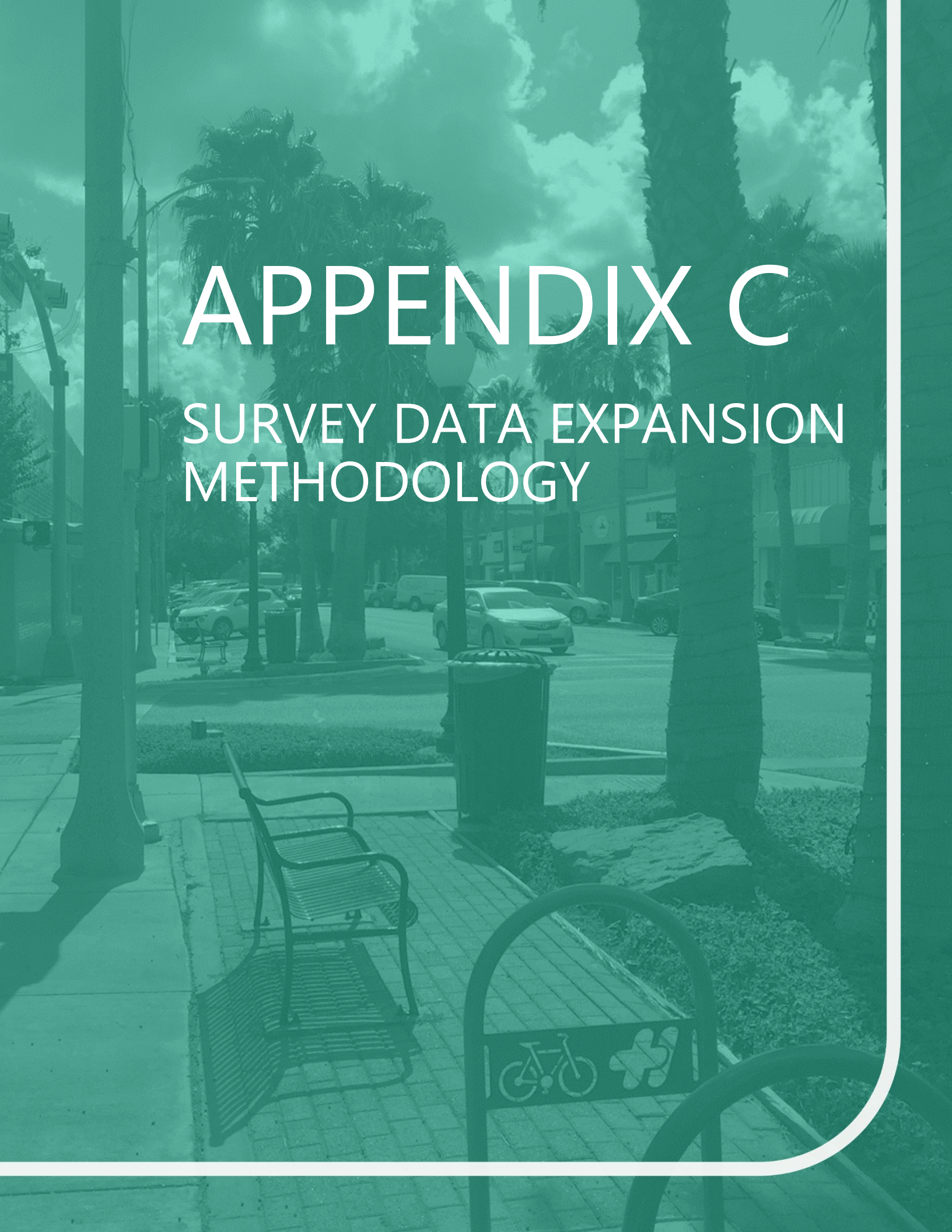


APPENDIX C

SURVEY DATA EXPANSION METHODOLOGY



METHODOLOGY OVERVIEW

The following process was used to develop weighting factors to expand transit on-board survey responses collected by Dikita to the total transit ridership in the Rio Grande Valley region. In order to correctly represent the total trips taken in the study area, two types of expansion processes were conducted.

- The unlinked trip expansion process was used to expand the completed surveys to the actual number of boardings in the region
- The linked trip expansion process was used to adjust the total number of boardings to one-way trips to account for transfers

Unlinked Trip Expansion

On-board survey records can be expanded based on route, time of day, and direction. In this case, there were not enough responses to summarize results based on time of day in a way that would produce significant results for individual routes. For the routes with very high volumes, the expansion factors were further developed by boarding locations. Specifically, the unlinked trip expansion factor for these routes was developed through the following steps:

1. Routes were segmented based on observed distribution of boarding and alighting using the collected boarding and alighting counts
2. The total number of boardings was estimated for each segment
3. Expansion factors were calculated by dividing total boarding on each segment of the route by the number of completed surveys for the segment

For low volume bus routes, the expansion factor was calculated by dividing number of boardings by the number of completed surveys in each direction of a route.

