Using GPS data to map and model Colby student public transit efficiency
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Introduction
Transportation on college campuses is a major challenge as both the institution's funding and accessible modes of travel are limited. Many colleges offer shuttle or bus services from campus to popular locations in the surrounding area (University of Wisconsin 2013). Colby Security currently offers two different forms of motorized transportation that leave campus: a Downtown Shuttle and the Jitney. The shuttle has a set route, while the Jitney serves as a taxi. In order to identify the most efficient means of transporting students from campus to various locations in the community, we have conducted a study of the routes of the Downtown shuttle and Jitney service run by the College to determine peak ridership and overlap in the popular destinations of the Jitney and the shuttle stops (University of Wisconsin 2013). The goal of this project is to determine inefficiencies in the current transportation system that could be used to improve how students and faculty living in the Downtown Dorm, as well as the rest of the campus community, are able to access transportation.

Methods
Jitney and Downtown shuttle data were analyzed and mapped separately. Both used data for Maine roads that came from Esri and Maine county data from the Maine Office of GIS projected in NAD 1983 Zone 19N. Shuttle and Jitney location data were collected using Accutracking GPS units that recorded location data every 30 seconds.
Jitney data spanned a full week, from Thursday, April 19 until Wednesday, April 25, however data were removed from 1:00 pm until 2:30 pm on Friday, April 20 when the Jitney was taken to Augusta. Shuttle data consisted of Monday, April 23 through Wednesday, April 25; a three day sample due to lack of time and irregularities in the data due to accommodations for Admitted Students weekend. Kernel density layers were created excluding points where speed was equal to zero. The Tracking Analyst was used to create a tracking map using all data points. The Tracking Analyst was also used to make the data clocks for points transmitted when the vehicles were moving and another clock for when the vehicles were stopped. The locations with the highest density of vehicle movement were used to create a proposed ideal shuttle route using the Network Analyst tool loosely following the protocol for a Clean Slate Analysis used by the University of Wisconsin (2013). The locations for stopped data were not used because this would have mostly focused on campus, and would have included stoplights.
Ridership data spanned from the start of the Spring 2018 semester (February 7) through the start of Spring Break (March 23), and were collected by the Colby Security Department. Shuttle ridership data includes the number of students, staff, and faculty on board the shuttle for each day and hour the shuttle was in operation. The Jitney is only available to students, and similarly included rider number by day and by hour. All ridership data were synthesized using Microsoft Excel 2013.

Results
The Jitney is able to travel anywhere within Waterville, is available only to students, and is in operation every day, with the hours depending on the day (Figure 8). The Shuttle is only in operation on the weekdays from 7:45 am to 6:00 pm (Figure 8). The most popular day for the Downtown Shuttle was Tuesday, while the Jitney is most frequently used on Friday (Figure 6). The Downtown Shuttle is most popular between 8-9 am and the Jitney is most popular 9-10 pm (Figure 7). The Jitney has greater ridership at any given time on any given day than the Downtown Shuttle overall (Figure 6, Figure 7). The Shuttle stops consist of Diamond, Davis, Gilman St, and Appleton St (Figure 2). The most frequently visited Jitney stops included in this analysis were Mayflower Hill Drive, JFK Plaza, Elm St, Carroll St, Waterville Commons, Elm Plaza, and the Pugh Center, which is the on-campus pick up point (Figure 1). A suggested expanded route for the shuttle, with a length of 8.5 miles, consists of a combined route of the common Jitney stops and Shuttle route (Figure 5). These stops were chosen to be included in the potential expanded shuttle route based on the Kernel Density layers generated for both the Jitney and Downtown Shuttle (Figure 3, Figure 4), while some locations were excluded because they were known to be stoplights or other time-intensive traffic patterns.
