



DECM

TxDOT Cluster Analysis Guide Preview

TEXITE Spring Meeting

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MEET THE TEAM

Introduction



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Setting the Stage

Corridors do not operate the same day to day.

How do we capture this variability in our traffic models?

Traffic Doesn't Have a "Typical Day"

The "Typical Day" Assumption	The Reality			
 <p style="background-color: #0056b3; color: white; padding: 5px; text-align: center;">Typical Traffic</p>	<div style="background-color: #c00000; color: white; padding: 5px; font-weight: bold;">MONDAY</div> <div style="background-color: #c00000; color: white; padding: 5px; font-weight: bold;">Heavy Congestion</div> 	<div style="background-color: #c00000; color: white; padding: 5px; font-weight: bold;">TUESDAY</div> <div style="background-color: #c00000; color: white; padding: 5px; font-weight: bold;">Major Incident</div> 	<div style="background-color: #0056b3; color: white; padding: 5px; font-weight: bold;">WEDNESDAY</div> <div style="background-color: #0056b3; color: white; padding: 5px; font-weight: bold;">Stormy Weather</div> 	<div style="background-color: #0056b3; color: white; padding: 5px; font-weight: bold;">FRIDAY</div> <div style="background-color: #0056b3; color: white; padding: 5px; font-weight: bold;">Directional Peak</div> 

Same Corridor. Completely Different Outcomes.

Setting the Stage



Not a case study



Not a project-specific application



Guidebook review

**Guidebook will Provide
Step by Step Process
to Perform Cluster
Analysis**

Purpose of the Guide

FHWA Requirement for IAJs with microsimulation

- Traffic Analysis Toolbox: Volume III – 2019 update

Why? Provide a Uniform Approach for Cluster Analysis

- Clear, structured, and data-driven approach
- Practical step-by-step approach provided

Performing Cluster Analysis Improves

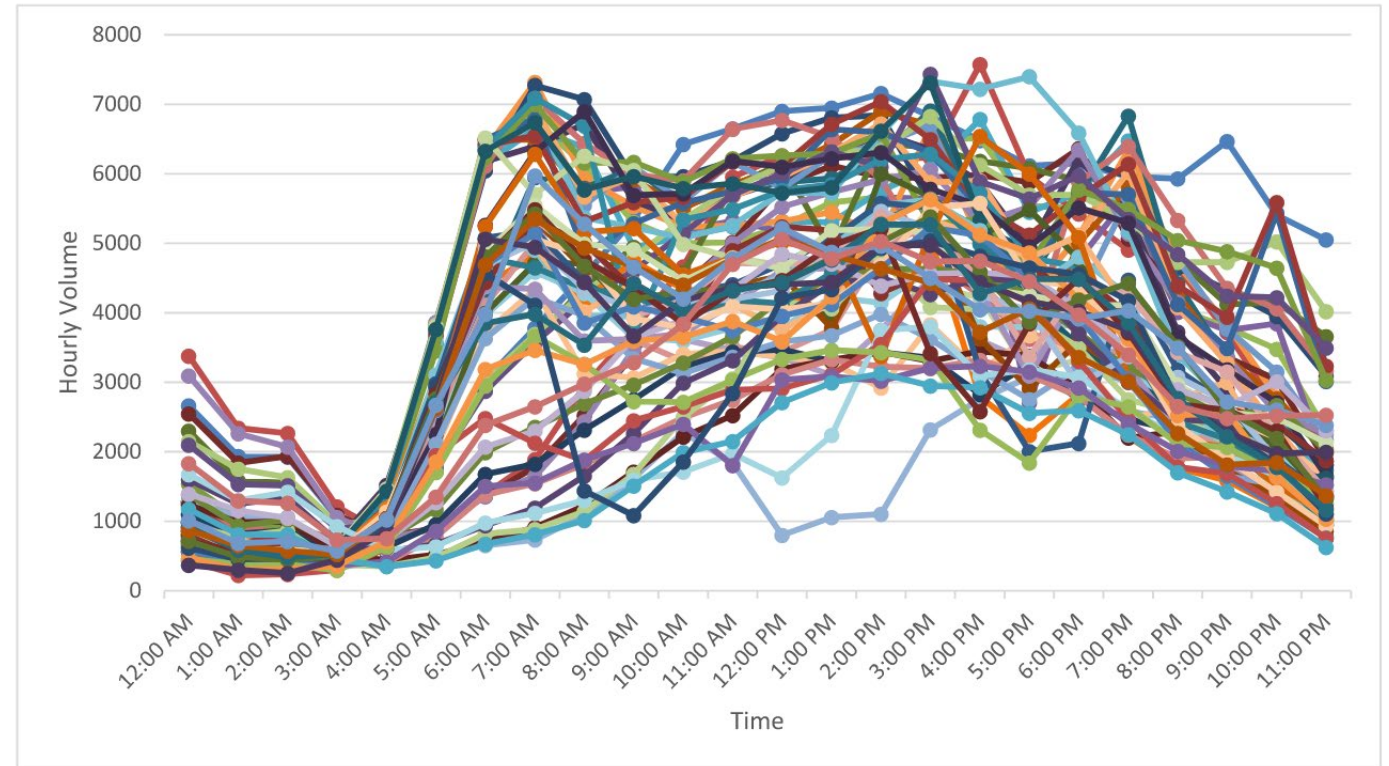
- Accuracy of microsimulation inputs and outputs
- Reproducibility of analyses
- Robustness of alternative evaluations
- Credibility of findings

