Lecture 2.8

2.3 Origin-Destination Studies

Definition and Concept of Origin-Destination (O-D) Studies

An Origin (O) is the location where a trip begins, and a Destination (D) is the point where a trip ends.

An O-D study collects detailed information about trip origins, destinations, travel routes, trip purposes, modes of travel, and mid-trip stops.

- Captures the true spatial pattern of human and freight movement
- Tracks travel desire independent of existing highway routes
- Identifies trip purpose (work, education, shopping, social)
- Measures multi-modal travel behavior across transportation networks

Purpose and Necessity of O-D Surveys

Traditional volume counts only measure traffic on existing roads, failing to show how traffic would redistribute if a new highway or bypass were constructed.

O-D studies provide fundamental data required to plan new arterial roads, expressways, mass transit lines, and urban ring roads.

- Determining true traffic desire lines across urban areas
- Evaluating bypass feasibility for bypassing city centers
- Planning mass rapid transit systems (Metro, BRTS)
- Developing travel demand forecast models (4-step transport modeling)

Planning and Defining Study Area & Cordon Lines

Before starting an O-D survey, engineers establish a study area boundary known as the External Cordon Line.

The cordon line encompasses all urbanized areas and anticipated growth corridors expected within the planning horizon (e.g., 20 years).

- External Cordon Line: Encloses the entire metropolitan study region
- Intersects all major entry/exit highway routes
- Must be clearly defined along natural or artificial barriers (rivers, railways)
- Enables tracking of internal, external-internal, and through traffic

Traffic Zoning System (Zones and Centroids)

To process O-D data, the study area inside the cordon line is divided into smaller geographical sub-areas called Traffic Analysis Zones (TAZs).

Each zone is assumed to generate and attract trips from a single central point called the Zone Centroid.

- Internal Zones: Subdivisions within the external cordon boundary
- External Zones: Geographic areas lying outside the cordon boundary
- Zone Boundaries: Follow major roads, rivers, ward boundaries, or rail lines
- Zone Centroid: Mathematical center representing trip generation/attraction point

Boundary Screen Lines and Cut Lines

Screen lines are imaginary lines dividing the study area into two large sections, usually drawn along physical barriers like rivers, canals, or railways.

Screen line checks compare total ground counts of vehicles crossing the barrier against the expanded O-D survey trip totals to verify survey accuracy.

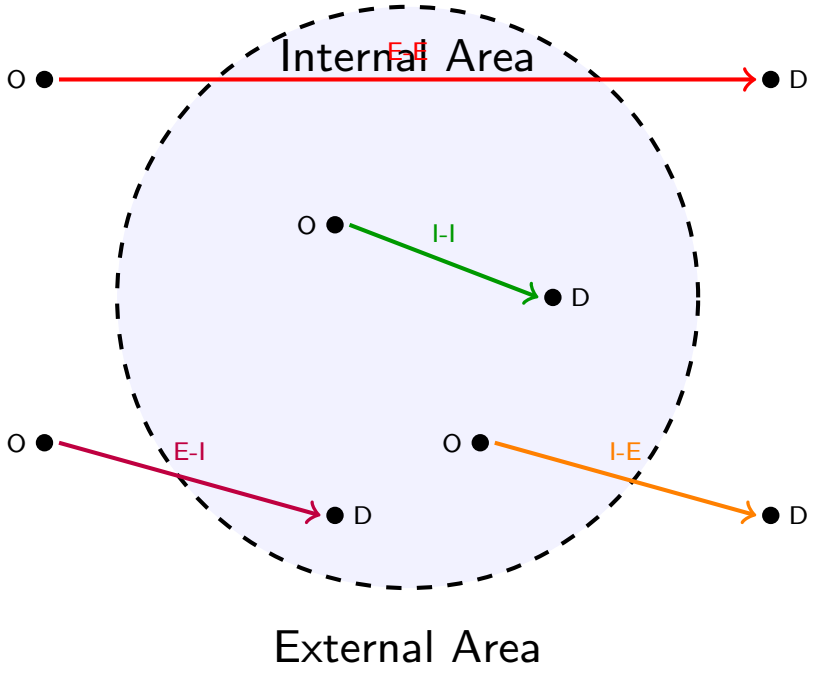
- Screen Line: Divides internal study area into major sectors
- Cut Line: Crosses specific corridors to validate sub-area assignment
- Serves as a calibration mechanism for survey sample expansion factors
- Acceptable error threshold between ground counts and expanded O-D: $\pm 10\%$

Types of Trips in O-D Analysis

Trips identified in O-D surveys are categorized based on their origins and destinations relative to the external cordon boundary.

Categorizing trip types helps engineers distinguish local urban traffic from regional transit traffic.

- **I-I**: Origin & destination inside
- **I-E**: Origin inside, destination outside
- **E-I**: Origin outside, destination inside
- **E-E**: Through traffic



Applications in Highway Network Planning

O-D survey data forms the empirical foundation for strategic transport network development.

Engineers analyze the O-D matrix to identify high-density traffic corridors requiring major infrastructure upgrades.

- Sizing arterial roads and urban expressways based on travel demand
- Locating major interchanges, flyovers, and elevated corridors
- Evaluating economic benefits of multi-modal transportation corridors
- Simulating traffic assignment under future master plan land-use scenarios

Bypasses and Ring Road Planning

Constructing a bypass around a congested city center is justified only if a significant portion of total entry traffic consists of through traffic (E-E trips).

O-D studies establish the exact percentage of through traffic, ensuring public funds are invested in viable bypass projects.

E-E Traffic	**Bypass Justification**	**Solution / Impact**
High ($> 30\%$)	Strongly justified	Viable bypass project
Low ($< 10\%$)	Not justified (will fail)	Urban street widening
Ring roads serve **through traffic** AND **peripheral movements**		
Reduces heavy freight congestion in residential/commercial hubs		

Public Transport Route Planning using O-D Data

Public transport operators use O-D patterns to structure bus routes, frequency schedules, and transit stops.

Aligning transit routes directly along high-volume desire lines maximizes passenger patronage and operational revenues.

- Identifying major commuter origin clusters and employment destination hubs
- Planning Metro Rail alignments and Bus Rapid Transit (BRTS) corridors
- Designing feeder bus routes connecting suburb zones to transit stations
- Optimizing fleet size and dispatch frequencies for peak transit hours

Data Accuracy, Sampling, and Checks

Because surveying 100% of travelers is impossible, O-D surveys rely on statistical sampling techniques.

Sample expansion factors must be computed carefully, and rigorous accuracy checks applied using screen line counts.

Key Parameter	**Typical Value / Strategy**
Roadside Interview Sampling	10% to 20%
Home Interview Sampling	3% to 5%
Expansion Factor	$\frac{\text{Total Ground Traffic Volume}}{\text{Sampled Vehicles}}$
Consistency Checks	Compare with census & demographic data
Error Minimization	Address non-response bias & sampling errors

Summary & Key Takeaways

Origin-Destination studies capture true travel desire lines, independent of current road network limitations.

O-D data is essential for planning bypasses, ring roads, mass transit systems, and master plan transportation networks.

- O-D tracks start points, end points, routes, and trip purposes
- Study areas are bounded by External Cordons and divided into TAZs
- Screen line counts validate sample expansion accuracy
- Through traffic (E-E trips) determines bypass feasibility