MXD

Getting Trip Generation Right!

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FEHR & PEERS

Overview.

1. Shortcomings of Conventional Methods

2. Background on EPA's MXD Trip Generation Methodology

3. MXD Trip Generation Model

4. MXD+ including NCHRP Report 684

5. Conclusion
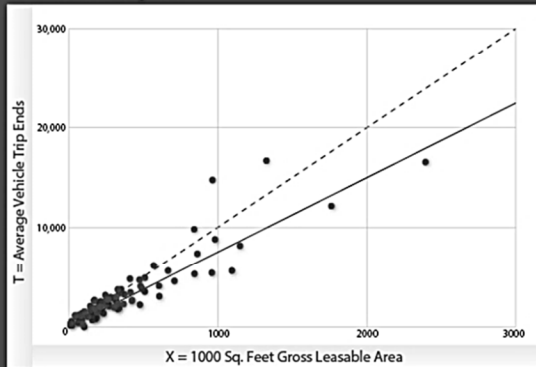
Limitations of current practice.

Single-Family Detached Housing (210)
Average Vehicle Trip Ends vs: Dwelling Units (On a Weekday)

Number of Studies: **350**
Avg. Number of Dwelling Units: **197**
Directional Distribution: **50% entering - 50% exiting**

Trip Generation per Dwelling Unit
Average Rate: **9.57** | Range of Rates **4.31** to **21.85** | Standard Deviation **3.69**

Data Plot and Equation

X Actual Data Points ——— Fitted Curve - - - - Average Rate
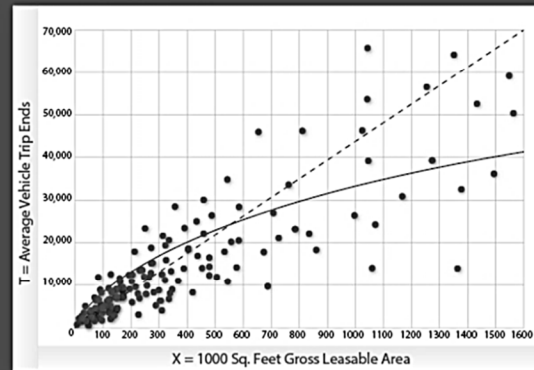**Fitted Curve Equation: Ln(T) = 0.65 Ln(X) + 5.83**   R2 = 0.78

Shopping Center (820)
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Leasable Area (On a Weekday)

Number of Studies: **302**
Avg. Number of Dwelling Units: **328**
Directional Distribution: **50% entering - 50% exiting**

Trip Generation per 1000 Sq. Feet Gross Leasable Area
Average Rate: **42.94** | Range of Rates **12.50** to **270.89** | Standard Deviation **21.38**

Data Plot and Equation

X Actual Data Points ——— Fitted Curve - - - - Average Rate
**Fitted Curve Equation: Ln(T) = 0.65 Ln(X) + 5.83**   R2 = 0.78

General Office Building (710)
Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Floor Area (On a Weekday)

Number of Studies: **78**
Avg. Number of Dwelling Units: **199**
Directional Distribution: **50% entering - 50% exiting**

Trip Generation per 1000 Sq. Feet Gross Floor Area
Average Rate: **11.01** | Range of Rates **3.58** to **28.80** | Standard Deviation **6.13**

Data Plot and Equation
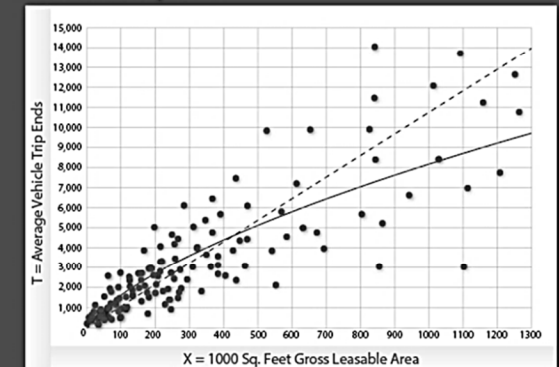
X Actual Data Points ——— Fitted Curve - - - - Average Rate
Fitted Curve Equation: Ln(T) = 0.77 Ln(X) + 3.65   R2 = 0.80

- One variable only - Size
- Scale of development disregarded
- Land use context disregarded
- Possibility of mode shift disregarded

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Limitations of current practice.

