# Transit InSight — A Commuter Benefits Analytical Platform for Jawnt

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Sylvia Lam (laivlys@upenn.edu)
Jiayue Ma (majiayue@upenn.edu)
Byron Huang (bairun@upenn.edu)

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## Introduction

At present, commuter benefits — discounted commuter options offered through employment — are on the rise, with cities such as Seattle, Philadelphia, and New York City implementing mandates on local firms to provide such options as part of their employee compensation packages (Jawnt, 2024). For instance, beginning Dec 2022, Title 9 of The Philadelphia Code[1] requires large employers in Philadelphia to provide a mass transit program to eligible employees, an initiative of Mayor Jim Kenney that persists till today.

In its original form, a commuter benefits scheme reduces commuting costs for workers by allowing their pre-tax income to be allocated to public transit and carpooling costs. By contrast, an entire industry has developed around commuter benefits solutions that extend the standard form of commuter benefits into other complementary or alternative modes, with some employers providing packages that encompass bikeshare services, pooled shuttles to work, journey planning services, and on-site electric vehicle charging facilities.

Our practicum client — Jawnt Inc. — is a fast growing start-up that operates in this field. Founded in Philadelphia in 2021 by Jeff Stade and Will Sanderson, the start-up has undergone multiple rounds of seed funding from venture capital firms such as Motivate Capital Management, Alumni Ventures and Crossbeam Venture Partners LLC, with the firm valued at $6.74 million as of Apr 2023[2]. Of note, Jeff is a 2022 graduate of the Master of Urban Spatial Analytics (MUSA) program.

Jawnt's main product offering is their commuter benefits consultancy service, advising human resource administrators on how different packages of commuter benefits can be offered to their employees based on locational attributes. This service is augmented by Jawnt Maps, an analytical platform that tracks enrollment data for commuter benefits and suggests intervention areas based on transport accessibility data to boost enrollment rates, in alignment with the environmental goals of client firms. It is envisioned that our practicum project feeds into the

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[1] The full ordinance text is available at https://phlcouncil.com/wp-content/uploads/2022/04/CM-Gym-4.21-Commuter-Benefits-Ordinance.pdf
[2] For detailed financials, please refer to Jawnt's data portal at S&P Capital IQ: https://www-capitaliq-com.proxy.library.upenn.edu/ciqdotnet/company.aspx?leftlink=true&companyId=1856195205

continued development and expansion of the Jawnt Maps platform, which was just rolled out in Oct 2024. Supplementing these services is the Jawnt Pass transit benefits card, a pre-tax travel wallet that allocates funds to be spent flexibly on commuting services such as ad-hoc parking fees and single rides. The Pass distinguishes itself from traditional subscription products offered by transit agencies such as SEPTA for its flexibility of use and the convenience of being a debit card that can be loaded into iOS and Android devices for contactless payments.

Beyond its practical and commercial applications, commuter benefits have also been the subject of academic attention, particularly towards the impact of such programs on commuting behavior. For instance, Shin (2020) studied the rollout of commuter benefits programs in the state of Washington for the Puget Sound region, finding that making transit benefits available to workers significantly incentivizes them to drive less not just to work but also for non-commute trips, indicating an individualized spillover effect on sustainable travel of such schemes. Such spillover effects were also observed at the household level, with significant reductions in vehicle miles traveled for households where members have enrolled in such schemes.

Meanwhile, commuter benefits programs in New Jersey were studied by Bueno et al. (2017) in combination with household travel survey data. It was found that benefits for public transit are strongly associated with an increased likelihood to ride transit, walk or cycle to work — an indicator that such schemes are a viable option to make non-driving modes more attractive to commuters. On the flip side, when commuter benefits subsidize workplace parking or reimburses Turnpike charges, such schemes tend to lock commuters into driving to work, reinforcing the inefficiencies of car commutes.

## Data

Prior to a description of our analytics and visualization approaches, it is timely to introduce three key data sources used throughout the span of the project, namely 1) the LEHD Origin-Destination Employment Statistics (LODES) dataset from the U.S. Census Bureau, 2) proprietary Penn Medicine commuter benefits enrollment data, and 3) a collection of publicly-accessible transport-related data, such as the Transit Score® metric by Walk Score, SEPTA's General Transit Feed Specification (GTFS) data, and 2023 Land Use Data from OpenDataPhilly.

### LODES data

The LEHD Origin-Destination Employment Statistics (LODES) dataset, provided by the U.S. Census Bureau, displays information on both residence and workplace characteristics[3].

