

COMMUNITY TRENDS

FALL 2017



WHO RIDES THE BUS: EXAMINING TRANSIT RIDERSHIP IN MARION COUNTY

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and Deb Hollon, MS*



This report was produced by The Polis Center at IUPUI for the SAVI Community Information System.
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WHO RIDES THE BUS: Examining Transit Ridership in Marion County

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*Suggested Citation: Davila, K; Nowlin, M; Andres, UM; and Hollon, D
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WHO RIDES THE BUS: EXAMINING TRANSIT RIDERSHIP IN MARION COUNTY

Transportation is not limited to one's ability to move from place to place; it is often essential for an individual or family's economic and social mobility. Transit advances opportunity for economic mobility by providing affordable transportation to better jobs, more jobs, and reliable transportation to the jobs riders already have. It also promotes social mobility by providing transportation options for people without vehicles, youth under the driving age, seniors, and those who cannot or choose not to drive themselves. Moreover, public transit also reduces traffic congestion and the negative environmental impacts of single-occupancy automobile use, promotes smarter regional growth, and creates an affordable choice for making daily trips.

This analysis clusters transit ridership into five groups (A-E) based on data from a recent ridership survey, which is described below. Data from surveys are combined with neighborhood statistics, allowing us to consider the role of transit and the service it provides to our community's diverse ridership. Approximately every five years, transit agencies conduct onboard surveys which typically include questions about riders' transit behavior and other information about themselves [1]. The responses are used to plan improvements to service and operations. The Indianapolis Metropolitan Planning Organization, in partnership with the Indianapolis Public Transit Corporation (IndyGo), most recently completed one of these surveys in October 2016.

Transit in Marion County

... Promotes Economic Mobility

More than 70% of Group A riders, and about half of Group B riders use transit to get to work. Together, these two groups account for

more than 75% of total ridership. Work trips comprise a large proportion of all trips (transit and otherwise), and commuting riders rely on dependable service to get to work.

Group D riders live in neighborhoods with relatively few jobs per acre compared to other groups, so transit may be necessary to connect them to more jobs. Conversely, Group C riders live in areas with many jobs per acre, but are largely unemployed, indicating there may be a mismatch of jobs available near them and their vocational skills. Transit may serve to connect these riders to better or more appropriate jobs.

If 2021 buildout occurs as planned, the increase in early morning and late night service could have a positive impact on second and third shift workers by providing a more flexible transit option. Expanded transit service hours may also open up potential work schedules for some commuting riders.

... Supports Social Mobility

Riders who cannot or choose not to drive, especially youth and seniors, use transit to make social connections and complete personal errands in the absence of a personal vehicle. For these riders, such as those in Group C, transit provides a useful service to get them to school or work, and also contributes to their social mobility by expanding their ability to travel outside their neighborhoods to visit friends, attend events, or keep appointments.

Half of all trips made by Group E are for social purposes. Combined with this group's dissimilarity to their home neighborhood demographics, social mobility is especially important for these riders to connect with others.

... Provides Affordable Transportation Options to Riders Living in Areas with High Housing Costs

Across all groups, IndyGo riders tend to live where housing costs are high in proportion to their incomes. Affordable transportation options are necessary to keep these residents in their home neighborhoods which in turn contributes to community stability. Some riders, such as college students in Groups B and C, may forego moving to a less expensive neighborhood farther from their classes if it means sacrificing access to a variety of transportation options, including transit. Similarly, commuters – especially in Group A – who rely on the existing transit service in their neighborhoods may be unwilling to move to less expensive housing markets with lower transit service, because their transportation costs could go up.

How Rider Groups were Developed

The profiles on the following pages summarize the results of a cluster analysis that yielded five meaningful groups of riders. We also mapped riders to their home neighborhoods to further explore the relationship between rider behavior, transit use, and the built environment, therefore providing a general audience with an informed geographic approach to the transit survey dataset.

We generated the rider profiles using cluster analysis, a flexible approach to creating

meaningful groups using the natural structure of a dataset. In this type of analysis, there is no single “true” grouping [2]. Instead we identified groups of riders by clustering them based on selected attributes. As a result, a respondent in one group is more similar to their groupmates than to members of other groups. These naturally occurring segments provide a useful abstraction from individual records in the dataset, which allows us to analyze and summarize the data based on the qualities that group members share.

Our approach to clustering is user-centric; that is, we were more interested in grouping riders based on their personal characteristics than the nature of their transit trip. So our analysis included three attributes about riders themselves and one attribute relating to the availability of transit in their home neighborhoods. The metric we used for transit service is revenue miles per square mile: the number of miles an in-service bus drives through a neighborhood, per square mile of area in that neighborhood. IndyVitals [3] and neighborhood areas were used as the boundaries for this analysis.