Conventional trip generation methods overestimate mixed-use project traffic by 35% (traffic impacts, VMT, air quality, GHG, noise, etc.)

ITE trip rates estimated for this type of development

Not this...
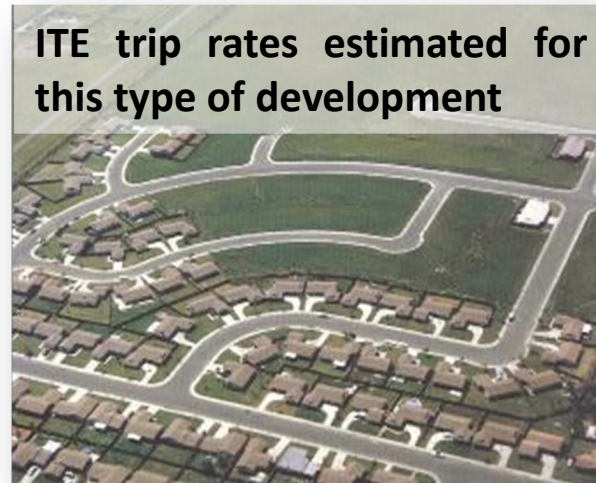
- Do not account for fact that trip generation varies with development density, mix, design, transit availability, and other factors
- Limited empirical validation

Strengths of the conventional method
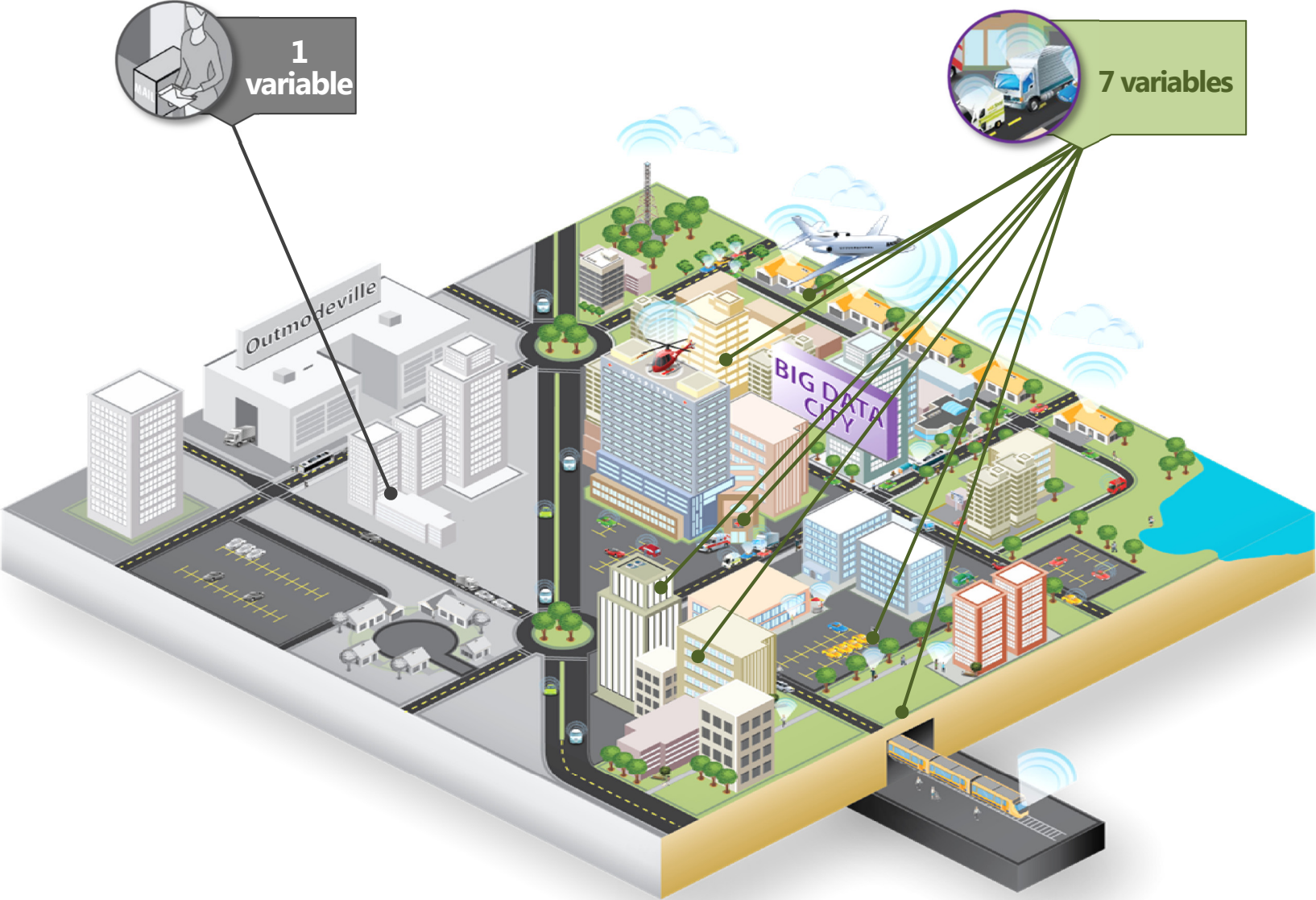- Objective,
- Logical, and
- Fast