In this project, we use its Origin-Destination (OD) data section from 2022, which is enumerated by 2020 census blocks. This dataset is notable for its high quality and comprehensiveness, providing a solid foundation for conducting commuter-related analysis.

### Proprietary client data from Penn Medicine

In February, Jawnt obtained approval to share Penn Medicine's commuter benefits enrollment data with our team, opening up a wide range of possibilities for analysis. The dataset includes information on 122 University of Pennsylvania Health System (UPHS) locations spanning Pennsylvania and New Jersey, including 1) the share of all UPHS employees for each location, 2) percentage of employees enrolled in commuter benefits for each location, and 3) the address and geographical coordinates of each location. There is a wide range of UPHS locations, from the main hospital site at 3400 Spruce St to smaller outpatient facilities such as the Penn Urgent Care Center at 1930 S Broad St.

[3] An interactive version of the block group level aggregated data can be viewed at https://onthemap.ces.census.gov/

### Transit data

In combination with the Census data described above, this project also utilizes SEPTA and PATCO's General Transit Feed Specification (GTFS) feeds available at https://github.com/septadev/GTFS and https://opendataphilly.org/datasets/patco-gtfs/. Despite the implementation of SEPTA's harmonization program[4], services are divided into two separate GTFS feeds — one with lines G, D, T and buses, and the other for lines L, B, M and commuter rail services. Using the `gtfstools` R package, the separate SEPTA and PATCO GTFS feeds are merged into a single GTFS file for subsequent calculations of travel itineraries.

### Transit Score® data

Supplementing the official GTFS feeds is the Transit Score® metric calculated by Walk Score, a commercial data broker owned by the real estate company Redfin. Jawnt's very own Maps dashboard makes extensive use of Transit Score® when demonstrating relative accessibility to transit for its clients. The metric describes how well a particular location is served by public transit using a scale from 0 to 100, with 0 indicating minimal transit services available and 100 showing excellent transit accessibility. For each location, the Transit Score® metric takes into account the distance to the nearest stop along a transit route, the frequency of the route, and type of route served, with some of these inputs derived from official GTFS feeds themselves. To note, not all of Penn Medicine's locations are covered by the Transit Score® metric, such as clinic locations outside of Philadelphia County.

### Parking Data

The 2023 Land Use dataset was obtained from OpenDataPhilly and was filtered to include only public parking lots. This was done by filtering any subcategory name that included the word "parking" in the `lu23subn` (land use 2023 subcategory name) column before it was manually analyzed and cleaned to only include the public parking spaces which can be seen in our sample code below (Code Block 1).

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[4] See for instance, the rebranding of SEPTA Metro services at https://wwww.septa.org/metro/

```
parking_sf <- parking_sf[grepl("Parking", parking_sf$lu23subn), ]

desired_categories <- c(
  "Parking - Recreation: General",
  "Parking - Commercial: General",
  "Parking - Commercial: Mixed-Use",
  "Parking - Institutional: General",
  "Parking - Industrial: General",
  "Parking - Residential: Mixed-Use",
  "Parking - Industrial: Mixed-Use",
  "Parking - Commercial: Shopping Mall",
  "Parking - Undeveloped: Undetermined Use"
)

parking_employee <- parking_sf %>%
  filter(lu23subn %in% desired_categories)
```

*Code Block 1. Sample code to filter parking data from Land Use dataset.*

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## Methodology

### Comparing park and ride routes with pure driving routes

For the Park and Ride section, our intention is to identify commuting routes to Penn Medicine locations where a modal shift from a transit-only commute to one that involves driving for the first-mile leg (between the home location and the nearest transit hub), and transit for the remaining legs to the workplace, would offer substantial time savings. In other words, the utilization of Park and Ride facilities here makes transit much more competitive as a mode choice compared to driving all the way to work, and plays to the modal flexibility of hybrid commuter benefit products such as Jawnt Pass which can be used across transit and sanctioned parking facilities.

To identify existing commuting routes favorable to such a modal shift to one taking advantage of Park and Ride facilities, we first identify the individual census block IDs that have residents commuting to each hospital location, using the LODES dataset as the carpooling section above. Following which, we filter for the top twenty blocks by commuting volume, and use r5r once again to build travel itineraries from each residential block to the corresponding Penn Medicine location, this time specifying three mode options: car-only, transit-only, and a hybrid of car and transit, achieved through Code Block 2 below.

```
itineraries_pnr <- detailed_itineraries(
      r5r_core,
      origins = origins,
      destinations = destinations,
      mode = c("CAR", "TRANSIT"),
      mode_egress = "WALK",
      max_car_time = 20,
      departure_datetime = departure_datetime,
      max_trip_duration = 120
  )
```