Programmatic Agreement Allows
TxDOT to Review some IAJs
without FHWA review – Expediting
Project Delivery

Why Perform a Cluster Analysis?

Capture Variability of Traffic Operations

- Demand
- Incidents
- Weather
- Seasonality
- Holidays
- Construction Activities
- Special Events



When Should a Cluster Analysis be Performed?



REQUIRED

- Microsimulation included
- TxDOT IAJR SOP applies
- FHWA requirement triggered



RECOMMENDED/ BEST PRACTICE

- Microsimulation (non-IAJR studies)
- Calibration required
- Corridor-level analyses



HIGH-VALUE USE CASES

- Long-term or high-resolution data
- Fluctuating congestion profiles
- Non-recurrent events (incidents, weather, construction)

Data Needed for Cluster Analysis

- a. Demand Data
 - b. Travel Time Data
 - c. Incident Data
 - d. Weather Data
- ✓ At least 100 days of data is recommended for input into the cluster analysis

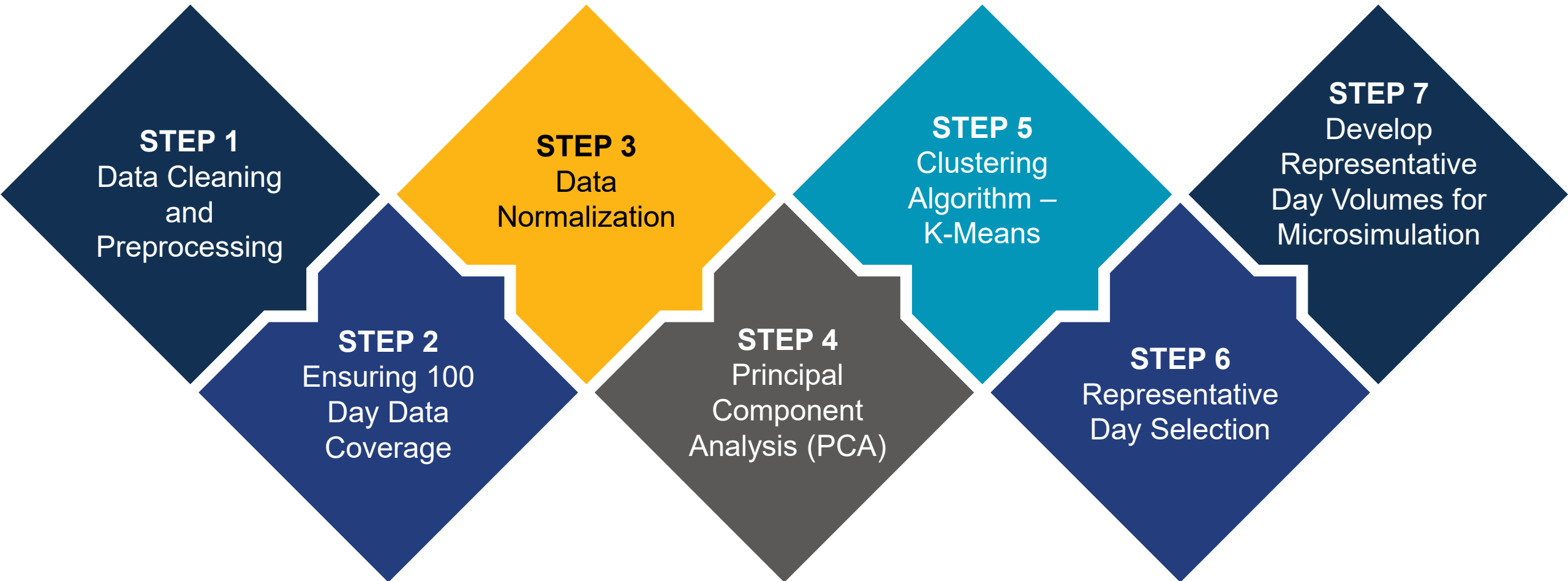
**Additional Data
Accounts for
Variations in Travel
Conditions**

Cluster Analysis Limitations

- a. Absence of natural clusters
- b. Curse of dimensionality
- c. Impact of outliers and noise
- d. Subjectivity in cluster interpretation
- e. Assumption violations

**Document these
limitations if they
occur**

Cluster Analysis Overview



STEP 1

Data Cleaning and Preprocessing



STEP 1
Data Cleaning
and
Preprocessing

- a. Days with missing or invalid data are identified and removed prior to analysis.
- b. Divide data into time periods of interest and evaluate completeness and quality of the input dataset. Scenarios could include:
 - i. Weekday AM Peak Period**
 - ii. Weekday PM Peak Period**
 - iii. Mid-Day Peak Period
 - iv. Weekend Peak Period
 - v. Special Events