Mistreatment of MXD.

Consequence is overestimation of trip generation for mixed-use, in-fill, and transit oriented development:

- Escalate development costs

- Skew public perception

- Heighten community resistance

- Favor isolated single use development

- Oversizing infrastructure

Conventional Method's Shortcomings.

1 variable

7 variables

Outmodeville

BIG DATA CITY

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Factors Associated with Reduced Trip Rates.

Density   Diversity   Design   Destinations   Distance to Transit   Development Scale   Demographics

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7Ds – Features Associated with Reduced Trip Rates.

- **Density** of population and employment

- **Diversity:** jobs/housing relative to regional balance
- **Diversity:** balance of commercial, office, and public

- **Design:** intersections per square mile

- **Destination Accessibility:** jobs within 1 mile
- **Destination Accessibility:** jobs within a 30 min by transit

- **Distance to Transit:** rail station, bus stops within ¼ mile

- **Development Scale:** MXD population and employment

- **Demographics:** household size, vehicle ownership

EPA MXD.

- The U.S. EPA–sponsored 2011 report - *"Traffic Generated by Mixed-Use Developments — A Six-Region Study Using Consistent Built Environmental Measures".* The Study Investigated:

    - Trip generation,

    - Mode choice, and

    - Trip length for trips produced and attracted by mixed use developments.
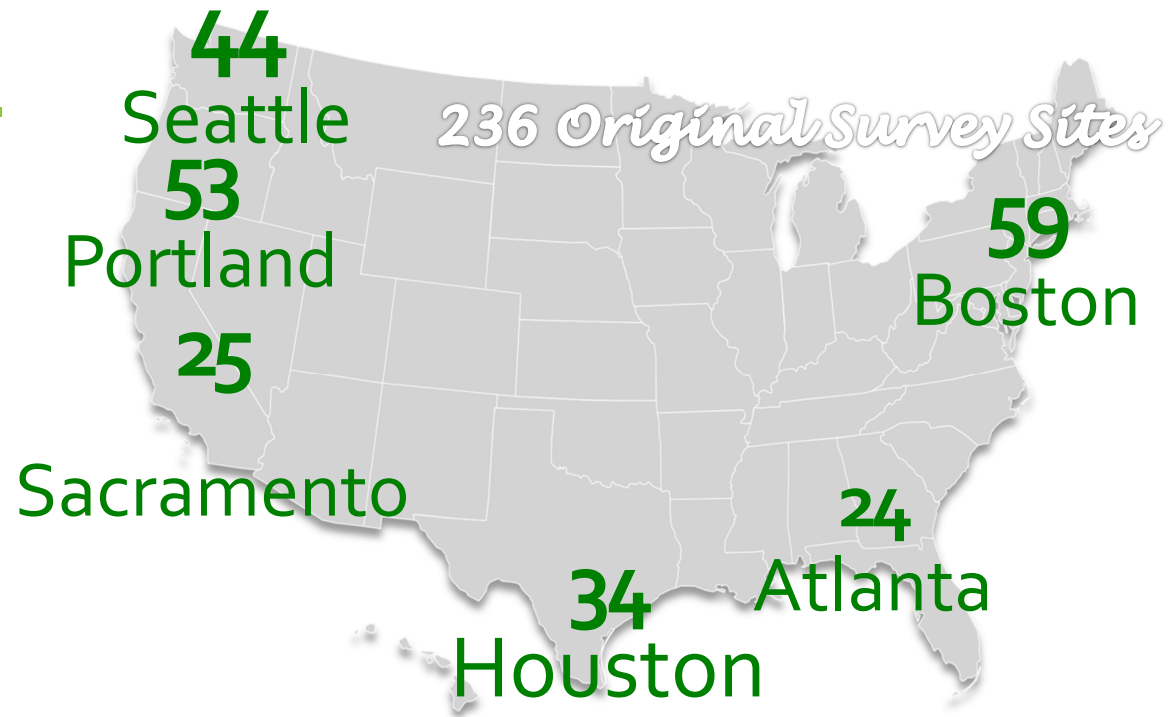
EPA MXD Model.