Linked Trip Expansion

The linked trip expansion factor is used to account for the impact of transfers on the total number of boardings. The expansion factor is inversely proportional to the number of transfers.

Available Data

- Origin and Destination Survey produced by Dikita including 2,146 valid results (71%).
- Boarding counts from February 2019 - 2020 for Valley Metro routes, UTRGV and STC routes, Metro McAllen routes, B Metro routes, and Island Metro routes.



EXPANSION PROCEDURE

The project team did not have the boarding and alighting distribution data, so the survey was expanded based on number of boardings. The following procedures were used to expand the origin and destination survey to ridership estimates.

Re-Organize and Process Boarding and Alighting Data

Survey data included the origins and destinations of trips, as well as the approximate location of boarding and alighting. This data was then assigned to route segments to produce ridership estimates by location on the route, as boarding and alighting data was not available by stop for all transit providers in the region.

1. Manually assign segments for each route by splitting each route into major segments and combining some smaller or non-fixed stops together to make a few major segments of the route for both inbound and outbound. These segments are in sequential order.
 - a. Identify major stops, direction changes, land use changes, major roadways, distance, deviations, and professional judgement to segment routes.
 - b. Apply segment ID format:
 - i. X-XX-X-XX
 - ii. "System Number" – "Route Number" – "Direction" – "Segment"
 - iii. System Number is maintained as provided by Dikita report
 - iv. Route ID should match Route Number
 - v. Assign Direction ID using 1 for Outbound or 2 for Inbound
 - vi. Segment Number:
 1. Start at the beginning of the route Outbound
 2. Count up in increments of five: 0, 5, 10, 15, 20, etc.
 3. Inbound starts around halfway on a loop or at the "turn around" point of the route
 4. On the switch to Inbound, start back at 0 and count up again by fives.
 - vii. Example:
 1. Segment ID = 1001101
 2. System ID = 1 = 1 Metro McAllen
 3. Route ID = 1 = 1 Route 1
 4. Direction ID = 1 = 1 Outbound
 5. Segment Number = 0 = First segment on the Route
2. Associate segment information with the boarding and alighting data records.
 - a. Based on each record's boarding location and alighting location, assign the appropriate segment ID.
3. For the same route, aggregate the boarding and alighting data by segment which gives the boarding and alighting distribution among segments and route.
4. Calculate total boarding per segment by route and total alighting per segment by route.
5. Calculate percent of total boarding per segment by route and percent of total alighting per segment by route.
6. Calculate total activity, or boarding and alighting combined, for each segment for an overview of ridership activity for maps.

Example

Major raw boarding and alighting info is found in Table 1. Note that a different trip for the same route has different Stop ID, which needs to be aggregated using common Segment ID later on.

Table 1: Raw Boarding/Alighting Info

Route	Stop ID	Bus On	Bus Off	Time
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The above raw data (Table 1) can be transformed to Table 2:

Table 2: Boarding/Alighting Data Transformation

Route	Segment ID	Aggregated Bus on	Aggregated Bus off	Total Activity	Time Period	% of on to total boarding of this route	% of off to total alighting of this route
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Calculate Ridership Expansion Target

1. Find the total ridership by route (Table 3).
2. Apply percent of total boarding per segment by route to total ridership by route to get the target boarding by segment by route (Table 4).

Table 3: Raw Ridership Data

Route	Avg Daily Ridership
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Table 4: Target Ridership Data

Route	Off Segment ID	On Ridership Target	Time Period
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Route	Off Segment ID	On Ridership Target	Time Period
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Reorganize Survey Data

The Boarding Stop ID and Alighting Stop ID in the survey data are different from the Stop ID in the boarding and alighting survey data.

1. Assign boarding Segment ID and alighting Segment ID for the survey Boarding Stop ID and Alighting Stop ID, respectively. The Segment ID needs to be consistent with the Segment ID used in the target ridership data and the boarding and alighting data.
2. Count the number of surveys conducted for the segment pair of the route.
3. Using the On Ridership Target expansion value from the Table 4, divide the On Ridership Target by the number of surveys for each route segment to derive the expansion factor.
4. Assign the expansion factor to each survey record (Table 10) for same segment on/off pairs.
5. Summarize the expansion factors by route and segment pair from Table 10 to get the final ridership by route and segment pair.



Table 5: Raw Survey Data

Survey ID	route	Boarding Stop ID	Alighting Stop ID	Time
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Table 6: Raw Survey Data with Segment_ID

Survey ID	Route	Boarding Stop ID	Alighting Stop ID	Time Period	On Segment ID	Off Segment ID
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After the conversion, aggregate survey records.

Table 7: Aggregate Survey Records

Route	On Segment ID	Off Segment ID	Number of Surveys	Time Period
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After calculate expansion factor, the results are as shown below:

Table 8: Calculate Expansion Factors

Route	On Segment ID	Off Segment ID	Expansion Factor	Time Period
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Table 9: Append Segment Expansion Factors to Back to Stops

Route	Boarding Stop ID	Alighting Stop ID	Expansion Factor	Time Period
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