The preliminary analysis yielded eight groups of riders. While verifying the rider clusters, we combined similar groups into five meaningful superclusters to better reflect the riders in our community. A discussion of the technical approach is provided in Appendix A.

Marion County Transit Plan

The IndyGo Forward plan [4], developed through public involvement, shifted transit resources from coverage to ridership. Focusing resources on ridership means running frequent transit in high-density areas with high ridership. Coverage instead spreads service across an entire community. With greater coverage, routes are less frequent, but access to transit is greater.

The Marion County Transit Plan achieves a more ridership-focused system by adding more high frequency lines (where vehicles arrive every 15 minutes) in high-ridership areas and creating three rapid transit lines (where vehicles arrive every ten minutes). This report serves as a benchmark for ridership characteristics before these changes are implemented, and as one possible framework to view how these service improvements will impact current ridership.

Global Group

All Marion County Riders

100% Of Total Ridership

About This Group

IndyGo riders live in 88 of the 99 Marion County neighborhood areas. These neighborhoods tend to have higher densities of population, jobs, and housing than the county overall. They also have more people of color, more non-car work commuters, and better access to parks and greenways. These neighborhoods also have higher rates of cost burdened households, lower housing costs, and higher poverty rates.

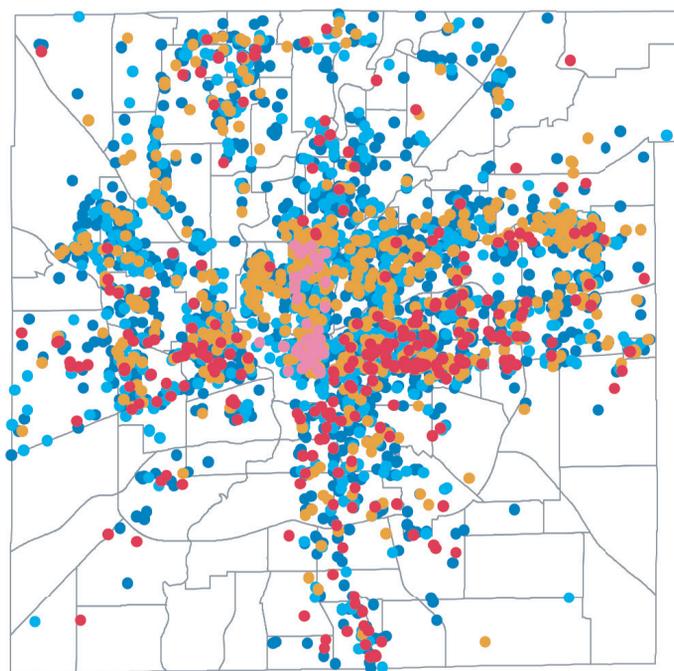
Three of every four riders take the bus at least weekly and live in areas with above average transit service. These riders' neighborhoods have 11 percent more transit service than the county as a whole. In 2021, the average Marion County neighborhood will see a six percent improvement in transit service relative to 2016.

Of every ten transit trips, five are work-related, three are for social purposes, one is for shopping, and one is for some other purpose. Most riders (57 percent) identify as Black. A third (32 percent) identify as White. Hispanic/Latino riders make up 4 percent of ridership, and the remainder identify as another or multiple races. Most riders are adults between 19 and 64 years old (89 percent). Three in four riders are employed. Two out of three riders have household incomes under \$35,000.