*Code Block 2. Syntax for plotting a Park and Ride itinerary.*

This syntax is worthy of note for future studies by both Jawnt and MUSA candidates involving Park and Ride itineraries, which are built by specifying a last-mile (final transit stop to workplace) option of walking (through `mode_egress`) and an initial car journey time of 20 minutes (with `max_car_time = 20`). The assumption of the latter is that in the context of the surrounding counties of Greater Philadelphia (Bucks, Chester, Delaware, and Montgomery), a 20-minute drive to a Park and Ride facility is to be reasonably expected, beyond which a modal shift from a car-only to a hybrid commute is likely to be less palatable as driving straight to work will incur substantial time savings than with Park and Rides.

After performing the calculations, the itineraries are grouped by Penn Medicine locations and their home origin block groups, and are visualized in the web application, which can be previewed below.

**Modelling commuter benefits enrolment rate**

To encourage public transit usage among employees of Penn Medicine, we aimed to increase enrollment in commuter benefits by identifying clinic locations where public transit is a viable commuting option. Our prediction model included the following three factors: 1) the transit score of each clinic location, 2) the number of public parking lots near each clinic location, and 3) the average time saved by driving as compared to using public transit.

The transit score was calculated using the H3 hexagonal grid system at scale 9, equivalent to an average area of $0.1053325km^2$ for each hexagon, across the city of Philadelphia. The transit score of each clinic location was determined by the hexagonal shape in which it is located.

The parking lots data was pulled from the 2023 Land Use dataset available on OpenDataPhilly. After cleaning the dataset to include only public parking lots, we used the Mapbox API to count the number of parking lots within a 10-minute walkshed of each clinic. This distance was deemed as a reasonable threshold for employees willing to walk to work after parking.

Using the r5r routing data, we calculated both the driving and public transit times from each employee's residential census block to their respective clinic, based on origin-destination data from the LODES dataset. We then computed the average time saved by driving as compared to using public transit for each clinic location.

A simple exploratory random forest model was then developed to predict the commuter benefits enrollment rate for each clinic location. We proceeded to compare the differences between the predicted versus the actual commuter benefits enrollment rate to identify Penn Medicine clinics that were underperforming — where commuter benefits can be further promoted — and locations that were overperforming, which could provide insights into successful transit-oriented practices.

**Identification of carpooling opportunities**

As Jawnt has recently been considering expanding into carpooling services, we would also like to provide a preliminary identification for carpooling opportunities in this application. To achieve this, we use the LODES dataset to establish block-level commute relationships and identify geographical areas where commuters are clustered — in other words, the "hotspots" of commuter residences.

The basic assumptions for identifying potential carpooling opportunities are: A) a large number of commuters to a specific workplace reside in the same or neighboring census blocks; B) commuting by car from their home location to the workplace results in significant time savings compared to public transit; and C) the home locations are far enough from the workplace that commuting on foot or by bike is unlikely. If all conditions are met, we consider there to be potential for workers to actively coordinate and integrate their commute trips through carpooling.

In our case, to determine whether "residence clusters" (assumption A) exist for each hospital, we summarized the total commuter count for each Origin-Destination pair in the LODES dataset, where destinations are limited to the census block IDs corresponding to each hospital location. Census blocks are typically small enough to cover only one or a few major employers, but they may also introduce some inaccuracies, which will be discussed later. In this analysis, we only considered hospitals located within Philadelphia, but included all related home locations across Pennsylvania and New Jersey.

Additionally, we define "a large number of commuters" in assumption A as at least 10 people living in the same or neighboring census blocks. To conduct our analysis, we merged all neighboring home census blocks for each hospital location and aggregated the total number of commuters within each merged area. We then filtered for any merged geography with more than 10 total commuters.

To identify location-specific travel time savings by car (assumption B), we reused the travel network established by SEPTA's GTFS feed and r5r package to determine travel time differences between car and transit, and between each OD pair. A travel time difference of 30 minutes is considered significant enough to influence commute mode choice. In other words, we consider commuters from home locations with such differences unlikely to favor public transit due to its particularly low efficiency.

For assumption C, a one-mile distance is used to filter out home locations that are too close to the workplace to require commuting by car or public transit.

By this data processing procedure, we were able to filter the Original-Destination pairs (or Home Cluster - Hospital pairs) that A) has a large employees number; B) time-wise inefficient for commuter to consider public transit benefits; C) time-wise inefficient to commute on foot or by bike. Therefore, it would be ideal to promote carpooling services to employees residing in those home clusters.