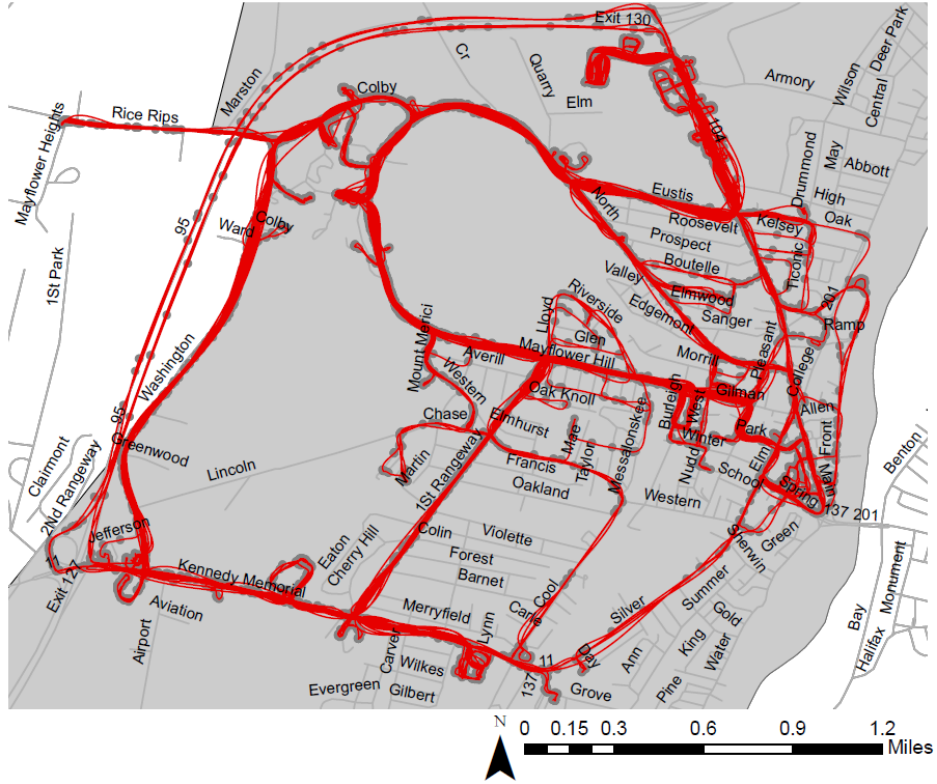
Figure 1. Approximation of Jitney Route made by ArcGIS Tracking Analyst using one week of data.
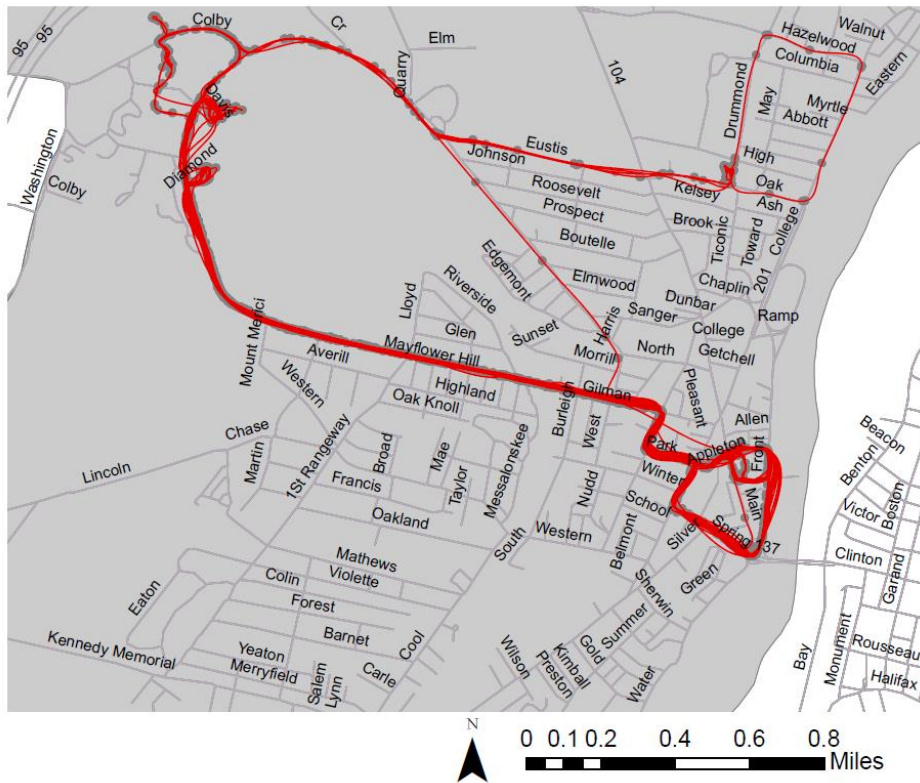

Figure 2. Approximate route of Downtown Shuttle made with the Tracking Analyst tool in ArcGIS using three days of data.
