Equitable Employment Access Assessed Through the Mobility Energy Productivity (MEP) Metric

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Overview

This analysis examines commuting options for an underserved neighborhood (Linden) in Columbus, Ohio to a major job hub (Rickenbacker). It uses the Mobility Energy Productivity (MEP) metric developed by the National Renewable Energy Laboratory (NREL) on behalf of the Department of Energy (DOE). The purpose of the analysis is:

1. To use MEP to quantify relative attractiveness, based on travel time, energy and cost, of four commute options linking Linden to Rickenbacker:
   - Previous transit express bus
   - Current transit bus offering
   - Drive alone
   - Proposed hybrid shuttle
2. To customize MEP in a specific origin-destination (O-D) scenario, whereas previously it has been used primarily as an aggregate metropolitan-wide statistical measure. :
   - Deprecation functions customized to case study
   - Results compared to drive-alone

The results provide quantitative scale for estimating employment accessibility across modes and considering equity implications of differing job accessibility across those modes.

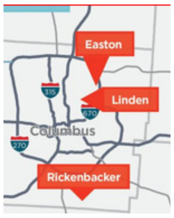
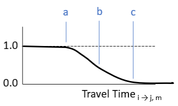


Figure 1. Relative locations of Linden neighborhood and Rickenbacker industrial park in Columbus, Ohio (source: SMART Columbus)

Mobility Energy Productivity (MEP) Mapping

The MEP metric uses three weighting factors, F[1..0], which are deprecation functions that provide multiplicative factors relative to travel time, user cost, and energy intensity of the trip between the origin *(i)* and destination *(j)* via mode m (below).

$$F[1..0]_{Travel\ Time_m} =$$



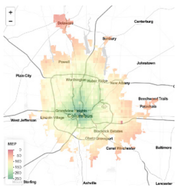


Figure 3. 'City-wide' MEP scores are calculated for each individual pixel (1 km²), mode of transport, and available destination. The cumulative MEP score from that pixel to all other locations for all trip purposes and modes are reflected. The color reflects an accessibility score from each location to a variety of goods, services, and employment throughout the region.

In the maps below (Fig. 4), MEP is calculated using a specific origin and destination pair: Linden and Rickenbacker, for drive-alone mode (top) and transit (bottom) using the equation below, where *O* are opportunities of type *p* reachable by mode *(m)* given an opportunity weighting factor (W_p).

$$MEP_{i\to j} = \sum_{mp} O_{pj} * W_p * F[1..0]_{Travel\ Time_m} * F[1..0]_{Cost_m} * F[1..0]_{Energy_m}$$

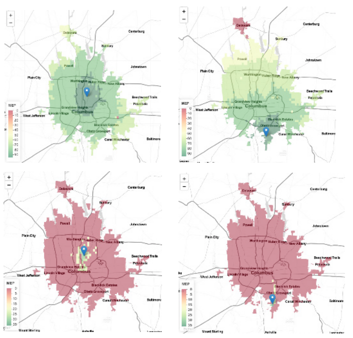
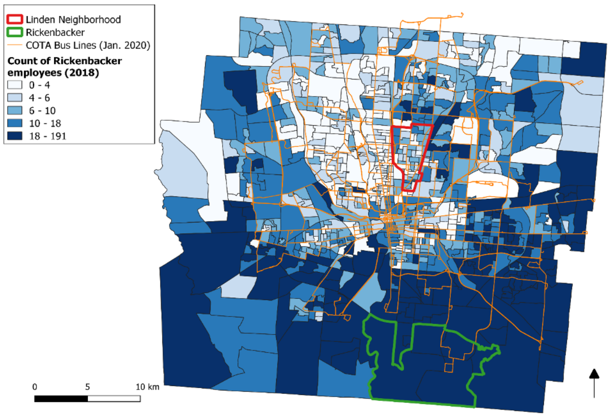


Figure 4. Point-specific MEP. Top row is MEP calculated from Linden (left) or Rickenbacker (right) if driving alone. Bottom row is MEP calculated from Linden (left) and Rickenbacker (right) if using current transit bus service.

