Relationships between the Arc Transportation Score and Location-based Accessibility Metrics

An Arc White Paper

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An Arc Research White Paper

Relationships between the Arc Transportation Score and Location-based Accessibility Metrics

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Summary

The COVID-19 pandemic has had a dramatic impact on building occupancy and building-related transportation. This provides an opportunity to reflect on how Arc scores transportation and the potential for complementary or alternative scoring strategies. This paper evaluates whether one or a combination of address-based accessibility scores could be used to predict Arc Transportation Scores and, potentially, provide an alternative to the existing transportation survey. We also investigate relationships for data underlying the Transportation Scores, notably including the diversity of travel modes. We present a practical method for scoring mode diversity. We found a positive, but relatively modest, correlation between the Arc Transportation Score and Walk Score's Transit Score. No combination of accessibility scores significantly improved the correlation. Both metrics provide useful information, and these relationships reflect differences in the way these metrics define and measure transportation-related factors (e.g., multimodal accessibility vs. greenhouse as emissions per commute). Walk Score and other metrics had higher correlations with travel mode diversity represented by the Simpson Diversity metric. We conclude that Walk Score and similar metrics are not a direct substitute for the Arc Transportation Score. We also conclude that travel mode diversity represents a practical, scoreable alternative performance metric that can be derived from existing project data.

Introduction

The Arc platform provides performance-based scores for spaces and buildings, including energy, water, waste, human experience, and transportation. The current Arc Transportation Score meets the requirements of the LEED v4.1 O+M rating system. The Transportation Score is a 0-to-100 metric reflecting the carbon intensity of transportation based on a combination of travel mode and distance. This paper explores several closely related issues, including:

- The impact of occupancy changes on the Arc Transportation Score.
- The potential to use location-based accessibility metrics to predict the Arc Transportation Score.
- An exploration of specific project examples to understand score and metric behavior under different circumstances.

Our purpose is to better understand the real world behavior of the Arc Transportation Score and to investigate practical options for addressing the impacts of the COVID-19 pandemic.

COVID-19 & Transportation

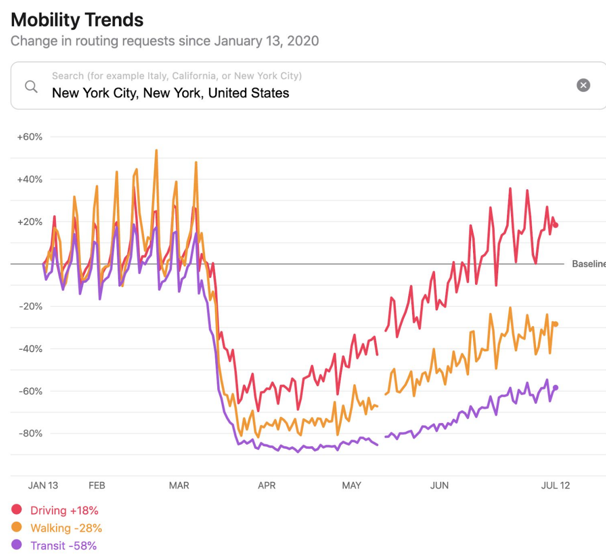
The COVID-19 pandemic has had a profound impact on how buildings are used and the building-related transportation. This includes wide-spread work-from-home and unprecedented shifts in travel modes. Many office and commercial buildings remain unoccupied, and it is difficult conduct or interpret traditional commuting surveys.

This new reality has implications for Arc's current approach for measuring and scoring transportation performance. The Arc uses occupant surveys to estimate the carbon intensity of home-to-work journeys based on distance and travel mode. These intensities are compared to the distribution of home-to-work intensities for commuters across the United States to provide a 0-to-100 Transportation Score. High scores reflect relatively low commuting emissions intensity (i.e., commutes to and from the facility have *much lower* emissions intensity than the US national average). Conversely, relatively high emissions commuting yields low scores, closer to 0 (i.e., commutes to and from the facility have *much higher* emissions intensity than the US national average).

Figure 1.Apple's Mobility Trends data for New York City show a 69% decrease in transit utilization, a 49% decrease in walking, and an 18% increase in driving.

Changes in occupancy and space utilization associated with COVID-19 create challenges for transportation data collection and interpretation:

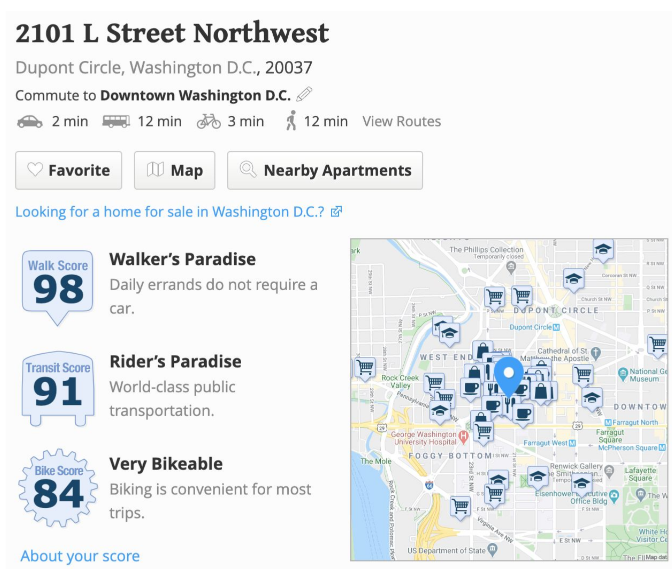
- Building occupants are not commuting in traditional ways.
- Traditional data collection campaigns, like lobby surveys, are not possible.
- The relevance of comparison with pre-pandemic commuting behavior is uncertain.