Where Transit Riders Live

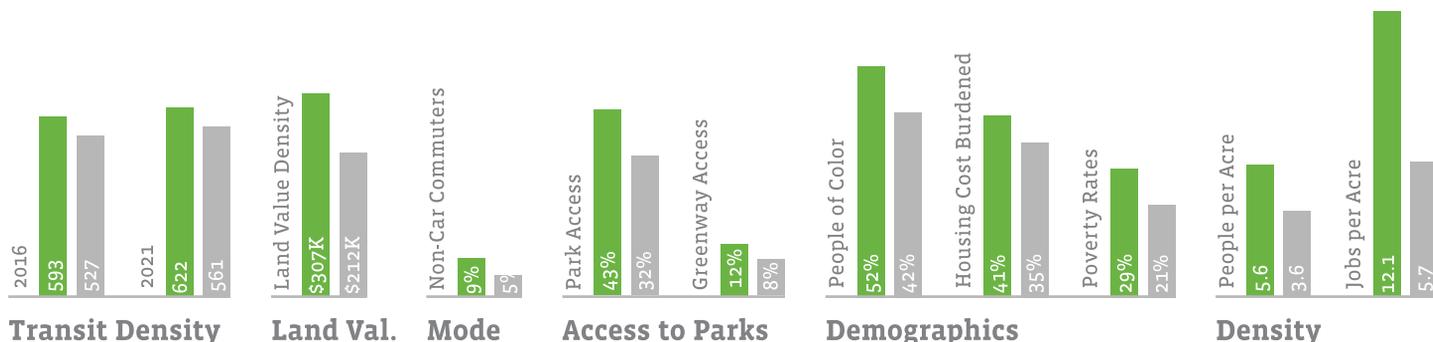
Rider Groups

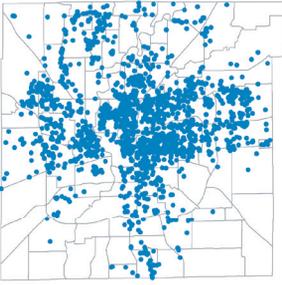
- Group A
- Group B
- Group C
- Group D
- Group E



Neighborhood Characteristics

- Riders' Neighborhoods
- County Overall





Group A

52% Of Total Ridership

Top Home Neighborhoods: Near Eastside, Far Eastside, Near Northside, Near Westside, Meadows

About This Group

This group includes riders with full time jobs living throughout Marion County. Because they use transit to get to work, they tend to ride more frequently than the other groups. For every ten Group A riders, five are millennials (age 19-34), three are age 35-49, and two are age 50-64. For every twenty riders in this group, twelve are Black/African American, six are White, one is Hispanic/Latino, and one is another race.

This group counts on good access and consistent service for economic and social activity. In response to the survey, about 20 percent of this group said they would not have made their trip without transit. Of those, a third were taking the bus to work. While this group currently has good transit access, the average Commuter neighborhood will see an 11 percent increase in service, driven by expanded service for early morning and late night workers.

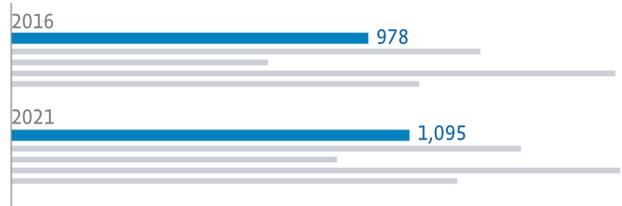
This group's neighborhoods have lower per capita incomes and higher rates of poverty than Marion County, indicating that while these commuters are working full time, they are working for lower wages than Marion County as a group. Affordable transportation options and access to a variety of jobs provide these riders with some economic mobility.

Typical Rider

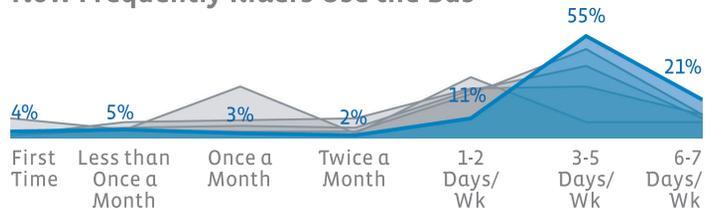
Working age person of color, fully employed and living in Center Township or on the east side of Indianapolis. Uses transit almost daily to get to work or for social purposes.

Transit Service and Usage

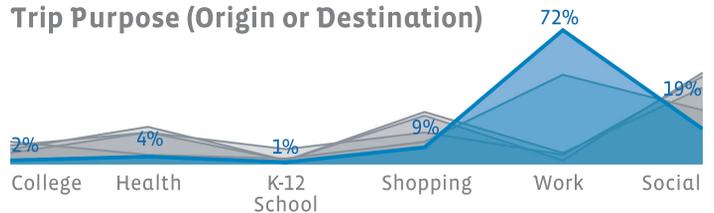
Miles of Bus Service per Week per Square Mile



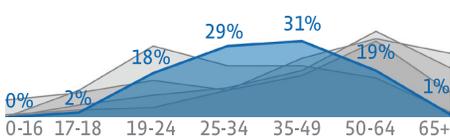
How Frequently Riders Use the Bus



Trip Purpose (Origin or Destination)



Ridership by Age

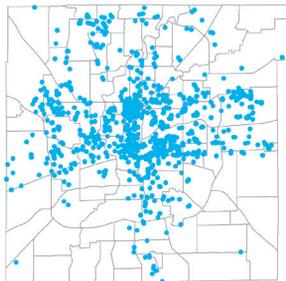


Ridership by Race



Ridership by Employment





Group B

25% Of Total Ridership

Top Home Neighborhoods: Downtown, Near Eastside, Far Eastside, Mapleton / Fall Creek

About This Group

This group enjoys above average transit service and utilizes it regularly for many purposes. For every ten riders, five are coming to or from work, three are using transit for social activities, one is commuting to college classes, and one is going shopping. This group is also multimodal. If transit were not available, they are equally comfortable walking, biking, or ride sharing to make their trip. Three out of five riders in this group are younger than 35.