Since we used census blocks as approximations for workplace locations, some hospitals initially identified as having carpooling opportunities turned out to be unreliable. Upon review, these hospitals had fewer than 10 total employees. In other words, it would be impossible for such hospitals to have more than 10 employees residing within a single home cluster. As a result, these hospitals were removed from the final results. The hospitals that remained on the final list typically employ 100 or more workers.

## Web Application

Figure 1 below reflects the landing page when the user (in this case a human resource manager working for Penn Medicine) first launches the website. On the left pane, a brief description of each view (Commuter Benefits, Park and Ride and Carpooling) is provided.

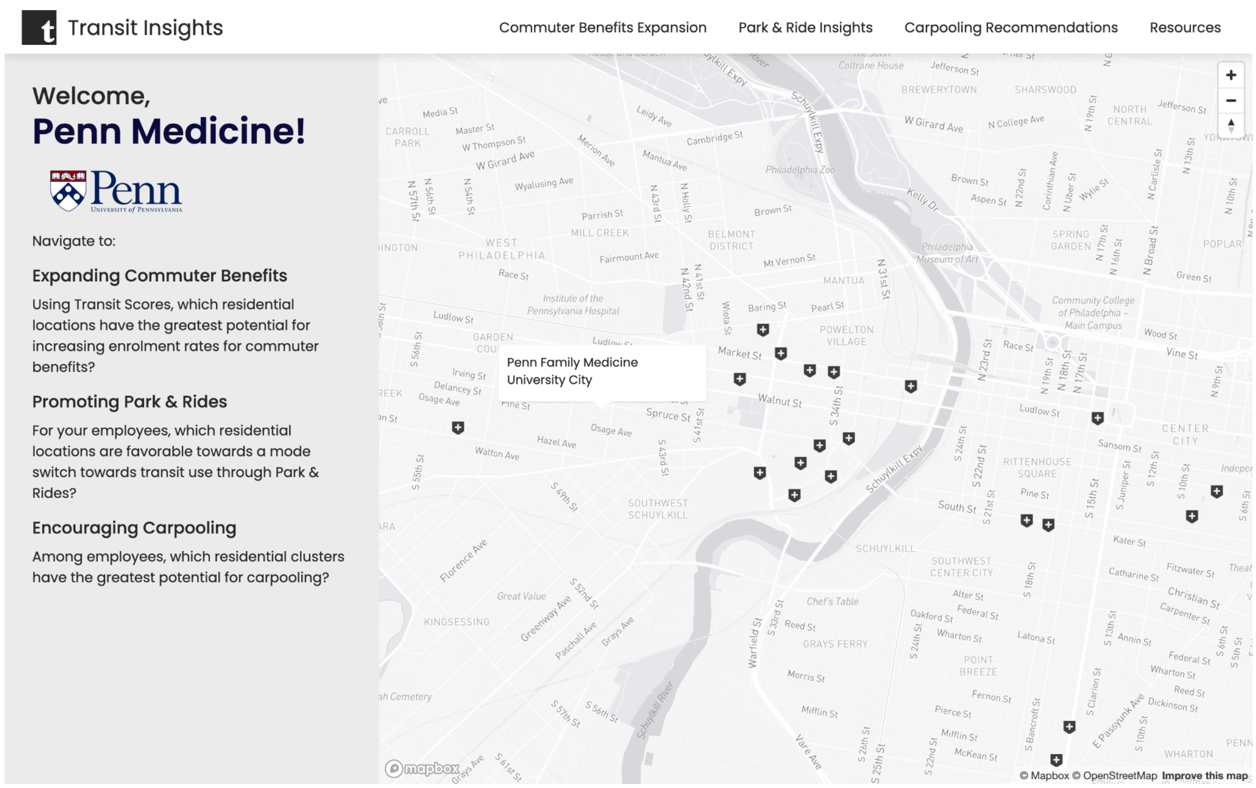



*Figure 1. The main landing page for Penn Medicine HR administrators, with individual clinic locations marked.*

**Commuter Benefits view**

When the Commuter Benefits Expansion page is loaded, each clinic location is represented by a triangle that indicates the current commuter benefits enrollment rate relative to the model's prediction. Upright triangles represent locations where the actual enrollment rate exceeds the predicted rate, suggesting a stronger-than-expected uptake of public transit among employees. Conversely, downward-facing triangles indicate clinics where the enrollment rate is below the predicted value. These locations may warrant further investigation to understand potential barriers to adoption and to inform targeted outreach efforts by Penn Medicine.