At a minimum, these circumstances indicate the need for short-term accommodations, but they also motivate use to evaluate alternative measures of transportation behavior (e.g., Duncan et al. 2011).

Figure 2. Example of WalkScore results for 2101 L St., NW, Washington, DC.

As part of our work to support COVID-19 Re-Entry, we wanted to take this opportunity to explore transportation scoring strategies that do not require survey-based responses and do not make assumptions about historic mobility patterns. Address-based accessibility scores meet these criteria. These scores estimate the availability of services within a specified distance around a given location.



Our question here is not whether the alternative scores are useful in an absolute sense. This is an issue for deliberation by LEED technical committees. Rather, we wanted to understand whether location-based metrics can be used to *predict* the existing Arc Transportation Score. If location-based metrics can produce an accurate prediction, they might provide an alternative to the current survey-based methodology. If location-based metrics cannot be used to predict the transportation score, it may still be possible to allow these metrics as substitutions, but it is important to recognize that they measure different aspects of transportation behavior. Both potential outcomes are useful in different ways.

Box 1. Summary of location-based metrics

Walk Score: a 0-to-100 metric representing the weighted diversity of services around a specified address. High scores reflect a large diversity of nearby services, such as shops, restaurants, schools, and parks.

Transit Score: a 0-to-100 metric of access to public transportation. Transit availability is weighted as a function of walk distance from a specified address. High scores reflect access to multiple transit options close to a specified address.

Bike Score: a 0-to-100 metric of access and utilization of bicycle infrastructure, including trails, lanes, and other systems. High scores reflect the proximity of relatively extensive facilities to support bike commuting.

AllTransit: a 0-to-10 metric of public transportation service within a U.S. Census Block Group. AllTransit is a bundle of approximately 200 metrics to help understand the social and environmental impacts of transit.

Methodology

We evaluated correlations between the Arc Transportation Score and four location-based metrics, including Walk Score, Transit Score, Bike Score, and AllTransit Score using the Walk Score API and AllTransit website.

The Walk Score platform provides three location-based metrics: Walk Score, Transit Score, and Bike Score. The original Walk Score metric provides an indicator of "walkability" for an address by measuring the density of common businesses and services within a 30-minute walking distance (the closer the better). Locations with a relatively high density and diversity of nearby services receive high Walk Scores.

Bike Score, available for U.S. and Canada locations, evaluates access to bicycle infrastructure, the number of bike commuters, and terrain to assess suitability for bicycling. Flat areas with dense networks of cycling paths and bike lanes receive high Bike Scores.

The Public Transit Score, available for approximately 1,300 cities in the U.S. and Canada, creates a composite score of transit modes and service frequency as a weighted function of distance from the selected location. Areas with a diversity of frequent transportation options receive high Transit Scores.

AllTransit is a product of the Center for Neighborhood Technology. It applies a different algorithm to provide a 1 to 10 score ranking transit performance in terms of usage and connectivity to jobs and services for cities across the United States.

The rationale behind selecting these location-based metrics in particular comes from the widespread availability of Walk Score and AllTransit scores. These location-based metrics do not require occupant surveys, and they do not use historic commuting behavior to generate scores.

We calculated Walk Score, Bike Score, and Public Transit Score values for 800 locations with valid Arc Transportation Scores. Data for US and Canadian projects is presented separately from the entire dataset, which includes international projects. The data including international projects showed almost no correlation to the Arc Transportation data (r^2 0.07). WalkScore indicates that metrics for many of these international locations may not be reliable.

The U.S. and Canada projects also included additional location-based metrics, specifically Bike Score (450 projects) and Transit Score (400 projects). These are not generally available outside of the U.S. and Canada.

We manually collected data for a further subset of 50 randomly selected projects in the U.S. This provides information about Public Transit and the 0 to 10 AllTransit Score[1].

After all the data from the Walk Score API and AllTransit website was gathered, correlations and regressions were produced between the Arc Transportation Scores from pre-COVID data and each of the location-based scores.

Results

Overall, Walk Scores, Public Transit Scores, and Bike Scores showed relatively low correlations with pre-pandemic Arc Transportation Scores. No r^2 value exceeded 0.4 (Table 1). The Transit Score had the highest correlation at 0.34, statistically significant at the $p < 0.01$ level. WalkScore and AllTransit Scores had comparable correlations with r^2 values of 0.23 and 0.21 respectively. Bike Score alone had the lowest correlation.

Table 1. Relationships between Transportation Metrics

Alternative Transportation Metric	Correlation to Arc Transportation Score
Transit Score (US & Can)	0.34*
Bike Score (US & Can)	0.18
Walk Score (US & Can)	0.23
AllTransit Score (US - not graphed)	0.21

* Significant at the p<0.01 level

[1] We did not have access to an API connection to automate the generation of AllTransit scores.

Figure 3(a). Correlation between Arc Transportation Score and Walk Score, n ~ 450, across the U.S. and Canada.