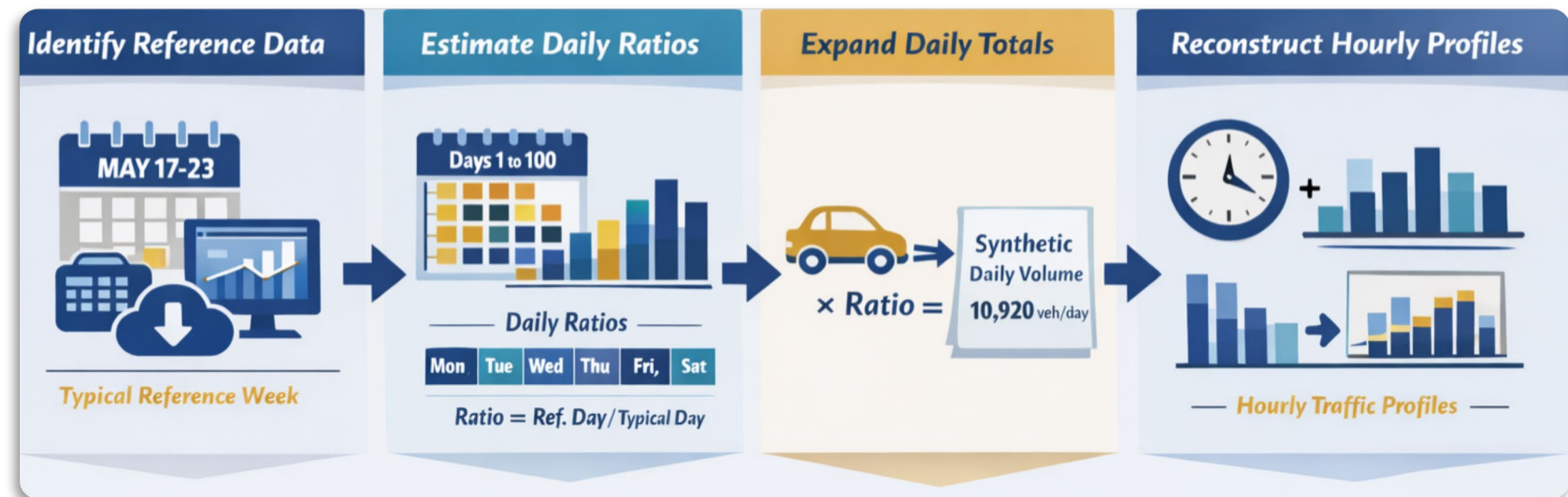
Too much data, not enough direction

STEP 2


Ensuring 100 Days of Data Coverage



- a. Use TxDOT Permanent Count Stations or Trusted Third-Party Sources
- b. Guide provides a methodology to obtain data, determine data requirements, validate the data, and expand the data to 100 days



Data Normalization