A slider in the sidebar allows users to set a custom enrollment rate threshold, aligning with any internal goals Penn Medicine may have for the participation rate of their clinics. Once a threshold is selected, clinics that fall below the target will be highlighted in red, signaling the need for prioritization, while those meeting or exceeding the threshold will remain green as seen in Figure 2.

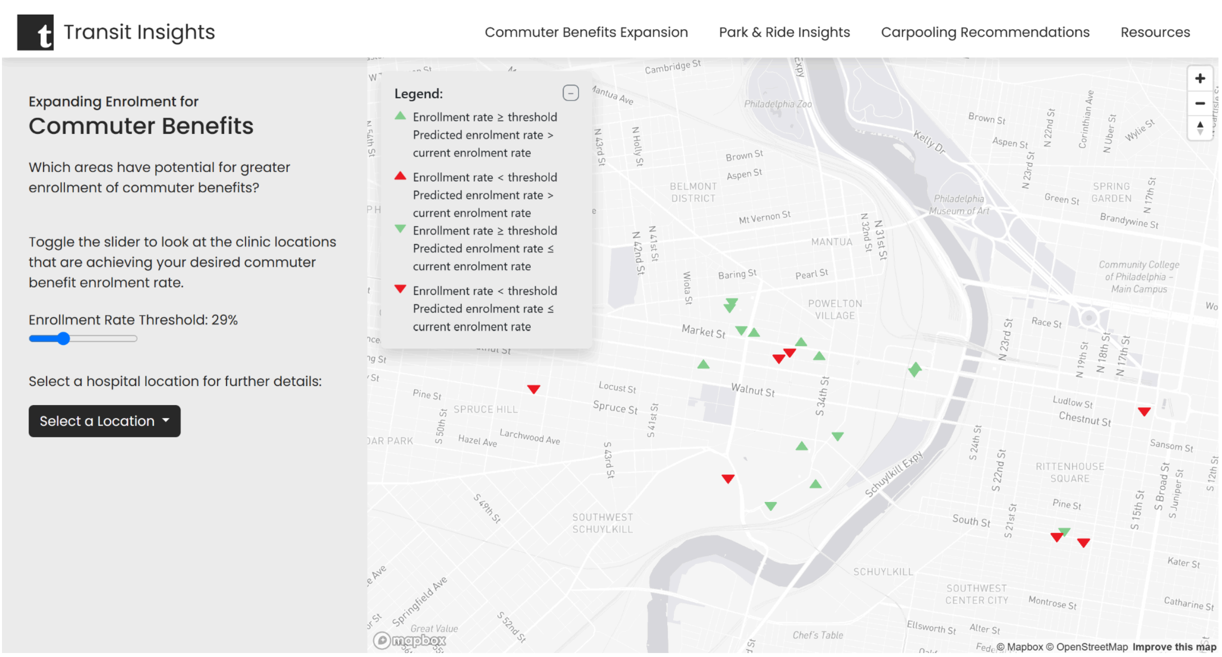



*Figure 2. Commuter Benefit Page, use of slider to set enrollment rate threshold.*

From the dashboard view, there are no immediately apparent spatial patterns among clinics with lower than expected enrollment rates. To support more detailed analysis, users can select a specific clinic from a dropdown menu in the sidebar. This action will zoom the map to the selected clinic and display a popup with a detailed breakdown of the factors included in the prediction model. The basemap will also update to show a transit score hex map, illustrating transit accessibility in the immediate area surrounding the clinic as seen in Figure 3.