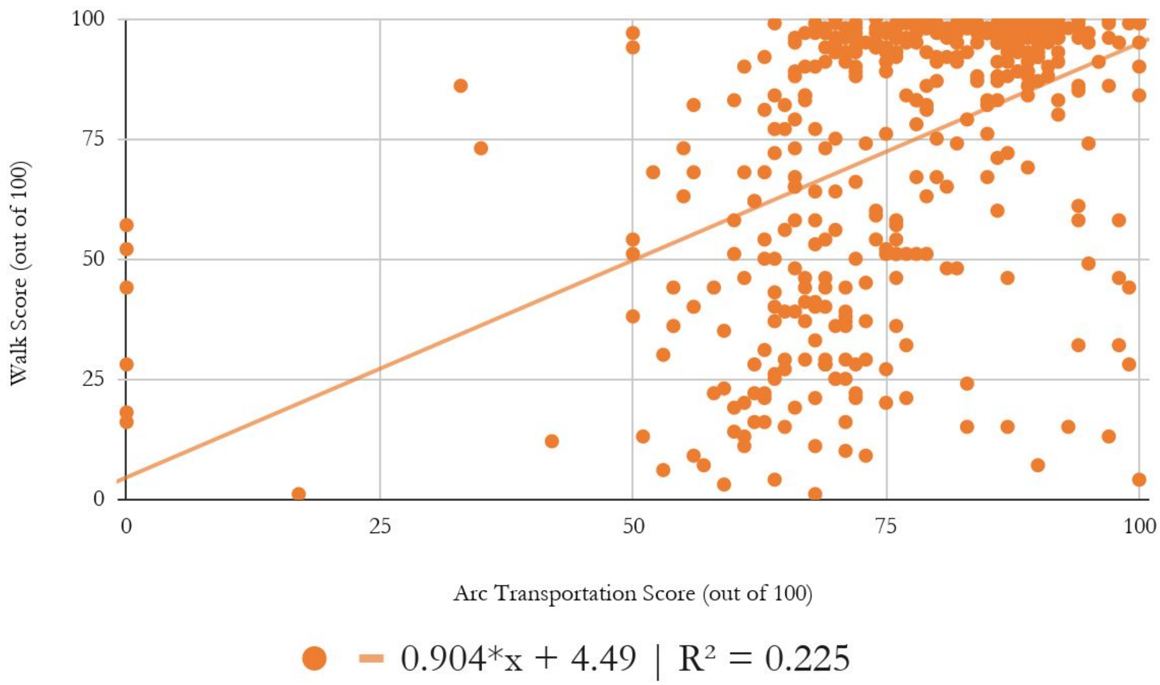
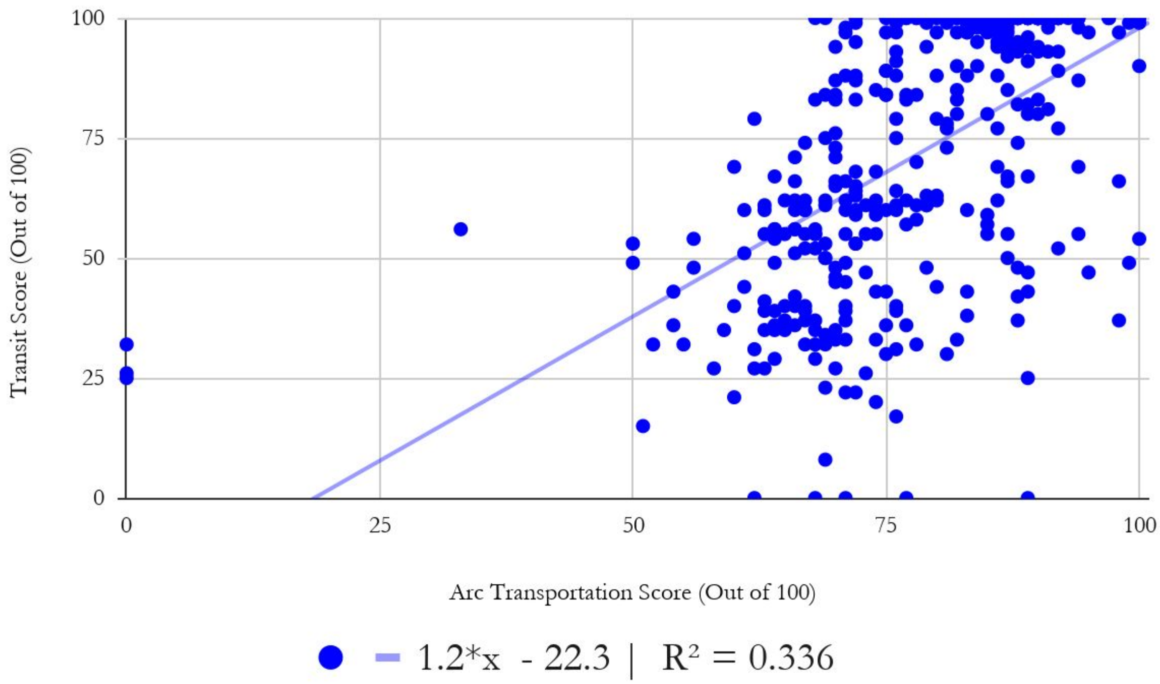


Figure 3(b) Correlation between Arc Transportation Score and Transit Score, n ~ 400, across the U.S. and Canada.



Discussion

This analysis underscores that location-based accessibility metrics and survey-based Arc Transportation scores are not substitutes. They represent distinct, sometimes complementary, ways to understand transportation. Critically, the Arc Transportation emphasizes the combination of travel mode and distance traveled for the purpose of estimating transportation-related emissions. Location-based metrics emphasize distinct combinations of features, such as transit or bicycle infrastructure.

Location-based scores have some predictive power when compared to self-reported travel behavior. This makes sense since access to transit, bicycling, and walking infrastructure play an important role in the emissions intensity of commuting. These low-carbon transportation options reduce emissions, and, in turn, they are reflected in higher Arc Transportation Scores. However, location-based scores cannot predict how far occupants travel, and this contributes to partial correlations.

Aggregated statistics only explain a fraction of the variation in the data. We explored patterns in detail by selecting eleven projects representing different levels of correlations between Walk, Bike, Transit, and Arc Transportation Scores.[2] The goal was to examine the edges of the distribution to better understand the behavior of these metrics (see Tables A1 through A4).

