Brien, A. Stevanovic, D. Hale, N. Matout, "A Methodology and Case Study: Evaluating the Benefits and Costs of Implementing Automated Traffic Signal Performance" U.S. Department of Transportation, Federal Highway Administration (FHWA) Office of Operations, Washington, DC, 2020.

Justin R. Effinger, P.E. (M) *serves as the Senior Traffic Engineer at NoTraffic, developers of the technology that brings traffic light interchanges to the 21st century. Justin is a seasoned traffic engineering leader and specializes in advanced traffic signal operations, Automated Traffic Signal Performance Measures (ATSPMs), and integrating and enhancing various ITS technologies. Before joining NoTraffic, he was a principal engineer with the Lake County Division of Transportation, where he helped advance their arterial ITS program, Lake County PASSAGE.*

New ABLOY USA lock brings Traffic Cabinet tampering to a screeching halt

The new 75481 series Traffic Enclosure lock from Abloy Critical Infrastructure USA is an effective solution for quickly upgrading your traffic system infrastructure. This lock can serve as a drop-in replacement for both existing and new modern traffic control cabinets, says Jerry Burhans, Managing Director of ABLOY USA.

"There are over 500,000 managed traffic intersections in the U.S. that are eligible for an upgrade. The marketplace currently is flooded with a single version of a lock that relies on using only one type of key," remarked Burhans. "Complicating security concerns is the need for qualified contractors and transportation agencies to have access for maintenance, repairs, upgrades and timing adjustments. Everyone can see the red flags that today's one-key option raises."

ABLOY's enclosure lock is available with a high security mechanical or electromechanical cylinder – the only product in the world that enables both types to be used in the same system. The mechanical components provide security through ABLOY's unique high security disc cylinder. The electromechanical CLIQ™ delivers added accountability with key tracking and audit trails, and allows for updating keys with new access rights electronically. Lost keys can simply be deleted from the system.

This flexibility provides a powerful and affordable solution since typically, only about 20% of cabinets need electronic locks. For example, if a Traffic District or DOT has 1,000 cabinets, buying 100% electronic locks for each could cost about $250,000. But with ABLOY technology, 80% of the locks can be mechanical and 20% electromechanical. The estimated cost for this solution is approximately $150,000, saving a customer nearly $100,000.

View a demonstration of the 75481 series and the 12 brass models to choose from at: https://www.youtube.com/watch?v=jQ-tseSpHNg or visit www.abloyusa.com.

ABLOY

ABLOY USA
www.abloyusa.com

Answer to "Where in the World?" on page 11: St. Petersburg, FL, USA. Photo submitted by Holly Stowell.

Why I Joined ITE's Mentoring Program

ite
A Community of Transportation Professionals

Why did you want a mentor?

When I applied to have an ITE mentor, I was looking to expand my industry network and learn from someone with continued involvement in ITE as a professional. At the time, I was working on graduate school applications and was advised that mentorship could be very beneficial.

How did having a mentor help you?

Having a mentor has helped me in a number of ways. My mentor was able to provide me feedback on fellowship opportunities and encouraged me to critically think about what I truly desire out of a graduate program. My mentor also helped me navigate different decisions regarding summer employment opportunities, providing seasoned industry insight about the potential benefits of respective positions that I was considering.

What was the most surprising thing that Bryce learned through his experience? Read his blog here: https://bit.ly/3BMMeXT

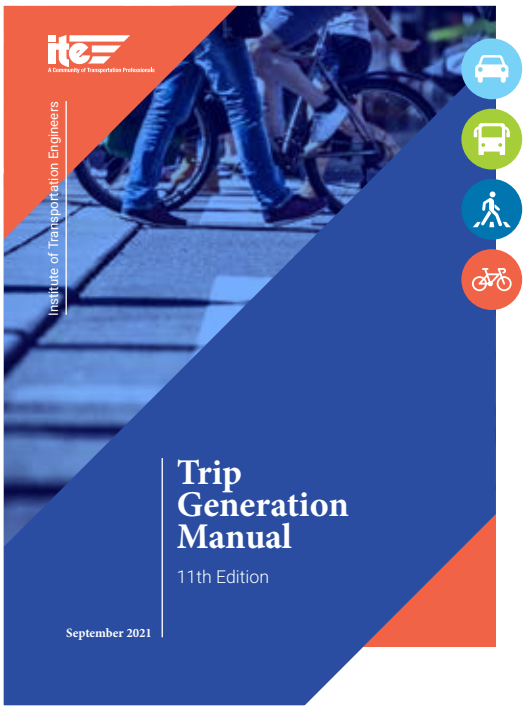
Learn from the Experience of Others & Share Your Experience with Others

Get involved: www.ite.org/professional-and-career-development/mentoring/

NOW AVAILABLE!

The **Next Step** in Trip Generation Estimation

ITE, the leader in Trip Generation, has released the 11th Edition of the *Trip Generation Manual* (TripGen11). This new edition enhances the 10th Edition's modernized content, data set, and contemporary delivery - making it an invaluable resource.



The 11th Edition features:

- All the latest multimodal trip generation data for urban, suburban and rural applications,
- Reclassified land uses to better meet user needs,
- Integrated digital copies of all land use definitions, plots and supporting materials,
- Full ability to filter the data to match local conditions.

Available in Multiple Formats at the same price of $895 for members

- Digital – All plots, descriptions and references available electronically.
- Hard Copy – A full printed version of the 11th Edition including, all plots and descriptions.

All-in-one-Bundle – A single user license and hard copy are available at a discounted price of $1290 for members

Significant Member Discounts for Multi-Users

- Additional user licenses only $395
- 5-Pack — Five user licenses for $1675
- Office Bundle — Five user licenses and one hard copy for $1995

Volume Purchasers should email membership@ite.org for pricing information.

Questions? Email membership@ite.org.

TripGen 11 is Your One Stop for All Your Trip Generation Needs!

https://bit.ly/Trip_Gen11

Go ahead. Make My Data.

ITS Plus Lightning Series Generates the Accurate Data You Need!

(All for $8,995 for a complete 4 way intersection with Ethernet)

Today it is beyond just simple vehicle detection. Agencies need accurate data. Lots of accurate data. ITS Plus with our unique Dual Algorithm technology provides multi-sensor performance from a single sensor. Coupled with our new 128 Output SDLC and Ethernet, ITS Plus offers agencies what they need at a fraction of the price of traditional video, thermal or radar technology.

After 16 years of lab/field development our 8th generation intelligent cameras with Artificial Intelligence can "see" thru complete white out conditions (like thermal or radar) while collecting copious amounts of data from a single camera/sensor. This provides stop bar, advanced detection to 1000 ft, vehicle, queue, pedestrian and bicycle detection/counts giving you all the data you need for Adaptive Control, Before and After studies, Purdue Performance Models, etc. You name it, we got it.

And by bypassing the middle man you always get real time Factory support for a fraction of the price ($8,995 for a complete 4 way intersection with Ethernet).

Proven Performance at the Best Price.

www.itsplus3.com

ITS PLUS INC.

All ITS Plus products are designed and manufactured in the USA.