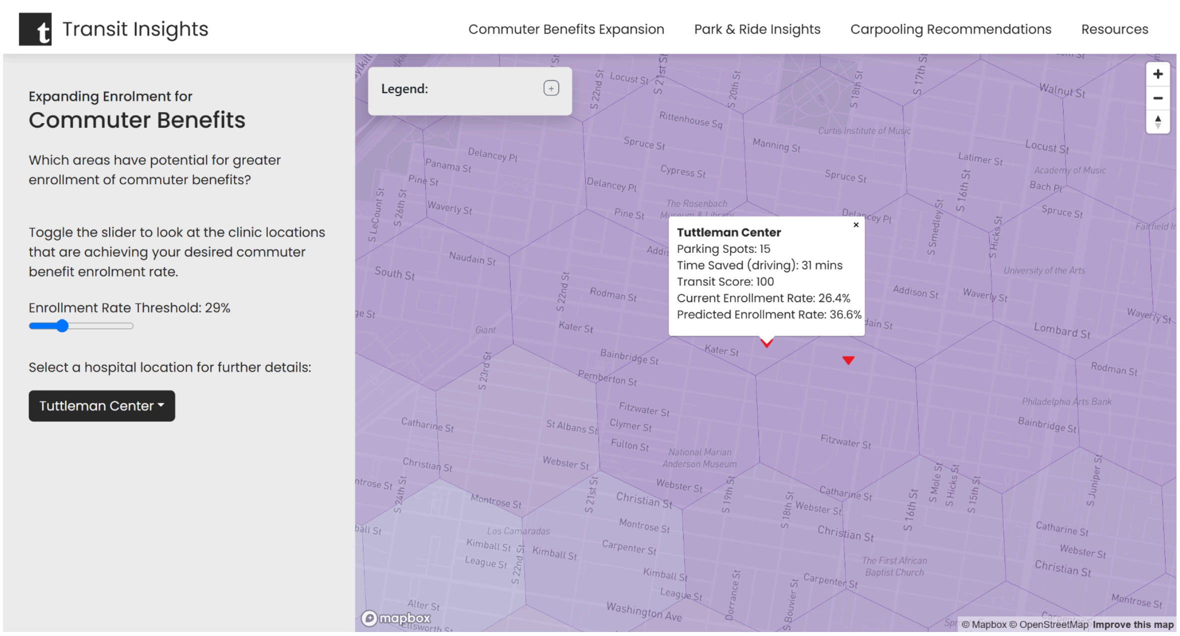
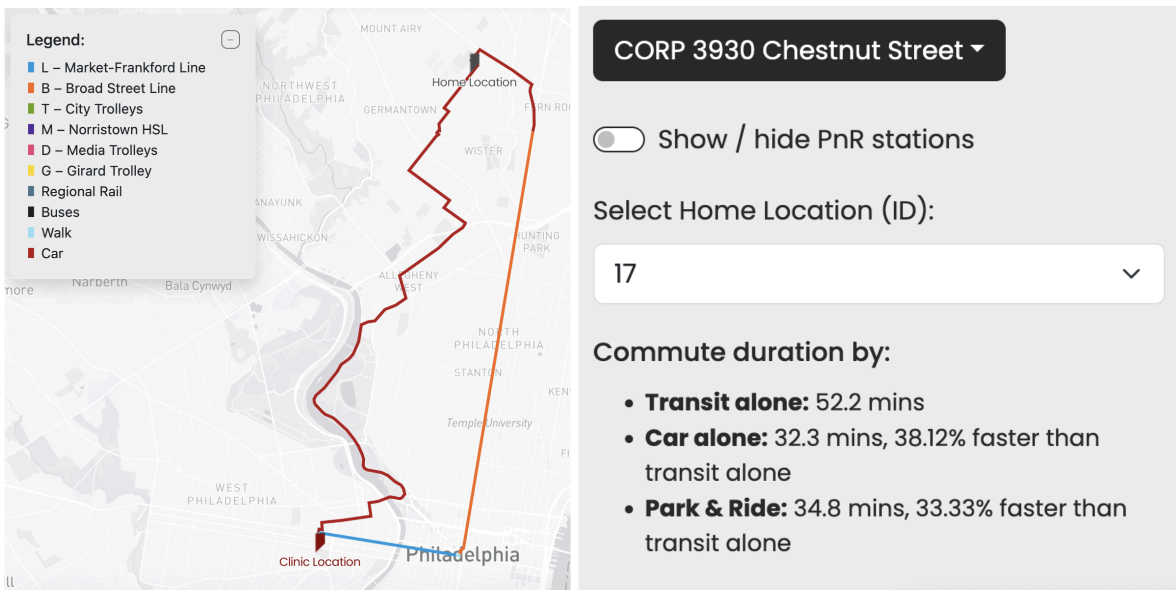



*Figure 3. Commuter Benefit Page, selection of a specific clinic location.*

By examining the factor breakdown for each clinic location, more tailored strategies can be developed to address specific challenges. In the example shown in Figure 3, the clinic has a maximum transit score of 100, indicating strong public transit infrastructure. This suggests that inadequate transit access is unlikely to be the primary reason for the lower than expected enrollment rate. However, the average time saved by driving exceeds 30 minutes, which may discourage employees from switching to public transit. In such cases, alternative commuting options such as park and ride programs or carpooling may be more practical and should be considered to change commuter behavior.

**Park and Ride view**

With the Park and Ride page, for each eligible Penn Medicine location, users can view the full itinerary of driving directly to work and a hybrid version where driving is restricted to the initial leg of the entire journey. Figure 4A below illustrates such a comparison, along with Figure 4B showing the summary statistics for the two routes.