Overall, these examples reinforced expected relationships. In all but one instance[3], single-occupant vehicle usage was often lower in locations where bike, transit, or walkable infrastructure existed. This finding has sparked new discovery as to how diversity of transit use for a particular project can correlate to Walk Score data.

In some instances, it was difficult to reconcile an Arc Transportation Score with Walk Score data. For example, a well-known city location with extensive public transit infrastructure could often have the same Arc score as a location in a heavily car-dependent area[4].

[2] See Tables A2-5 for selected project details.
[3] See 1801 J St., Sacramento, CA, in Table A3.
[4] See Table A5.

These results could potentially reflect a situation where employees drive alone from outlying areas, despite the availability of transit. We documented similar circumstances in an earlier study of mobility associated with LEED O+M-certified office buildings using aggregated anonymous cellular data (Pyke et al. 2014).

Other instances may reflect limitations of survey data (e.g., sample size, recall bias) or the impact of the timing of surveys. All of these can distort self-reported mobility data and contribute to mismatches (as reviewed by Kelly et al. 2013).

Conclusions & Recommendations

The findings presented here support the following conclusions:

1. COVID-19-driven changes in occupancy create challenges for survey-based data collection and scoring.

2. Walk Score, Transit Score, Bike Score, and AllTransit metrics are not direct substitutes for the Arc Transportation Score or its underlying performance metrics.

3. Location-based metrics could potentially be used as alternatives to the Arc Transportation Score; however, they would represent different information about infrastructure and behavior. Scores based on these metrics would not be directly comparable to those using occupant surveys.

The conclusions suggest the need for new, more flexible approaches to measuring and scoring transportation. We recommend three short-term actions to address this situation:

1. Clarify LEED guidance related to transportation surveys to set participation requirements based on current/post-pandemic occupancy -- i.e., the number actually working in the space, instead of the nominal population.

2. Consider creating a LEED “alternative performance path” based on Transit Score. This metric should not be compared directly to the existing

Transportation Score, but it does provide an immediately available alternative to represent transportation options for a given facility.

3. Consider derivatives of the current Arc Transportation Score which are less sensitive to occupancy and self-reported travel information. Options include a focus on mode choice and diversity and tracking apps.

The intent of these recommendations is to provide immediately actionable steps to make it easier and more robust for project teams to use Arc to achieve LEED certification during the pandemic. On the longer term, these issues also highlight the need for a more fundamental conversation about LEED's market transformation strategy with respect to transportation. This issue is beyond the scope of this paper, but it should guide medium- to long-term strategies for measuring and scoring Transportation.

Acknowledgements

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About Arc

ArcSkoru (Arc) is a subsidiary of the Green Business Certification, Inc and part of the U.S. Green Building Council (USGBC) family of organizations. Arc supports USGBC's mission to provide spaces, buildings, and places that benefit people and the environment. Learn more about Arc and USGBC.

Appendix

Walk Score, Public Transit Score, Bike Score Cross-Correlations

We used multiple linear regression to explore combinations of Walk Scores, Public Transit Scores, and Bike Scores. These did not significantly improve model predictions when compared to Public Transit Score alone. We also compared Walk Scores, Public Transit Scores, and Bike Scores to one another in order to understand the correlation between location-based scores. As demonstrated in Figure 2, all combinations produce an r^2 value above 0.6, which indicates a stronger correlation.

Figure A1. Correlation between scores obtained from the Walk Score API.

Walk Score

The following figures explore additional correlations between Walk Score and Arc Transportation Score.

Figure A2. Correlation between Arc Transportation Score and Walk Scores, n~800, for all data points, US & international.

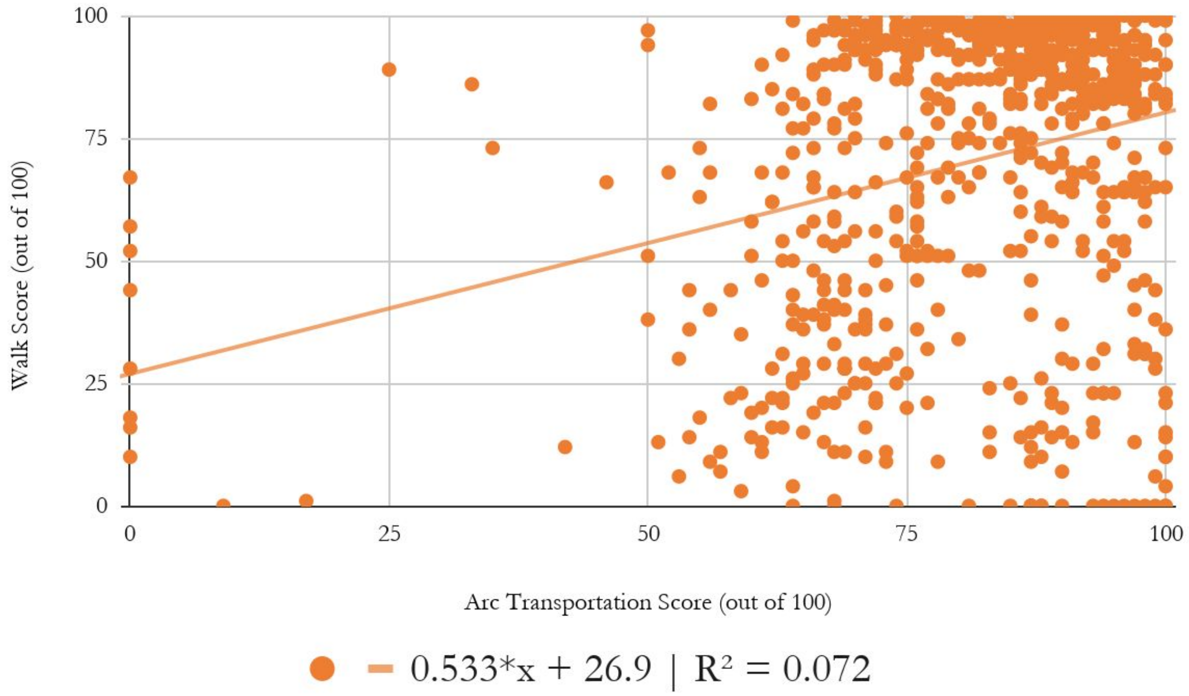


Figure A3. Correlation between Arc Transportation Score and Walk Score, n ~ 450, across the U.S. and Canada (same as Figure 3(a)).