These riders live in neighborhoods with many options for recreation, socializing, working, shopping, and interacting with each other, and choose their transportation on a trip-by-trip basis. However, their neighborhoods tend to have higher land value densities and higher rates of housing cost burden. Coupled with this group's part-time employment, a balance between affordable housing and transportation is important to these riders so they are able to stay in their home neighborhoods.

Typical Rider

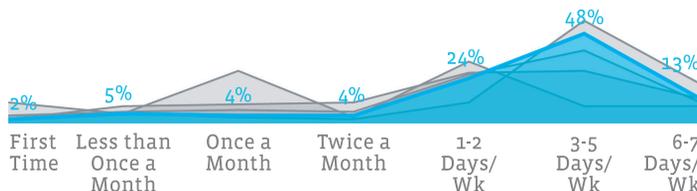
Young person of color working part-time, living in Near Eastside and along Meridian St. corridor. Uses transit several days a week for work, college, social purposes, and shopping.

Transit Service and Usage

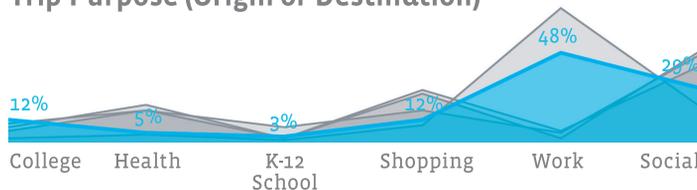
Miles of Bus Service per Week per Square Mile



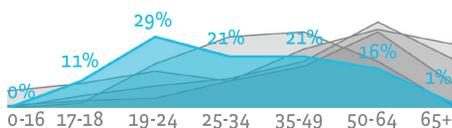
How Frequently Riders Use the Bus



Trip Purpose (Origin or Destination)



Ridership by Age

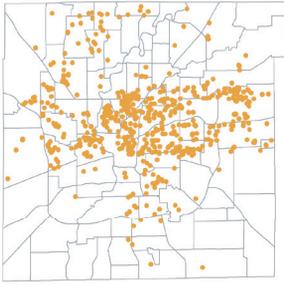


Ridership by Race



Ridership by Employment





Group C

15% Of Total Ridership

Top Home Neighborhoods: Downtown, Near Eastside, Far Eastside, Near Westside

About This Group

This group's riders are less employed than riders overall, and tend to use transit for a variety of purposes. A third of these riders are students (of any educational level). This group has the highest proportion of K-12 students of any group, as well as the highest proportion of riders under 18 years old. More than 40 percent of riders are age 50 or older. This group's riders are entirely riders of color who have moderate transit service compared to other groups. Service will improve by about 9 percent by 2021.

Group C riders live in neighborhoods where more than two in five households are cost burdened, and per capita income is around \$21,000. Employment density is around 12 jobs per acre, which is more than twice the average for the county. However, these riders are largely unemployed. While a high proportion of school-aged riders can account for the group's low unemployment, a large proportion of riders may benefit from improved access to other jobs or job training. Older, retired riders and the youth in this group would also benefit from improved access to social, shopping, and other destinations.

Typical Rider

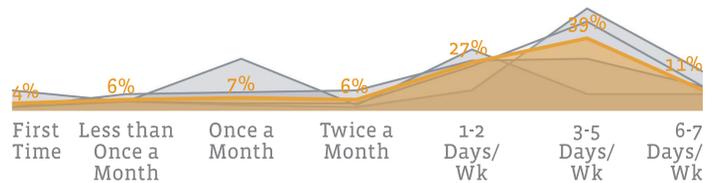
Older person of color, not employed, and using transit a few times a week for social, shopping, and health needs. Or, student of color using the bus for school and social purposes.