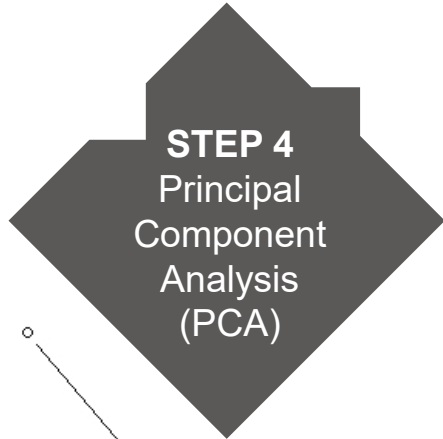


STEP 3
Data
Normalization

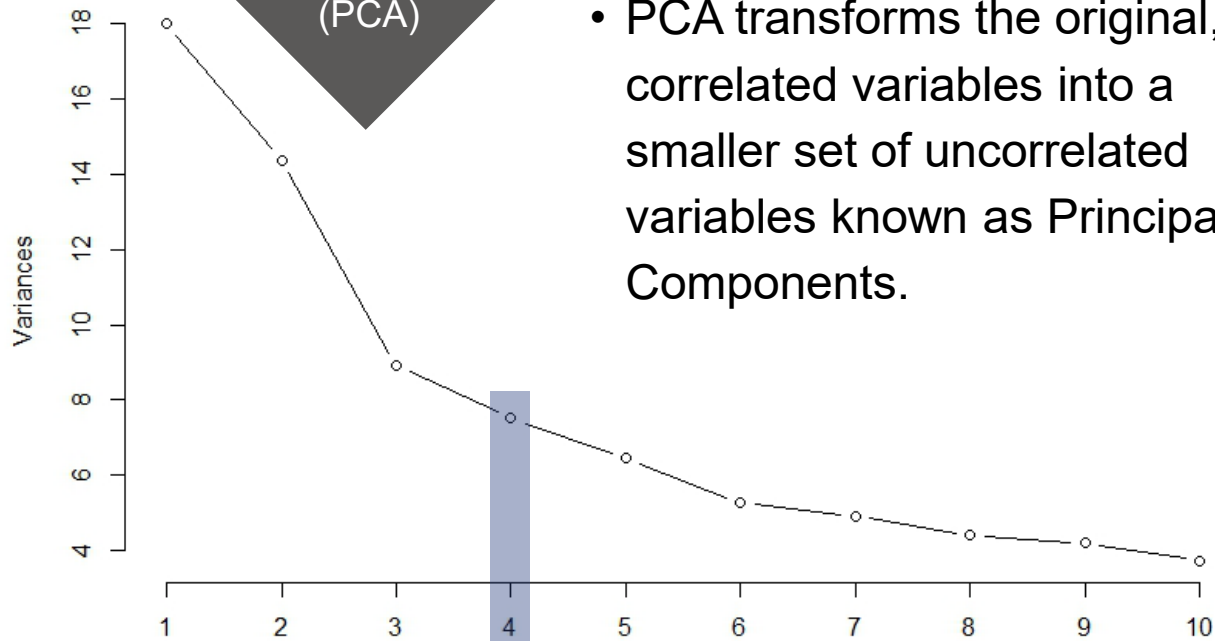
- a. Apply Z-Score Standardization prior to Principal Component Analysis (PCA)
 - i. This is different from the FHWA toolbox, but the purpose is the same
- b. Done to ensure variables with larger scales do not dominate the analysis