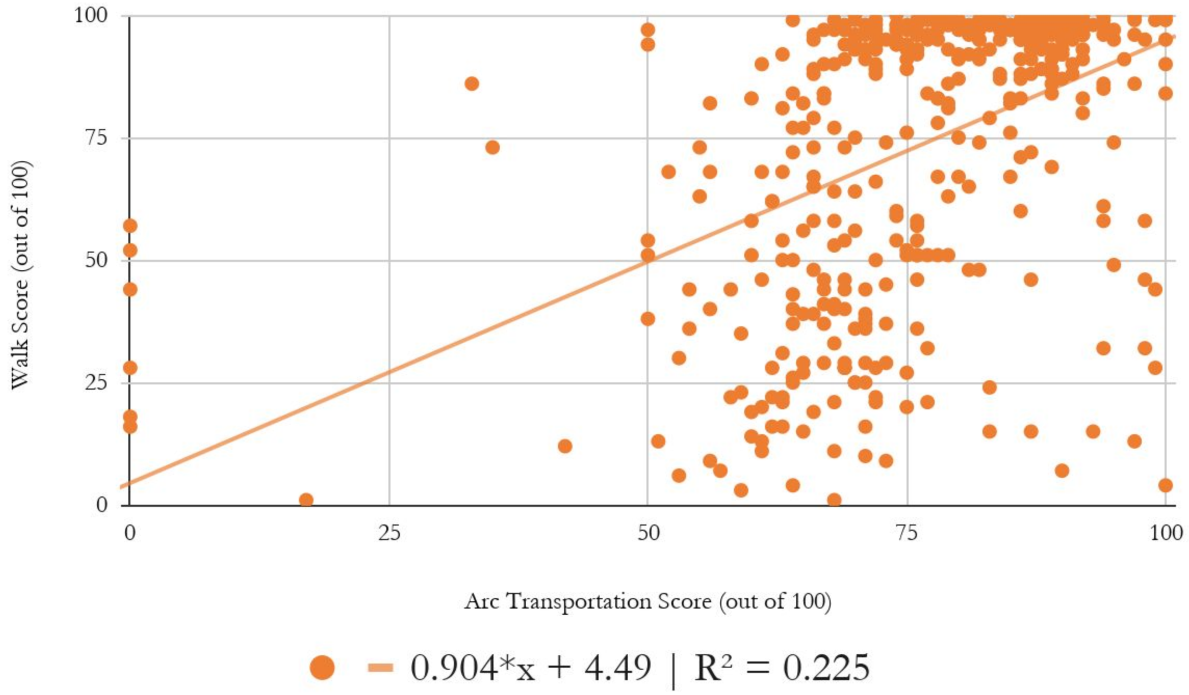
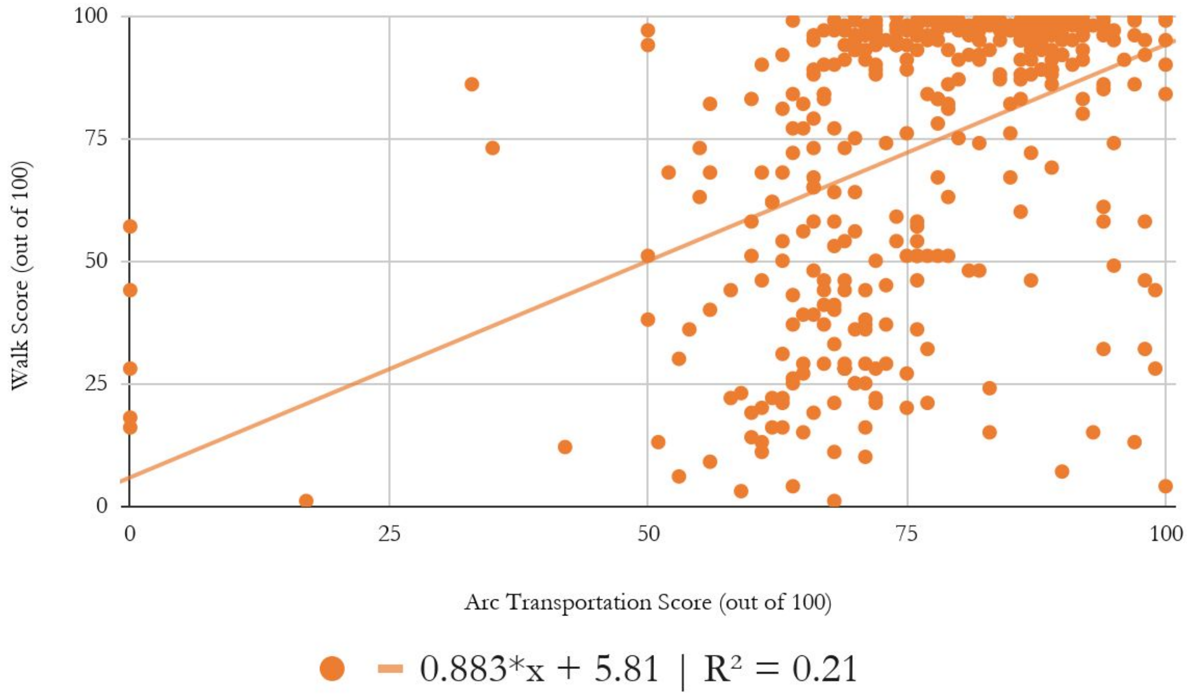
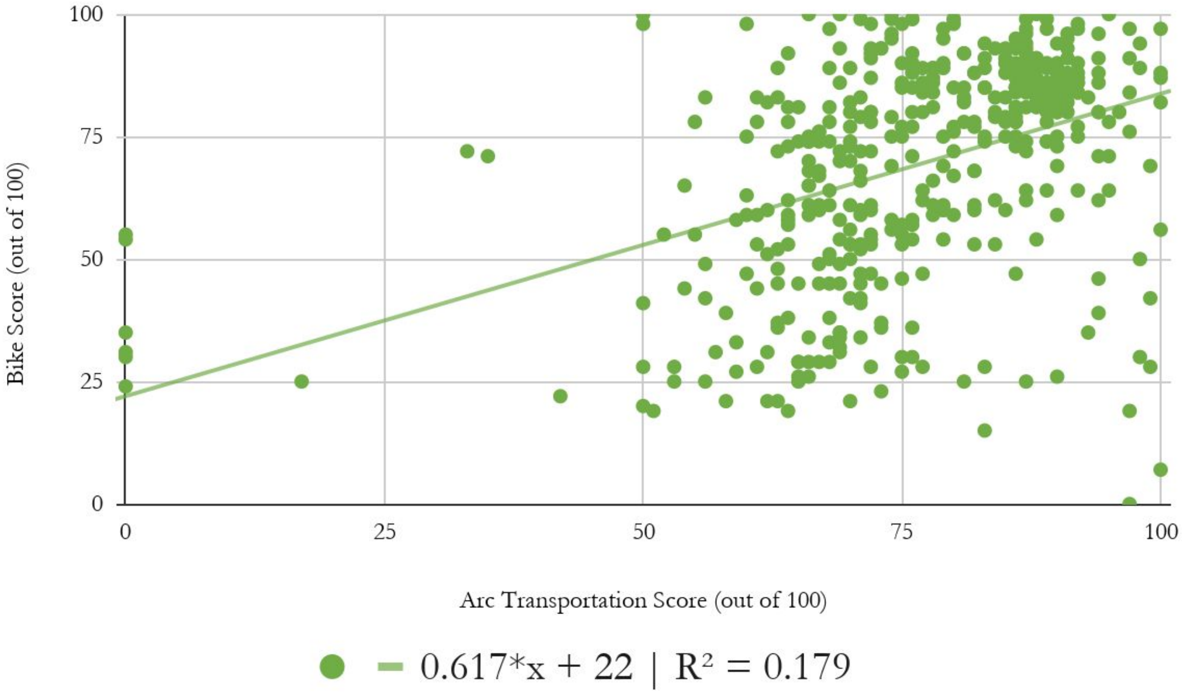