*Figures 4A and 4B. Comparison of the fastest driving-only route and a hybrid Park and Ride route (using Broad Street Line and Market Frankford Line) from a Germantown census block to Hospital of the University of Pennsylvania at 3930 Chestnut St.*

In the above two figures, a modal shift from driving-only to the hybrid mode incurs a negligible time cost (2.5 mins), yet reduces vehicle emissions significantly by parking at Olney station's Park and Ride facility. With this insight, HR administrators could reach out directly to employees currently driving to work to offer a bespoke commuter benefits package combining parking and SEPTA Metro access, through flexible products such as the Jawnt Pass. For some commuters, the prospects of tax deductions through commuter benefits enrollment, less time spent on the morning drive, and a reduced environmental footprint may be sufficiently convincing to undertake such a modal switch. Moreover, as workplace parking in Center City and University City tend to be time constrained, leaving the car nearer to home opens up commuters to trip-chaining opportunities after work, such as recreational and dining activities in Center City, without the need to worry about parking in those locations.

**Carpooling view**

The Carpooling Recommendation Page is visualized in Figure 5 below. On the left panel, users can select from a list of hospitals identified as having carpooling opportunities. When a hospital is selected, the map zooms in to show all home locations linked to that hospital with potential for carpooling.

High recommendation home locations (with more than 10 commuters, significantly shorter commute times by car, and located more than one mile from the workplace) are highlighted in dark red. A number label on each of these locations indicates the number of employees residing there. Additionally, secondary recommendation home locations (with more than 10 commuters and located more than one mile from the workplace) are shown in gray.

Clicking on a recommended home area displays detailed information in the left panel, including the total number of commuters from that area, commute time by car, commute time by public transit, and the time difference between the two modes.

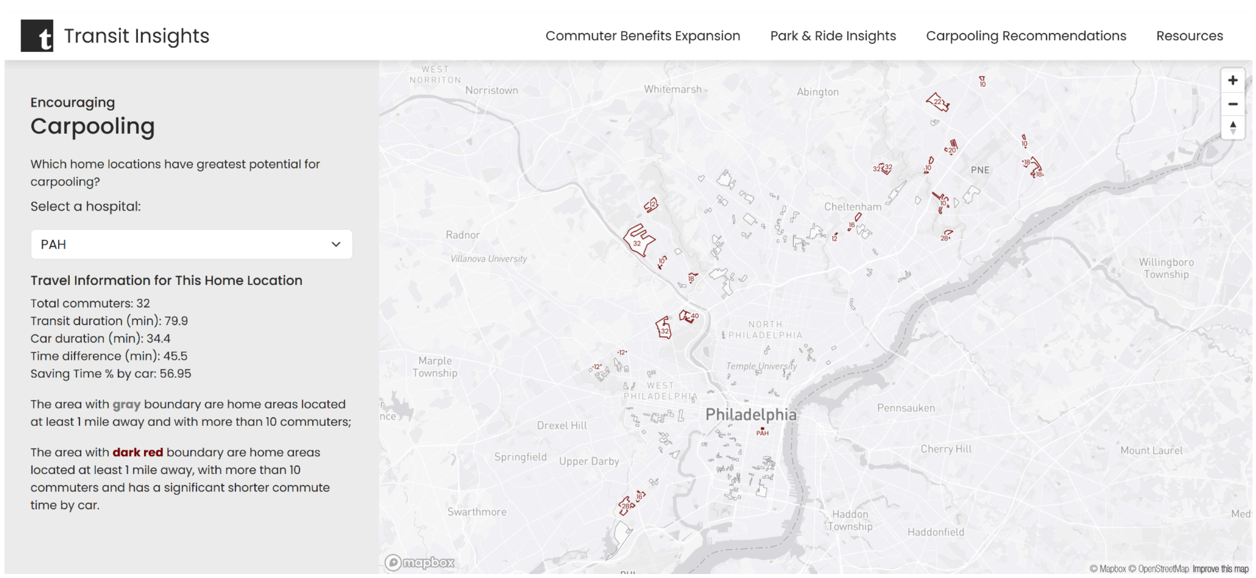



*Figure 5. Carpooling Recommendation Page, with areas with high recommendation highlighted in dark red and secondary recommendation in gray.*

## Resources view

Lastly, the dashboard houses a Resources page which points users to Jawnt's suite of services for optimizing commuter benefits for organizations. Figure 6 below shows the various links to Jawnt's own product website.