STEP 4

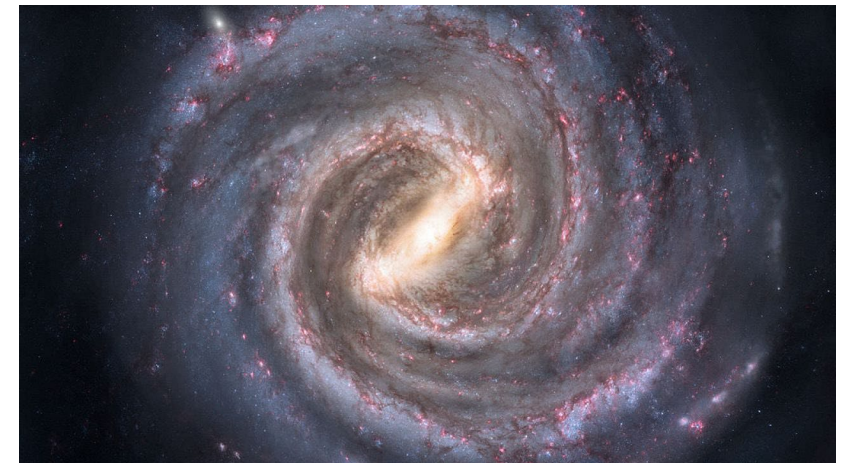
Principal Component Analysis



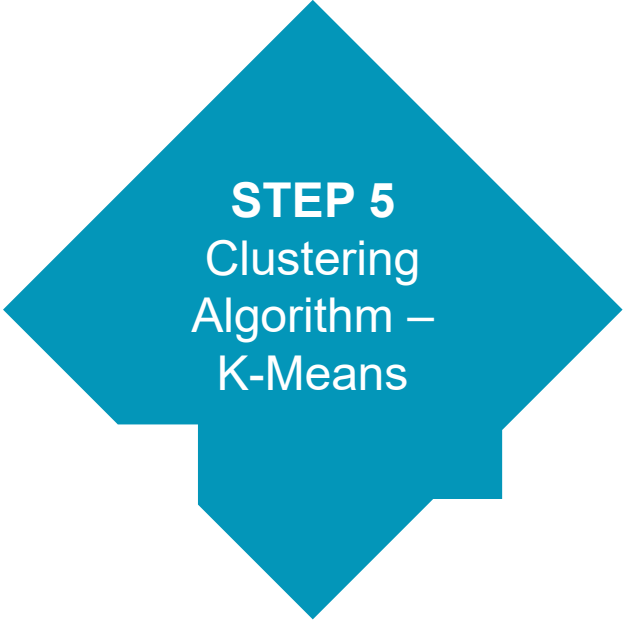
- Many traffic variables are inherently correlated (e.g., Demand and Travel Time)
- PCA transforms the original, correlated variables into a smaller set of uncorrelated variables known as Principal Components.