Transit Service and Usage

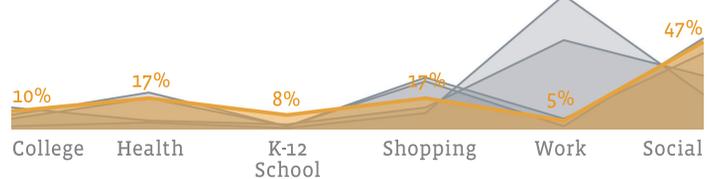
Miles of Bus Service per Week per Square Mile



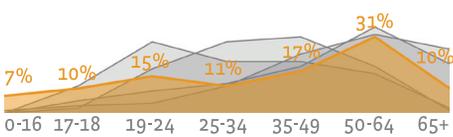
How Frequently Riders Use the Bus



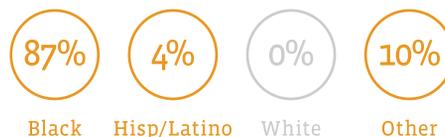
Trip Purpose (Origin or Destination)



Ridership by Age

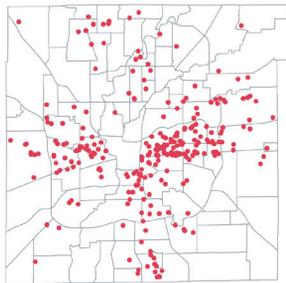


Ridership by Race



Ridership by Employment





Group D

7% Of Total Ridership

Top Home Neighborhoods: Near Eastside, Irvington, Christian Park, East Gate

About This Group

These riders are unemployed or retired, so they use transit for social, shopping, or health related trips, like doctor or clinic visits. With fewer commuting trips, these riders use transit less frequently. Still, seven out of ten riders in this group ride at least weekly. More than half of these riders are age 50 or older. Like most riders, a majority of Group D riders have household incomes lower than \$35,000, but one in ten have household incomes of \$60,000 or more.

This group lives in neighborhoods with somewhat low employment density (fewer than seven jobs per acre, compared to nearly 12 jobs per acre in other groups). Their neighborhoods also have, on average, lower high school graduation rates and proportionally fewer adults with a high school diploma. Improving access to jobs matching the skills of these unemployed riders, or to education or job certification, may improve the financial stability of these riders and their neighborhoods.

Transit service in their neighborhoods is infrequent. That service will improve by more than 20 percent by 2021. This increase is influenced by bus rapid transit, which will provide much higher frequency service than is currently available in these areas.

Typical Rider

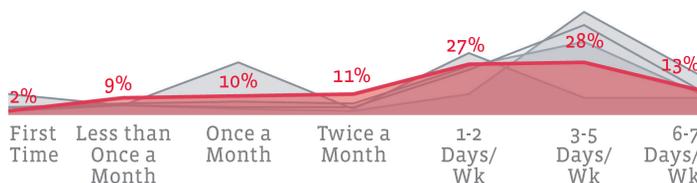
White, unemployed person living on the eastside. Middle-aged and using transit weekly for social, shopping, and health needs.

Transit Service and Usage

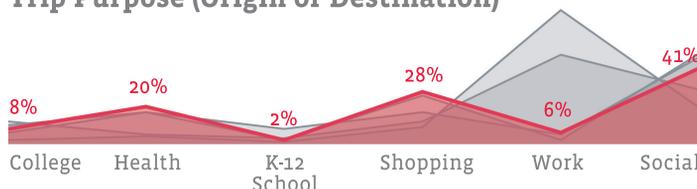
Miles of Bus Service per Week per Square Mile



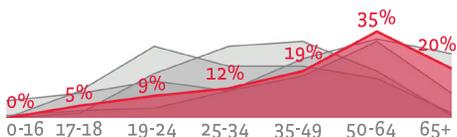
How Frequently Riders Use the Bus



Trip Purpose (Origin or Destination)



Ridership by Age

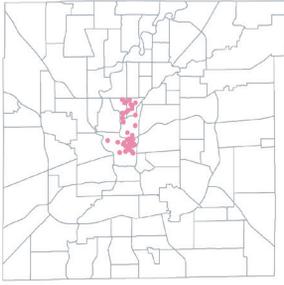


Ridership by Race



Ridership by Employment





Group E

1% Of Total Ridership

Top Home Neighborhoods: Downtown, Mapleton / Fall Creek, Near Northside, Crown Hill

About This Group

This small group (one percent of ridership) has good transit service, but uses transit infrequently—usually once a week or less. These riders are mostly unemployed or retired, so they use transit for social purposes, shopping, and health-related trips. Most Group E riders make less than \$35,000 per year, but the group also has the highest proportion of high-income riders. One in four of these riders are older than 65. Notably, survey respondents over 65 were least likely to make a trip if transit were unavailable [5].