Background

Linden Neighborhood

The Linden residential neighborhood of Columbus, Ohio has been a partial focus of the U.S. DOT Smart City Challenge grant investment since 2016.[1] For example, an autonomous shuttle (Linden LEAP) distributed food during the pandemic. Linden was also the focus of efforts to address high infant mortality rates by providing enhanced mobility. However, early in the Smart Columbus initiative during a neighborhood meeting, a primary concern voiced by residents was access to good jobs. **Linden is one example of a residential neighborhood with a strong concern for better employment opportunities, and, by extension, the corresponding quality mobility options to access quality job opportunities.**



Rickenbacker

The Rickenbacker industrial area is more than 15 miles south of Linden on the southern edge of the Columbus metro. It is a center of sustained employment growth, as a number of logistic centers and distribution hubs have located on the land adjacent to Columbus' Rickenbacker International Airport, a major regional air freight hub. There are currently plans to continue expanding the industrial park. The map to the left of Franklin County, Ohio (Fig. 2) shows where employees who work in the Rickenbacker area live, most commonly in the southern part of the county but also around the periphery of urban Columbus (center of map) to the east, northeast, and a bit to the west. In Table 1, 'High Rickenbacker Worker Areas' are census blocks in the top quintile of where Rickenbacker employees live (darkest blue on the map, and n > 17). There are no 'High Rickenbacker Worker Areas' in the Linden neighborhood or in downtown Columbus.

Figure 2. Geographic distribution of Rickenbacker employees within Franklin County, OH (LEHD LODES data, 2018). Rickenbacker is outlined in green at the southern end of the county, and the Linden neighborhood is outlined in red, just northeast of downtown Columbus, OH.

Table 1. Comparison of American Community Survey data (2015-2019) across geographies: Linden Neighborhood, High Rickenbacker Worker Areas in Franklin County, and all of Franklin County.

Metric	Linden	High Rickenbacker Worker Areas	Franklin County
% of households in poverty	26.6%	12.5%	16.6%
% African-American	43%	29.3%	24.3%
% Latino	6.5%	5.1%	5.6%
SOV commuters	72.4%	84.1%	79.0%
Transit commuters	7.6%	1.8%	3.3%
Carpooling commuters	9.1%	8.7%	8.3%
Commute time > 60 minutes	3.7%	3.3%	3.3%
Commute time > 30 minutes	25.2%	29.9%	24.1%
Households with children	36.3%	34.4%	---
Adult males, less than high school diploma/GED	21.5%	11.6%	10.7%
Adult females, less than high school diploma/GED	18.9%	10.8%	10.3%

Findings

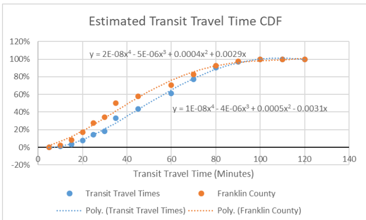


Figure 5. Cumulative distribution function of transit travel times for Franklin County, OH (ACS 2015-2019), where the 90th percentile is approximately 80 minutes and is used as the threshold for the travel time deprecation factor.

To customize MEP factors for transport scenarios between Linden and Rickenbacker, we:

- Utilized data on transit rider travel times (American Community Survey, 2015-2019)
- Created a cumulative distribution function of willingness to travel (Fig. 5), making it clear that travel times for transit (Table 2) are on the right tail of the CDF, pushing deprecation factor (Table 3) towards zero.

Final MEP scores (Table 3, last row), demonstrate that:

- Subsidized carpool/vanpool could easily compete with drive-alone for predictable work trips, even with a longer travel time (45 minutes vs. 20 minutes).
- Transit, especially the current route, is not desirable because of much longer travel time.

This case study thus assesses context-specific travel time, cost, and energy deprecation functions, showing how these methods can be data-driven and mode specific. **Our application of the MEP metric is a quantitative lens to compare commute alternatives and can be used by employers, local government, or transit agencies to evaluate competitiveness of proposed new modes, or even route changes, with driving alone.**

	Estimated travel time (minutes)
Express bus (historic)	79
Normal transit route (current)	90
Drive-alone	20
Carpool/ Vanpool (proposed)	45

Table 2 (left). Travel times used in case study MEP estimates to obtain context-specific travel time deprecation factors by mode, where the current transit route (90 minutes) exceeds the threshold derived from the CDF.

Table 3 (below). Deprecation factor values and final MEP scores by mode, reported as raw values and, in parentheses, as a percentage of the value for the drive-alone mode.

	Express bus (historical)	Normal route (current)	Drive-alone	Carpool/Vanpool (proposed)
Travel time deprecation factor	0.025 (6%)	0.000 (0%)	0.400 (100%)	0.264 (66%)
Energy factor	0.720 (92%)	0.720 (92%)	0.787 (100%)	0.890 (113%)
Cost factor	0.653 (102%)	0.653 (102%)	0.638 (100%)	1.000 (157%)
Final MEP score	0.017 (9%)	0.000 (0%)	0.200 (100%)	0.230 (115%)

[1]https://www.columbus.gov/smartcity/

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