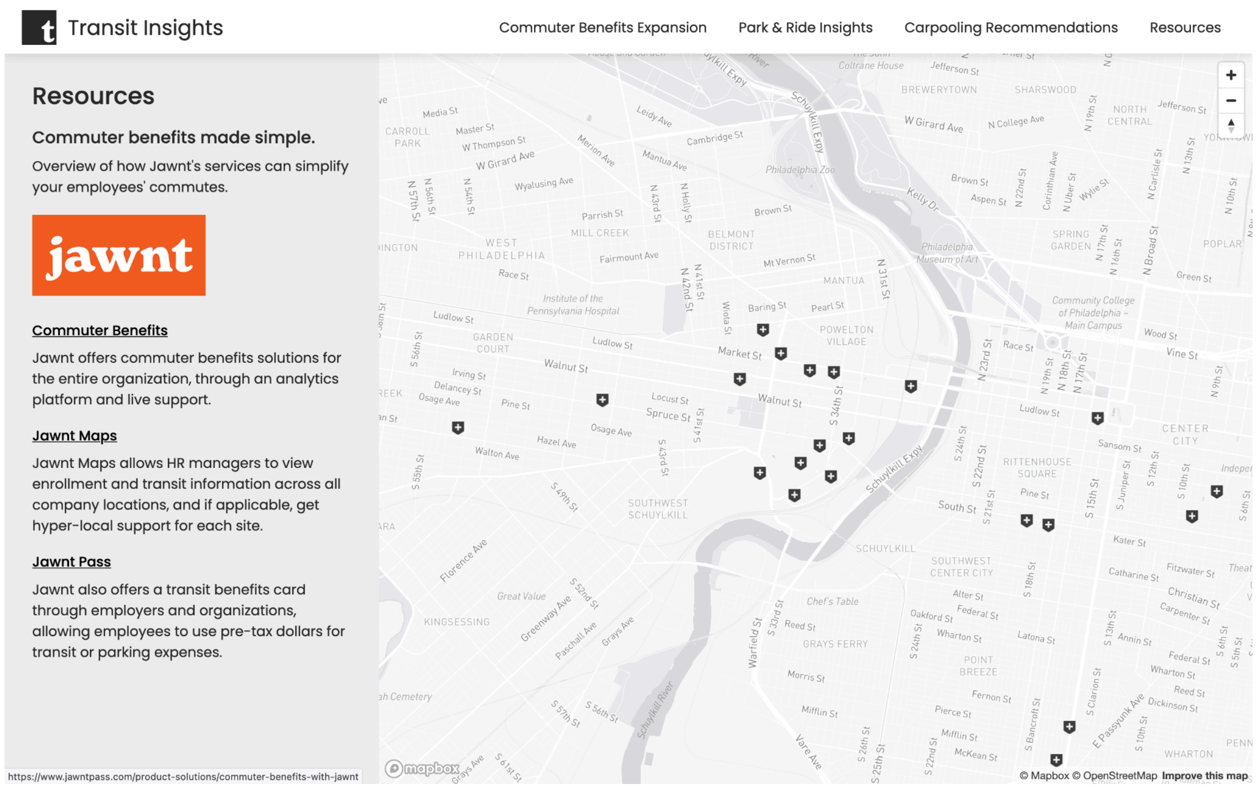



*Figure 6. Links to Jawnt's consultancy services, Jawnt Maps and Jawnt Pass within the Resources view.*

## Conclusion and Future Extensions

In conclusion, the practicum project has been a fruitful endeavor, with detailed insights for Penn Medicine HR administrators to tailor the messaging process for commuter benefits to different commuter segments at different UPHS locations. The use of the open-source `r5r` routing package and publicly-accessible U.S. Census data also means the analytical process is scalable to any city in the U.S. with an active GTFS feed. Future analyses can also opt to leverage commercial routing solutions such as Google's Directions API as an alternative.

For future collaborations between Jawnt and the University, there are various avenues for teams to extend our current project. Using the same Penn Medicine dataset, future teams could recruit volunteers from selected UPHS locations to record travel diaries that supplement the enrollment data, with anonymized itineraries for HR administrators to fine-tune commuter benefits strategies at the individual level. In addition, the nuances of odd-hours commutes typical of many UPHS employees are a rich area for future studies, which our team has considered but did not explore in depth due to time constraints.

Moreover, the availability of data from other Jawnt clients will definitely provide richer insights into how commuting behavior (and hence targeting strategies) differ across firms in the same city, and whether the nature of the industry or the geographical spread of firm locations influence commuting choices. Lastly, if resources may allow, pilot behavioral studies may be conducted within a specific firm location to gauge how different bundling of commuter benefits may be perceived by employees.

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