Figure A4: Correlation between Arc Transportation Score and Walk Scores, n~400, for the US projects only.



Bike Score

Figure A5. Correlation between Arc Transportation Score and Bike Score, n ~ 450, across the U.S. and Canada.



Public Transit Score

Figure A6. Correlation between Arc Transportation Score and Public Transit Score, n ~ 400, across the U.S. and Canada.

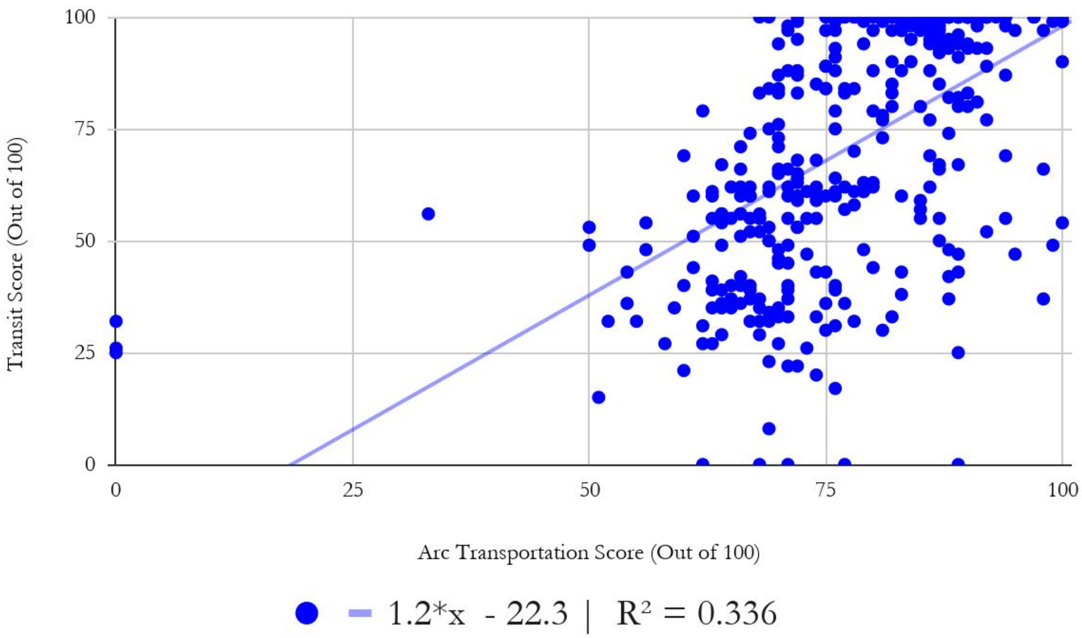


Figure A7. Correlation between the Arc Transportation Score and AllTransit Score

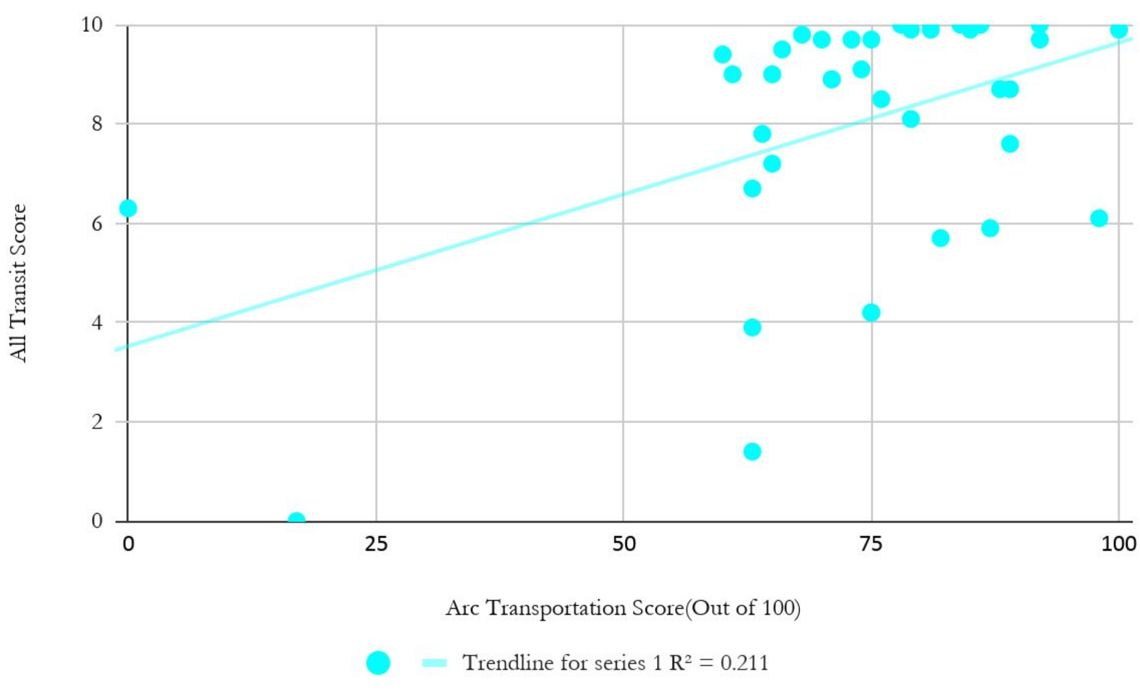
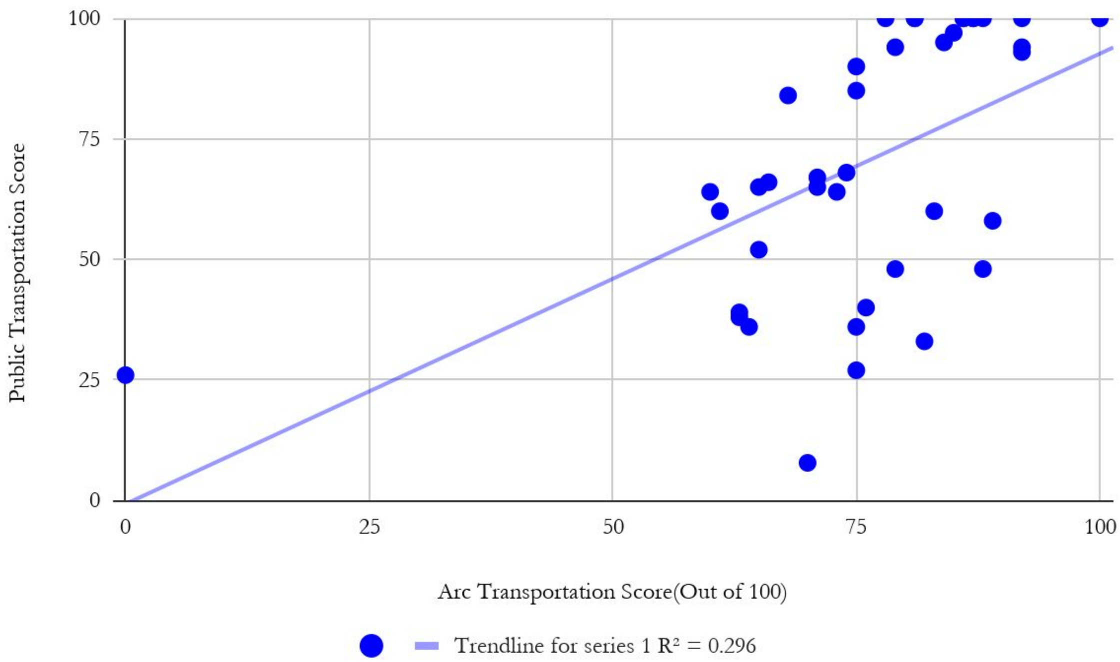


Figure A8. Correlation between the Arc Transportation Score and Public Transportation Score .



Scoring Examples

The following tables highlight select projects that compare Walk Scores, Bike Scores, and Public Transit Scores to Arc Transportation Score. For each Walk Score datapoint, we also included a descriptor contextualizing what a given score means about the community's walkability, bikeability, or transit connectivity. These examples were chosen in order to identify diverging or aligning patterns within the Transportation Score parameters, which may provide insight into the behavior of the aforementioned correlation. Furthermore, including more quantifiable data on location, project, and commuting patterns helps to recognize other relationships between location-based scoring and Arc's methodology.