What is the MXD Model?

- A model for percent reduction in internal to external (IX) and external to internal (XI) vehicle trips

- Framework for immediate and continuing improvement to estimating mixed-use trip generation

- Still uses ITE (or other) trip rates

- Replaces current ITE mixed-use method but uses ITE trip rates

EPA MXD Model.

- Selected regionals included Atlanta, Boston, Houston, Portland, Sacramento, and Seattle.

- **239** MXD that met the ITE definition of multi-use development.

- Represents a wide range of urban scale, form, and climatic conditions.

- Accuracy verified through traffic generation comparisons at 27 mixed-use sites.

236 Original Survey Sites

44 Seattle
53 Portland
25 Sacramento
59 Boston
24 Atlanta
34 Houston

27 Validation Sites

2 Utah
15 California
2 South Carolina
2 Texas
2 Georgia
6 Florida

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Sample MXD Model Validation Sites.

Atlantic Station, Atlanta

Uptown District, San Diego

Irvine California

Plano Texas

Celebration Florida

Otay Ranch California

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EPA MXD Model Validation.

Legend: ■ Gross Trips ■ Net Trips ■ MXD Model ■ Observed

Y-axis: External Vehicle Trips (1000s)

X-axis: Site 1 through Site 28

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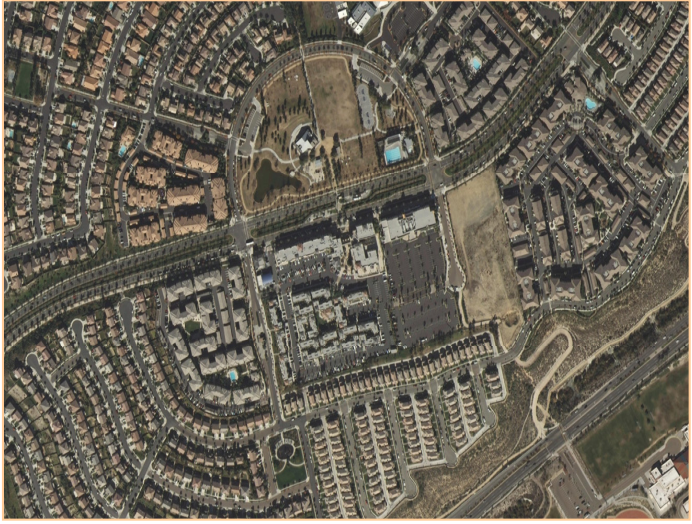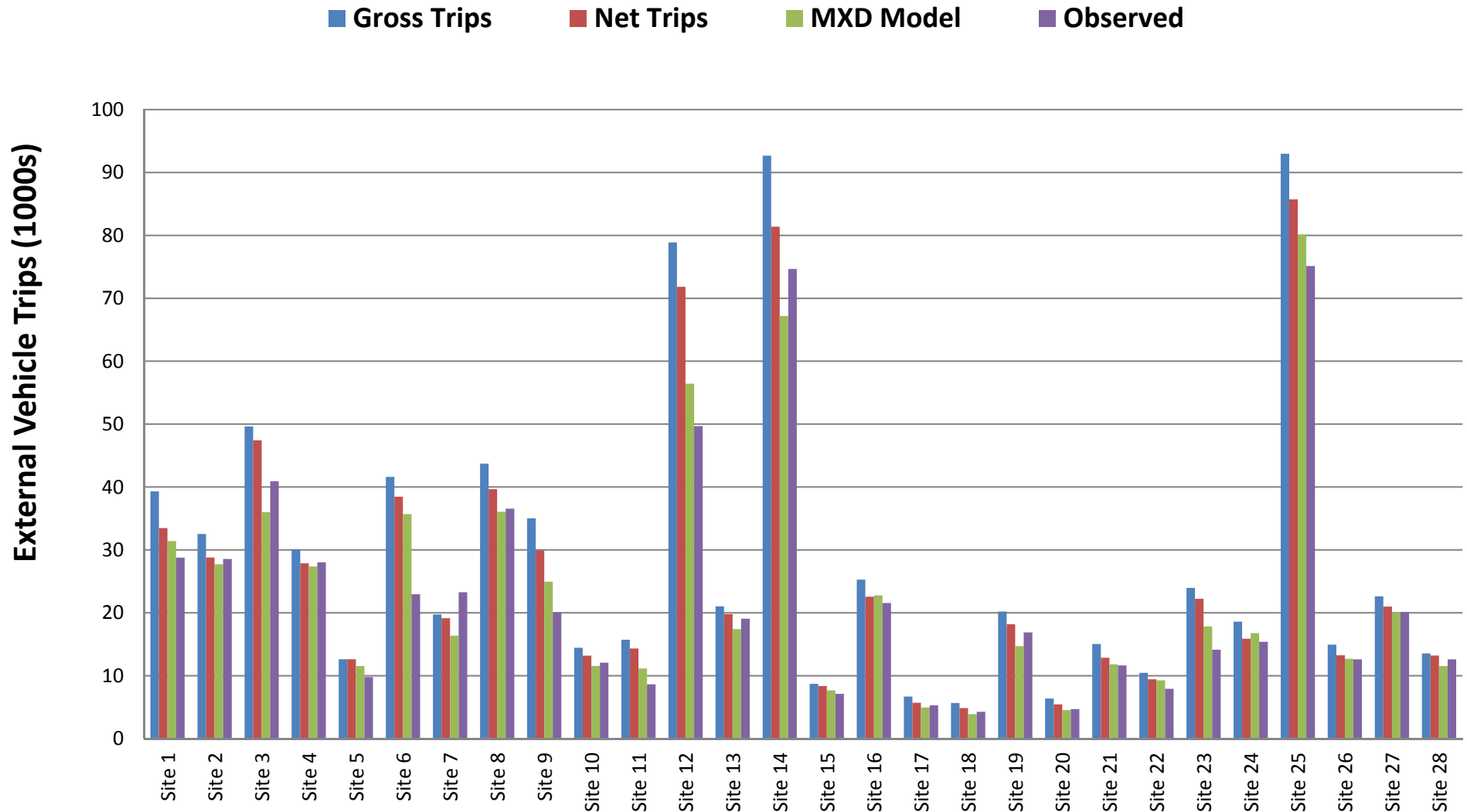
EPA MXD Model Inputs.

D Variable	MXD Model Input	Sources
Density	Activity Density	Land Use Program
Diversity	Diversity	Land Use Program
Design	Intersection Density	EPA Smart Location Database (SLD)
Destinations	- Employment within 1 mile - Employment within 30 minutes by transit	Local or Regional Travel Model
Distance to Transit	Percentage of project within ¼ mile of transit	GIS Analyst
Development Scale	Building footprint	Site Plan
Demographics	- Household size - Auto ownership	Census Data American Community Survey

EPA MXD Model Outputs.