These riders tend not to match their neighborhood demographics. While Meridian Street riders are older, they live in neighborhoods with a relatively low median age of 32 years. The riders tend to be low income, but live in neighborhoods with higher per capita income than the county. This group makes up a small proportion of the overall ridership in the county, and the demographics of its riders vary from the average of their home neighborhood. Therefore, social isolation may be a concern, and reliable access to social or religious events and personal errands are important for these riders to age in place.

Typical Rider

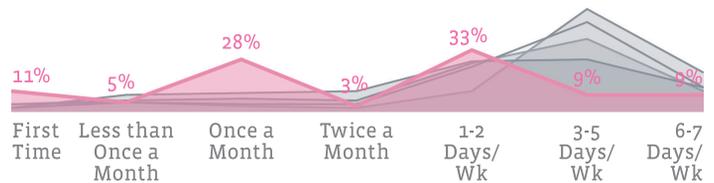
White, older person living along Meridian Street corridor. Unemployed and using transit a few times a month for social, shopping, and health needs.

Transit Service and Usage

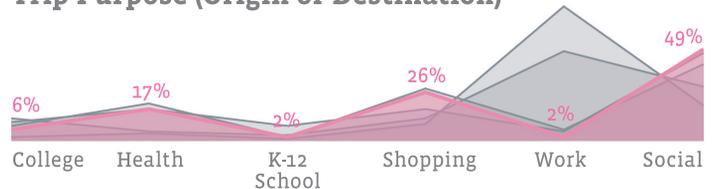
Miles of Bus Service per Week per Square Mile



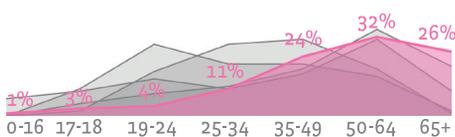
How Frequently Riders Use the Bus



Trip Purpose (Origin or Destination)



Ridership by Age



Ridership by Race



Ridership by Employment



⁵Footnote to go here.

Appendix A: Technical Supplement

Our primary research objective was to create “segments” of riders to guide our analysis of how transit is used and by whom. To do this, we turned to cluster analysis—a commonly used methodology for finding meaningful separation using the natural structure of a given dataset.

Using the survey data provided by IndyGo, we began with 4,189 records. Each record indicates one survey response. We geocoded the “home” address of each rider using ArcGIS to create geographical points on a map. Using those points, we were then able to link information about riders’ home neighborhoods to the survey results. Our “neighborhood” unit of analysis was the IndyVitals neighborhood area [6], so any rider with a home address outside of Marion County was dropped from the dataset. The resulting sample included 3,965 records.

Variables used in the clustering model are summarized below.

Input 1: PM Peak Transit density

When choosing transit over other modes of transportation, density matters. When more destinations (jobs, schools, shops, etc.) are near transit, more people likely to find that transit access useful [7]. Some analysts have found that transit density near work is a stronger predictor of transit use overall [8]. We opted to analyze the home neighborhood of transit users because we were interested in identifying trends in all transit-taking behavior, not just commuting behavior.

Our definition for transit density for a given neighborhood is the number of revenue miles (miles driven by in-service buses) per hour, per square mile. We calculated this in ArcGIS using transit frequency data provided by IndyGo.

Input 2: Survey respondent’s self-reported race is White, Non-Hispanic/Latino

Census trends [9] indicate that people of color commute [10] by using transit more than white people, who more often commute by driving alone. Also, recent national polling reveals that people of color are generally more likely to take transit for any trip purpose [11].

To implement this in the model, we created a Boolean field where 1 indicates the respondent described themselves as White and no other race/ethnicity on the survey. Otherwise, the attribute was listed as 0.

Input 3: Survey respondent’s self-reported employment status

Among most transit services, commuter trips usually take up a large proportion of total trips [12], which we therefore expect to see reflected in the survey data. We included employment status to determine if natural groups existed between commute and non-commute riders.

The survey data provided this information in coded format, where the code corresponded to a level of employment (e.g., employed full time, seasonally employed part time, retired, etc.). Based on this information, we developed an interval variable that reflected employment status, with the highest value given to full time employment and the lowest value given to retirees [13].

Input 4: Language spoken at home

Census trends [14] and public polling [15] suggest that the foreign-born population uses transit two to three times as often as the native-born population. Indianapolis is home to a diverse array of communities, so we used language spoken at home as a potential proxy for nativity.

We again created a boolean field for this variable, with 1 indicating a home language of English and a 0 indicating a home language other than English.