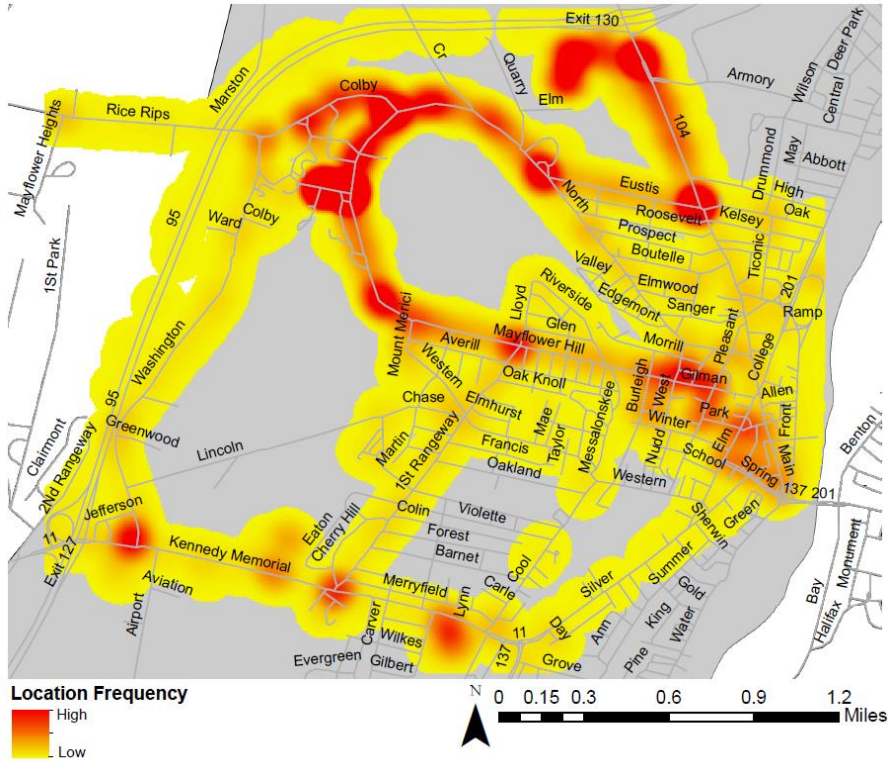
Figure 3. Kernel density of Jitney data points transmitted while the Jitney had speed greater than zero.
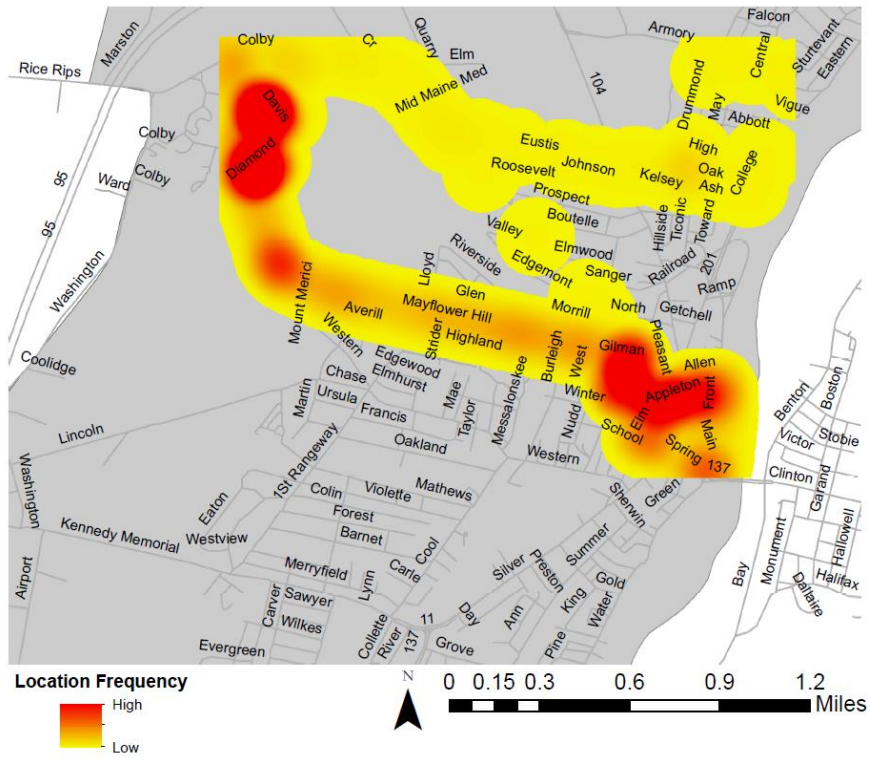

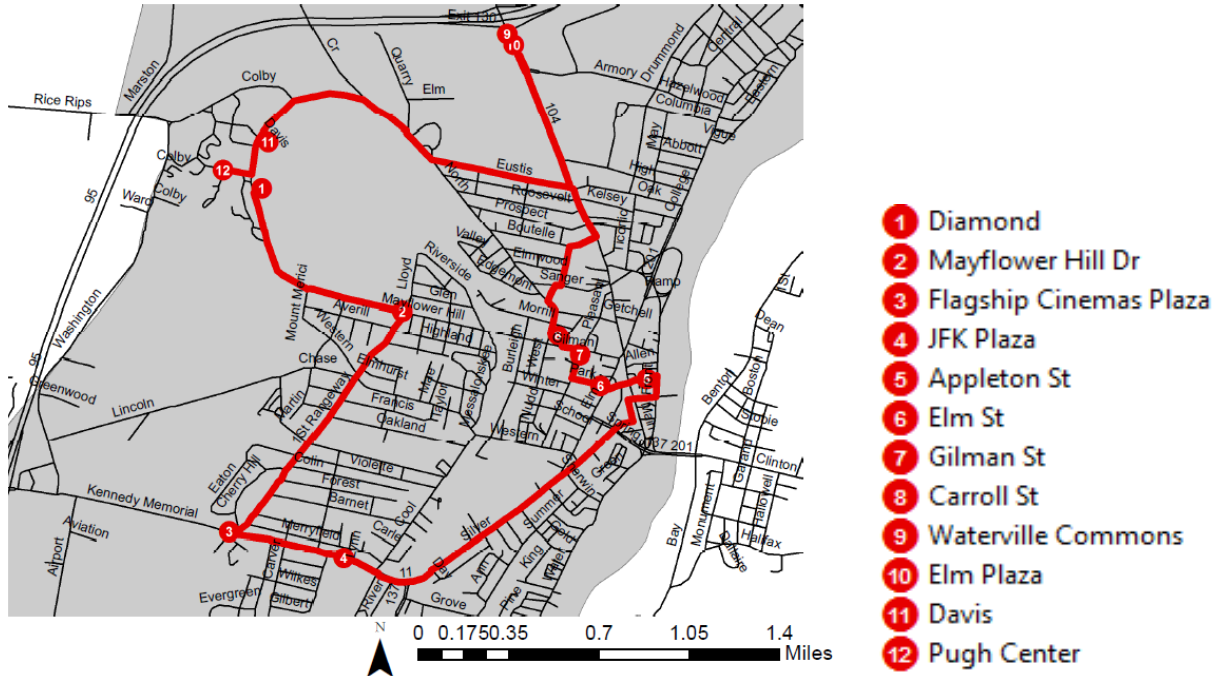Figure 4. Kernel density of the Downtown Shuttle GPS location where the vehicle had a speed greater than zero.