Table A1. Walk Score Examples

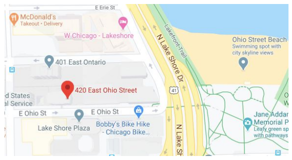
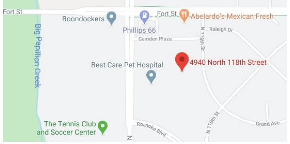
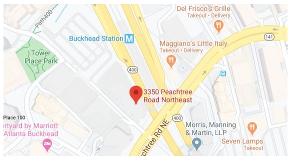
	420 E Ohio Street, Chicago, IL (1000101239)	4940 North 118 Street, Omaha, NE (10122072)	3350 Peachtree Road, NE Atlanta, GA (1000128504)
Walk Score	91 - Walker's Paradise	32 - Car-Dependent	82 - Very Walkable
Arc Transportation Score	92	77	56
Map			
Project type	Multi-Family Residential Apartment	Office Building	Office Building
Average 1-way commute distance	0.5 miles	8.6 miles	5.8 miles
Fraction of SOV commuters	49%	82%	78%
Fraction of bike commuters	1.26%	0%	0.33%
	E Ohio Street has both a high Walk Score and high Arc Transportation Score, making the results similar in this case.	North 118 Street has a low Walk Score but high Arc Transportation Score.	3350 Peachtree Road has a high Walk Score but low Arc Transportation Score.

Table A2. Transit Score Examples

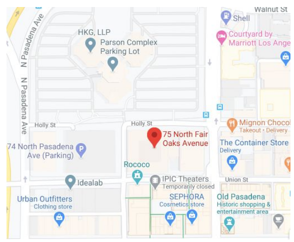
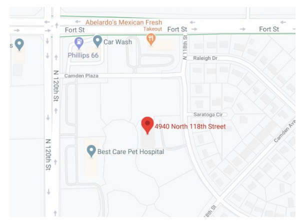
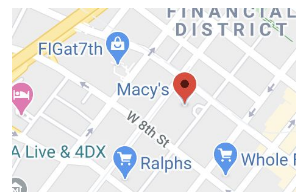
	75 North Fair Oaks, Pasadena, CA (1000042374)	4940 North 118 Street, Omaha, NE (10122072)	750 West 7th Street, Los Angeles, CA (1000035005)
Transit Score	66 - Good Transit	0 - Minimal Transit	100 - Rider’s Paradise
Arc Transportation Score	66	77	75
Map			
Project type	Parking Garage	Office Building	Shopping Center
Average 1-way commute distance	4.8 miles	8.6 mi	0.9 miles
Fraction of SOV commuters	61%	82%	50%
Fraction of bikers	0.49%	0%	0.32%
	75 North Fair Oak have the same, moderate Transit Score and Arc Transportation Score.	Despite the lowest possible Transit Score, 4940 North 118 Street has a very high Arc Transportation Score.	Though the Arc Transportation Score is moderate, 750 West 7th Street has a perfect Transit Score.

Table A3. Bike Score Examples

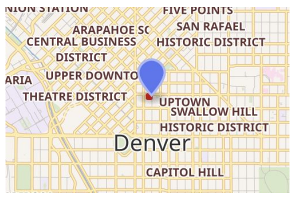
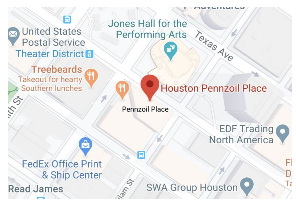
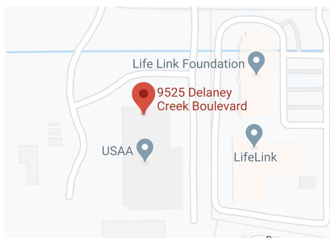
	1775 Sherman Street and 1776 Lincoln Street, Denver, CO (1000042711)	711 Louisiana St., Houston, TX (1000002940)	1801 J St., Sacramento, CA (1000109159)
Bike Score	25 - Somewhat Bikeable	72 - Very Bikeable	98 - Biker's Paradise
Arc Transportation Score	81	72	50
Map			
Project type	Office Building	Office Building	Office Building
Average 1-way commute distance	0.8 miles	0.8 miles	1.8 miles
Fraction of SOV commuters	45%	49%	92%
Fraction of bikers	.88%	1.3%	0%
	1775 Sherman Street has a low Bike Score and high Arc Transportation score.	711 Louisiana St. has the exact same Bike Score and Arc Transportation Score.	18801 J St. has a high Bike Score, low Arc Transportation Score, and a 0% fraction of bikers.

Table A4. Overall Examples

	9525 Delaney Creek Blvd, Tampa, FL (1000039103)	900 7th Street, NW, Washington, DC (1000023845)
TransitScore	0 - Little Transit	100 - Walker's Paradise
WalkScore	11 - Car-Dependent	97 - Rider's Paradise
BikeScore	38 - Somewhat Bikeable	97 - Biker's Paradise
Arc Transportation Score	68	68
Map		
Project type	Office Building	Office Building
Average 1-way commute distance	3.33 miles	3.75 miles
Fraction of SOV commuters	95.23%	33.75%
Fraction of bikers	0.3%	0.62%
	Despite the low values for Walk, Bike, and Transit Score, 9525 Delaney Creek Blvd shows a high performing Arc Transportation Score.	900 7th Street has really high scores for Walk, Bike, and Transit Score, despite a moderate and relatively low Arc Transportation Score.