Cluster Methodology

With the above inputs for our 3,965 records, we performed k-means clustering in Stata15, using the Gower coefficient for similarity measure. K-means is a useful clustering algorithm to begin with because it is simple to run and can accommodate many iterations and experimentations with minimal impact on computing and processing speed. As with most clustering algorithms, many iterations are needed before meaningful clusters begin to appear. The Gower coefficient was necessary to accommodate boolean variables which would otherwise have been treated as continuous.

Once we settled on the input and the range of reasonable clusters (between three and ten groupings), we applied a stopping rule based on the Calinski-Harabasz pseudo-F statistic. This statistic provides a measure by which to judge the optimal number of groups. Based on the above, we identified eight preliminary groups of riders.

In the final phase of the analysis – validation – we analyzed the model’s outputs to determine if the results reflected what we expect to see in the real world. Based on that validation analysis, we refined the model’s eight groups into five. This was done to meaningfully categorize riders on other characteristics they shared. For example, the model separated riders with commute-to-work habits based on race. We recombined them into one commuter supercluster to better describe that group of riders based on their transit habits.

The raw data supplied by IndyGo also included a linked weight value, which we applied to our analysis to create generalizations about the overall ridership for the area. This value controls for oversampling certain routes, and is necessary to extrapolate meaningful results about ridership in its totality from the sampled responses to the survey.

About the Authors

The analysis and report were completed by Kelly Davila, Senior Research Analyst; Matt Nowlin, Research Analyst; Unai Miguel Andres, GIS Technician; and Deb Hollon, GIS Analyst.

The authors would like to extend their thanks to John Marron, AICP for methodological and report review.

Appendix B: Data Notes

Survey data was provided by IndyGo courtesy of the Indianapolis Metropolitan Planning Organization. Supplemental neighborhood demographic and socioeconomic information

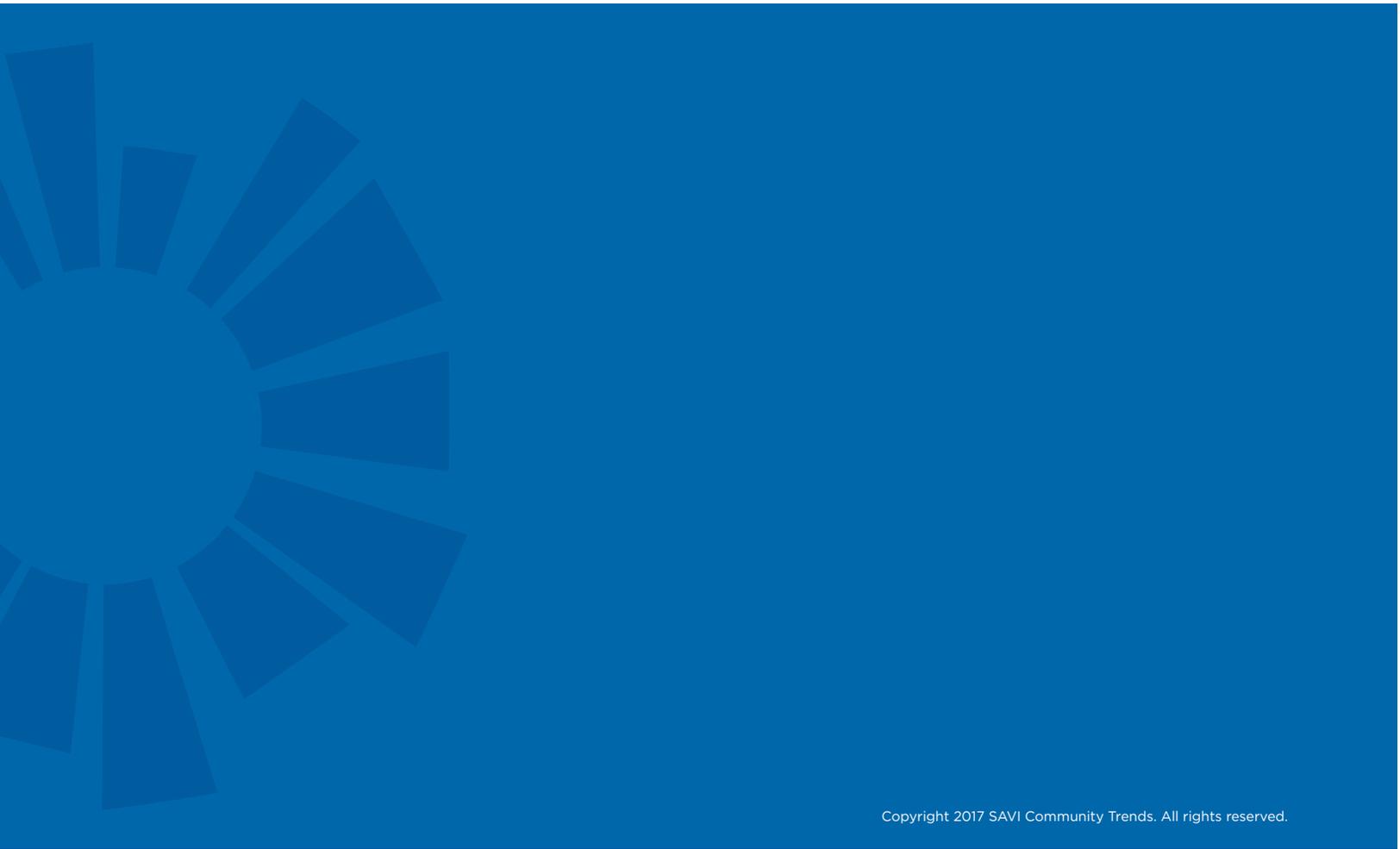
was compiled using data from the SAVI Community Information System.