Scree Plot



Clustering Algorithm

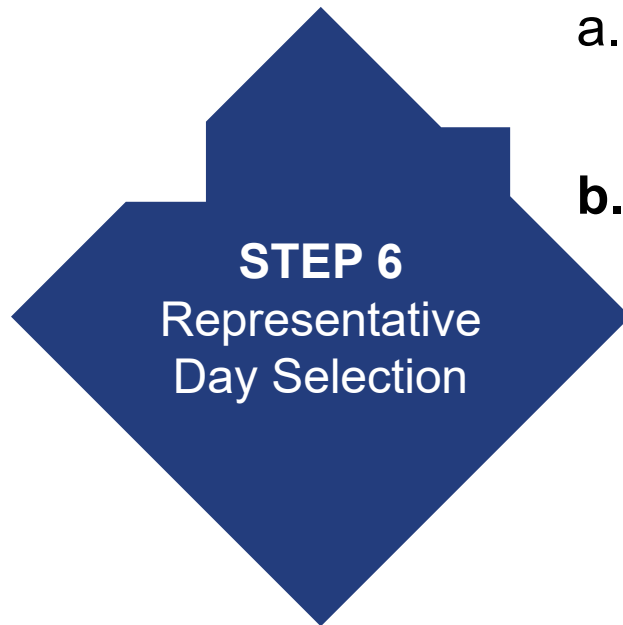


STEP 5
Clustering
Algorithm –
K-Means

- a. Manual is agnostic about what method of Clustering is used, but K-Means is the most common – others can be used if deemed necessary
 - i. The manual includes information about the different clustering algorithms and the preprocessing requirements
- b. K-Means Steps
 - i. Establish the range of K Values
 - ii. Running K-Means and Ensuring Stability
 - iii. Selecting Optimal Number of Clusters

STEP 6

Representative Day Selection



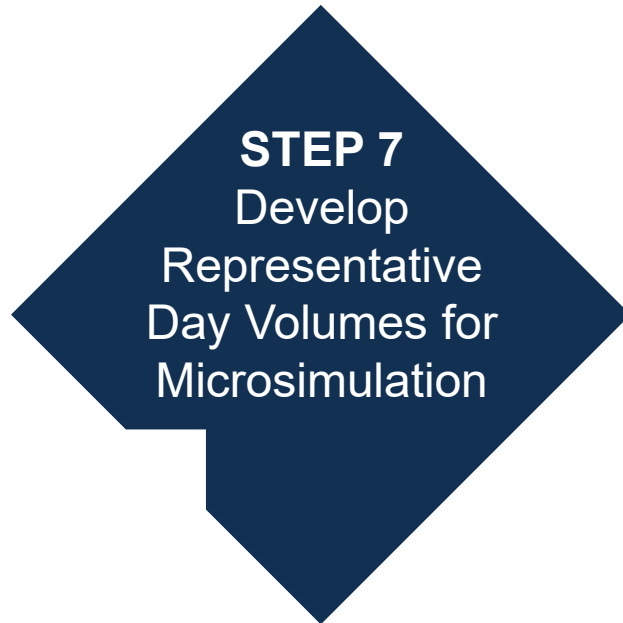
- a. Select representative day for each cluster
- b. **Choose which day to model**

Traffic models based on time-dynamic system performance of an actual day



STEP 7

Step 7 – Develop Representative Day Volumes for Microsimulation



Develop factors to convert collected counts into volumes that match the representative day conditions – these are then used as the basis of microsimulation.

Count Date	AM Factor	PM Factor
May 3	1.028	1.055
May 4	1.007	1.005
May 5	1.011	1.196
May 17	0.986	1.043
May 19	0.991	1.037
May 26	1.013	1.078
June 7	0.986	1.036

This isn't just analysis—it's a repeatable decision framework

Resources

Guide Posted to TxDOT
Website

COMING SOON
Design Tools and Training

Acknowledgements

Khalid Jamil – TxDOT DES
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Milad Kiaee – TxDOT DES
Kittelsohn & Associates, Inc.