- Raw External Trips
- Net External Trips
- Internal trip reductions
- Non auto mode reductions (Transit, Bike, Walk)

- Raw Vehicle Miles Traveled (VMT)
- Net VMT
- Internal trip reductions
- Non auto mode reductions (Transit, Bike, Walk)

- Raw VMT per Household
- Net VMT per Household

SAMPLE DEVELOPMENT PROJECT PRELIMINARY TRANSPORTATION SUMMARY

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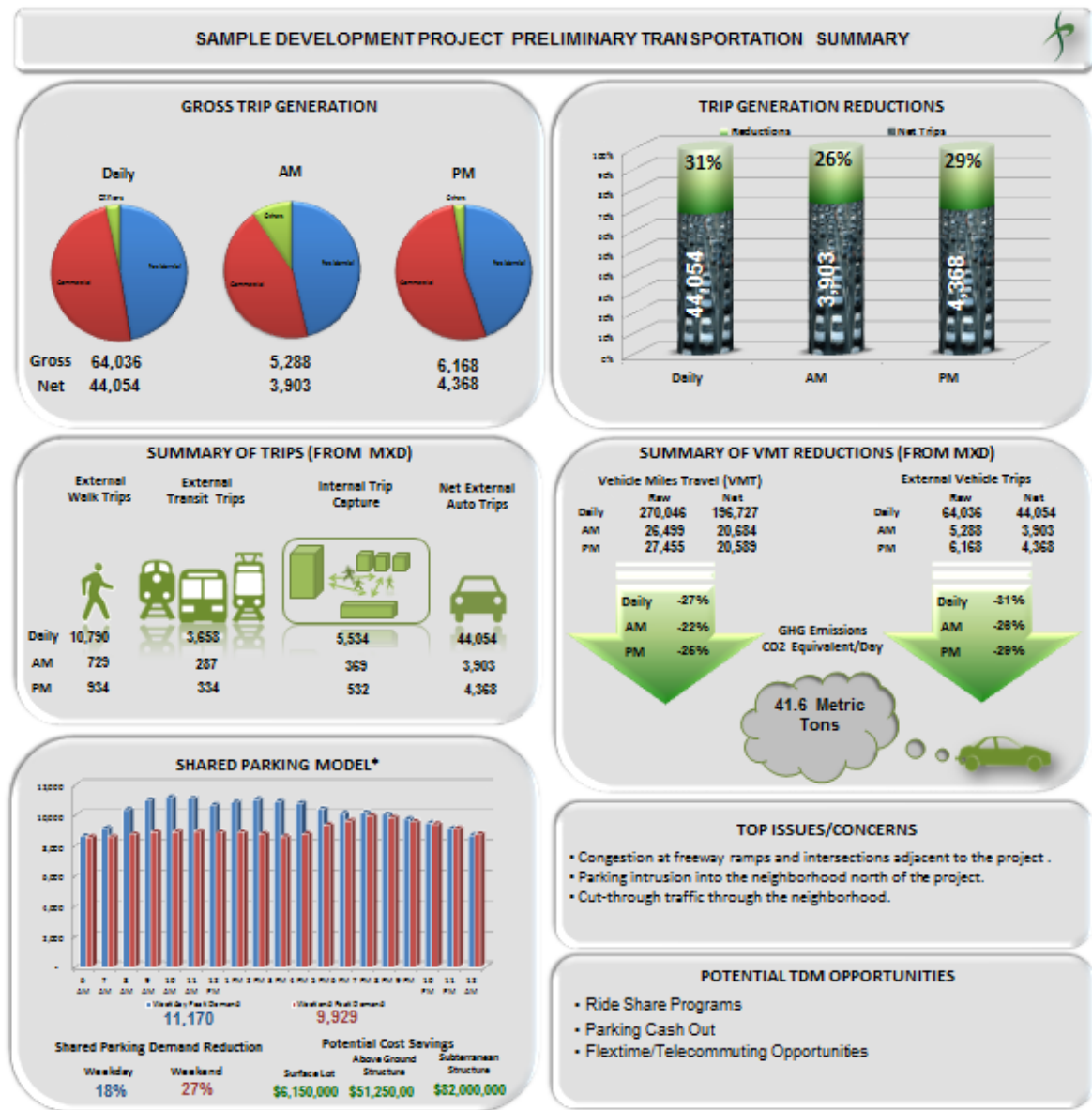
NCHRP Report 684.

National Cooperative Highway Research Program (NCHRP) Report 684, "Enhancing Internal Trip Capture Estimation for Mixed-use Development":

- Analyzed internal-capture relationships of MXD sites, and
- Examined the travel interactions among six individual types of land-uses:
    - Office
    - Retail
    - Restaurant
    - Residential
    - Cinema
    - Hotel

NCHRP Report 684.