For more information on these data sources, visit savi.org and indyvitals.org.

Indicator	Data Year	Source, via SAVI Community Information System
Population density	2015	American Community Survey 5-year Averages
Employment density	2015	American Community Survey 5-year Averages
Race	2015	Longitudinal Employer Dash Household Dynamics (LEHD), LEHD Origin-Destination Employment Statistics
Land value density	2013	Indiana Dept. Local Govt. Finance
Poverty rate	2015	American Community Survey 5-year Averages
Housing cost burdened	2015	American Community Survey 5-year Averages
Non-car work commute	2015	American Community Survey 5-year Averages
High school graduation rate	2015	Indiana Department of Education
Greenway access	2014	IndyGIS - Indianapolis / Marion County Geographic Information Services
Park access	2014	IndyGIS - Indianapolis / Marion County Geographic Information Services

Appendix C: End Notes

1. There is some interest in who uses public transit, but studies often tend to combine the results of many onboard surveys into a broader analysis of transit ridership in the United States (see Neff, John and Larry Pham, “A Profile of Public Transportation Passenger Demographics and Travel Characteristics Reported in On-Board Surveys”, American Public Transportation Association, 2007, http://www.apta.com/resources/statistics/Documents/transit_passenger_characteristics_text_5_29_2007.pdf and, more recently, Higashide, Steven, et al., “Who’s On Board 2016: What today’s riders teach us about transit that works”, TransitCenter, 2016, http://transitcenter.org/wp-content/uploads/2016/07/Whos-On-Board-2016-7_12_2016.pdf). However, we have taken here a local approach. Results in this report may differ from those published elsewhere.
2. Tan, Pang-Ning, Michael Steinbach, & Vipin Kumar, Introduction to Data Mining (Boston: Addison-Wesley, 2005), p. 491.
3. <http://indyvitals.org/>
4. Jarrett Walker and Associates, IndyGo Forward Volume II: Service Changes for 2016 (2015), p. 5.
5. Lochmueller Group and ETC Institute, IndyGo On-Board Transit Survey Final Report. (2017), p. 12.
6. <http://indyvitals.org/>
7. Higashide, Steven, et al., “Who’s On Board 2016: What today’s riders teach us about transit that works”, TransitCenter, 2016, http://transitcenter.org/wp-content/uploads/2016/07/Whos-On-Board-2016-7_12_2016.pdf, p. 5.
8. Hertz, Daniel, “When it comes to transit use, destination density matters more than where you live”, CityObservatory, <http://cityobservatory.org/when-it-comes-to-transit-use-destination-density-matters-more-than-where-you-live/>.
9. McKenzie, Brian & Melanie Rapino, “Commuting in the United States: 2009”, U.S. Census Bureau American Community Survey Reports, <https://www.census.gov/prod/2011pubs/acs-15.pdf>, p. 5.
10. Note that the Census considers only work-based trips in their commute mode share.
11. Anderson, Monica, “Who relies on public transit in the U.S.”, Pew Research Fact Tank, 2016, <http://www.pewresearch.org/fact-tank/2016/04/07/who-relies-on-public-transit-in-the-u-s/>.
12. Higashide, Steven, et al., 2016, p. 27.
13. We treated this as a continuous variable. Future studies may attempt to capture hours worked per week as a continuous variable for clustering.
14. McKenzie, Brian & Melanie Rapino, p. 3.
15. Anderson, Monica, 2016.



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