REACH OUT

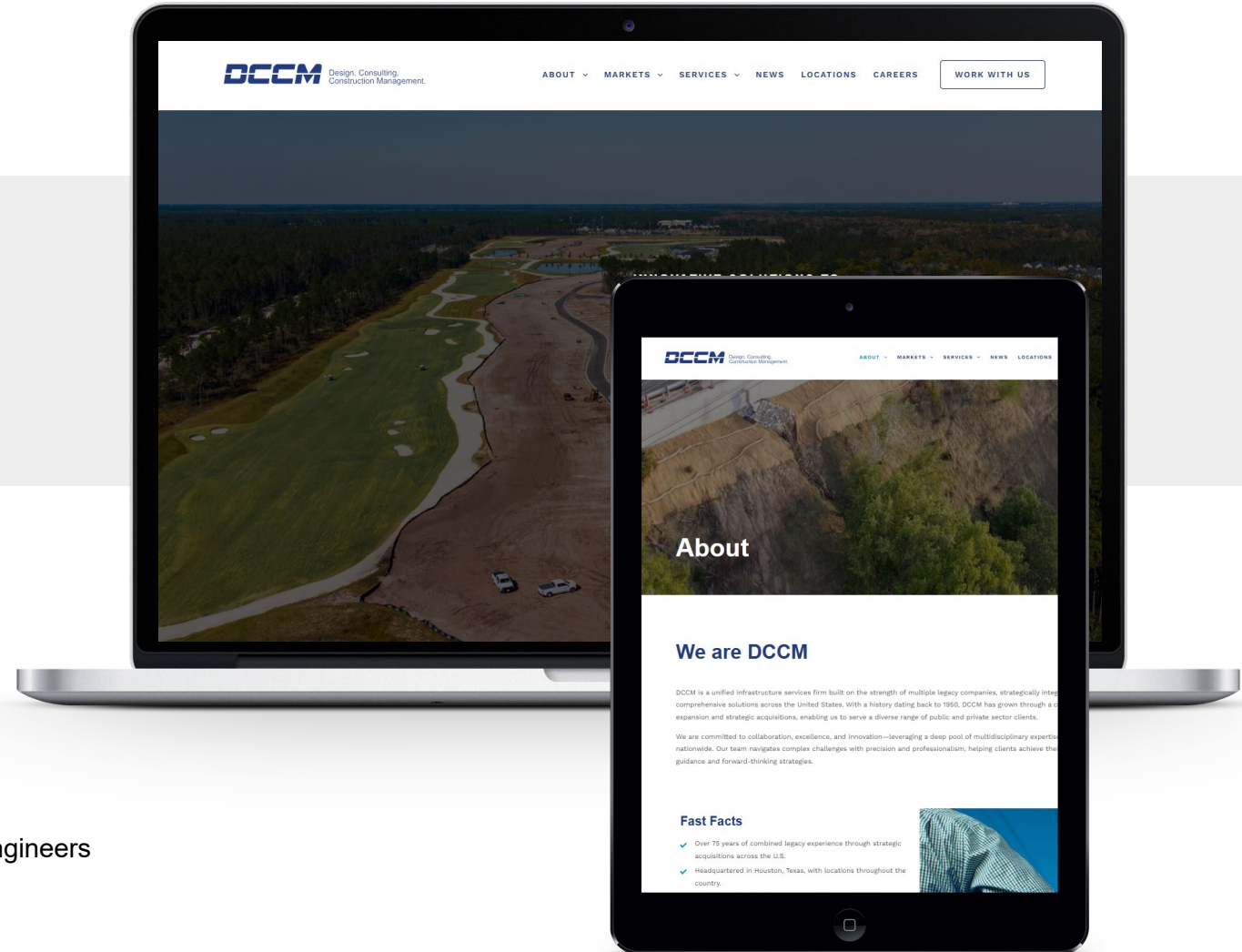
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Thank you.

Innovative strategies to **design, develop, and grow.**

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