- Established interactions among the six land-use types of interest and compared them with site characteristics

- Examined percentage visitors to each land-use type who also visited each of the other uses during the same trip

- Considered site context factors and described percentage reductions in total traffic generations attributable to availability of transit service and other factors

- Compared results to the three sites in Florida provided in the ITE handbook

NCHRP Report 684.

Development	Percent Internal Capture			
	AM Peak Period		PM Peak Period	
	At Trip Origin (Outbound Trips)	At Trip Destination (Inbound Trips)	At Trip Origin (Outbound Trips)	At Trip Destination (Inbound Trips)
Mockingbird Station	31%	22%	36%	38%
Atlantic Station	17	12	38	44
Legacy Town Center	11	15	37	33
Country Isles	--	--	22	24
Village Commons	--	--	9	9
Boca del Mar	--	--	8	7

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MXD⁺ - MXD and NCRRP-684 Combined.

	EPA MXD Method	NCHRP 684 Method	MXD⁺ Method
Density of Development	☑		☑
Diversity of Uses: Jobs/Housing	☑	☑	☑
Diversity of Uses: Housing/Retail		☑	☑
Diversity of Uses: Jobs/Services		☑	☑
Diversity of Uses: Entertainment, Hotel		☑	☑
Design: Connectivity, Walkability	☑	☑	☑
Design: Separation Among Uses		☑	☑
Destination Accessibility by Transit	☑		☑
Destination Accessibility by Walk/Bike	☑		☑
Distance from Transit Stop	☑		☑
Development Scale	☑		☑
Demographic Profile	☑		☑

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MXD⁺ - MXD and NCRRP-684 Combined.

	EPA MXD Method	NCHRP 684 Method	MXD⁺ Method[1]
Daily Traffic Generation			
R-squared	96%	--	96%
Average Error	2%	--	2%
Root Mean Square Error	17%	--	17%
AM Peak Traffic Generation			
R-squared	97%	93%	97%
Average Error	12%	30%	12%
Root Mean Square Error	21%	33%	21%
PM Peak Traffic Generation			
R-squared	95%	81%	97%
Average Error	8%	18%	4%
Root Mean Square Error	18%	36%	15%

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MXD⁺ Acceptance.

Conclusion.

- ITE trip generation rates are not default. ITE Handbook recognizes that land use context is the biggest variable influencing trip generation rate differences in the manual

- ITE rates include only one variable, the amount of land use.

- MXD/MXD+ allows users to consider seven variables that directly address the Handbook recommendations to consider context while using ITE rates as the starting point.

- MXD/MXD+ also includes the ability to calculate VMT with the simple integration of trip lengths by purpose consistent with the new SB743 guidelines.
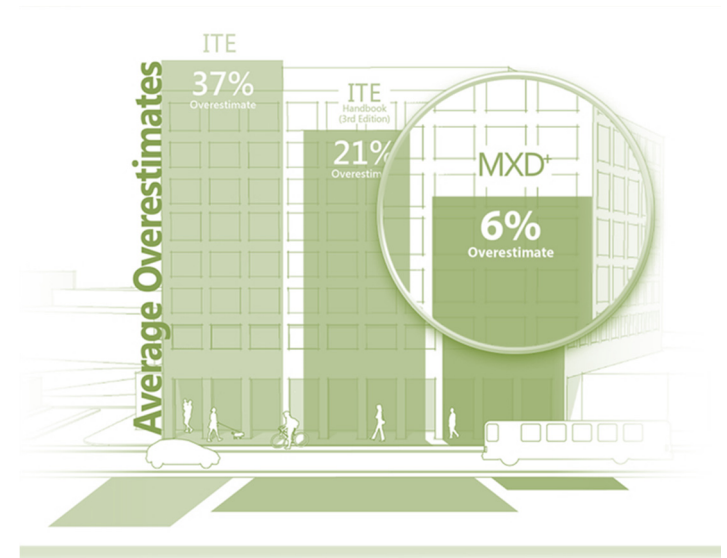
Thank You.
Questions?

Helpful Links:

* https://www.epa.gov/smartgrowth/mixed-use-trip-generation-model

* http://www.fehrandpeers.com/wp-content/uploads/2013/07/APA_PAS_May2013_GettingTripGenRight.pdf

* http://asap.fehrandpeers.com/sustainable-development/mxd/

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