Figure 5. Map of combined common Jitney stops and existing Downtown Shuttle route created using the Network Analyst tool. Stops are numbered in chronological order. The total length of the route is 8.5 miles.

1. Diamond
2. Mayflower Hill Dr
3. Flagship Cinemas Plaza
4. JFK Plaza
5. Appleton St
6. Elm St
7. Gilman St
8. Carroll St
9. Waterville Commons
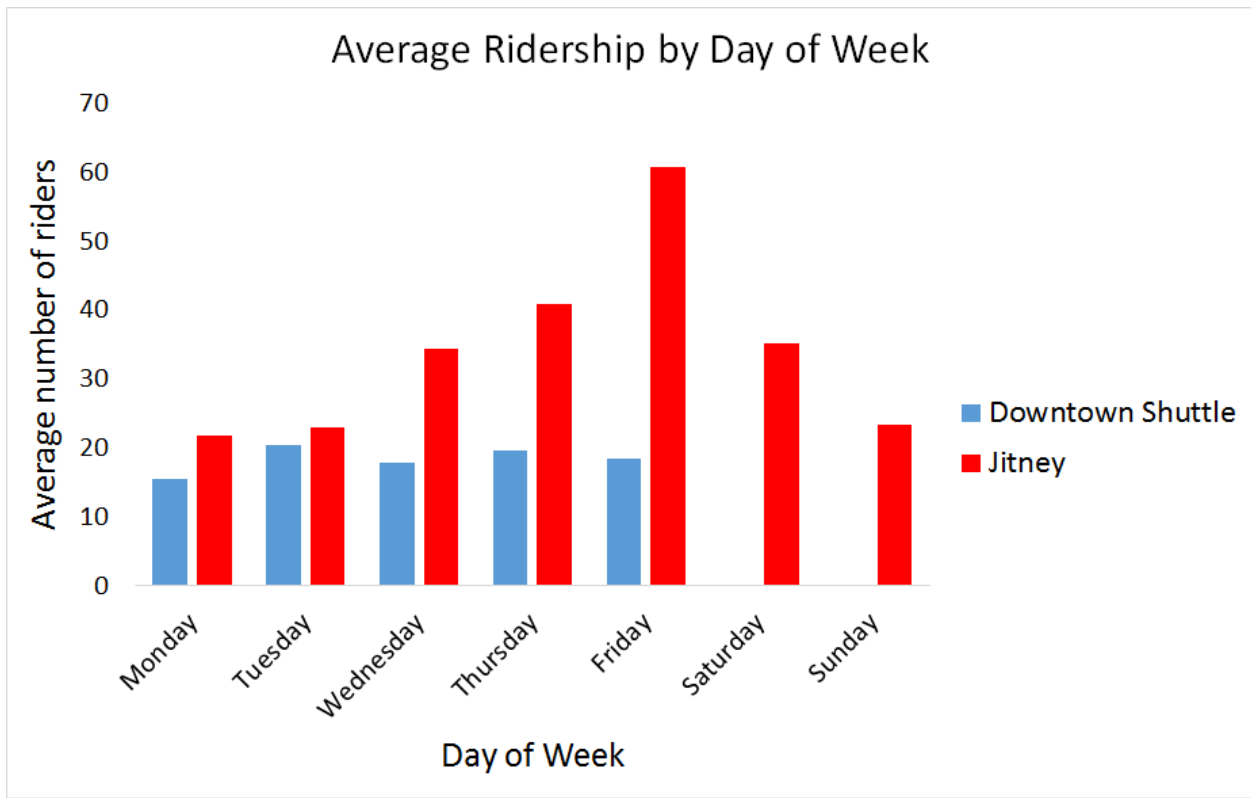10. Elm Plaza
11. Davis
12. Pugh Center

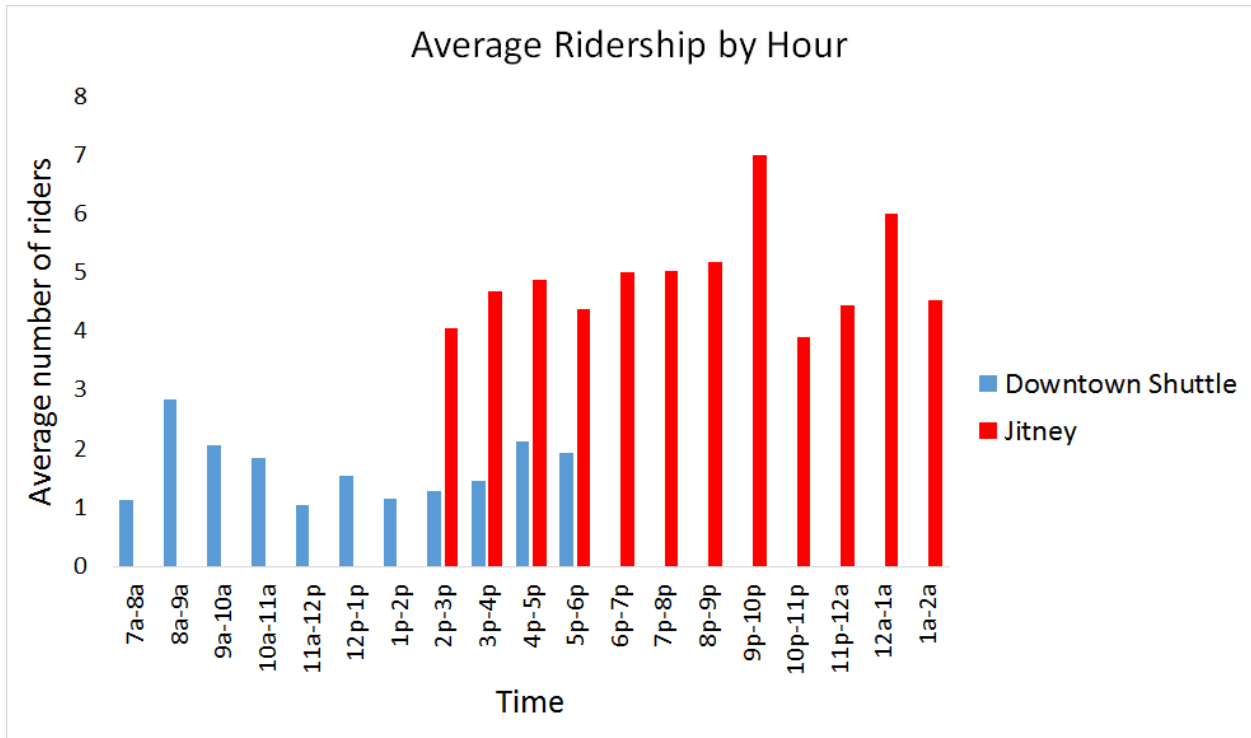Figure 6. Graph showing the average Jitney and Downtown Shuttle ridership by day of the week.

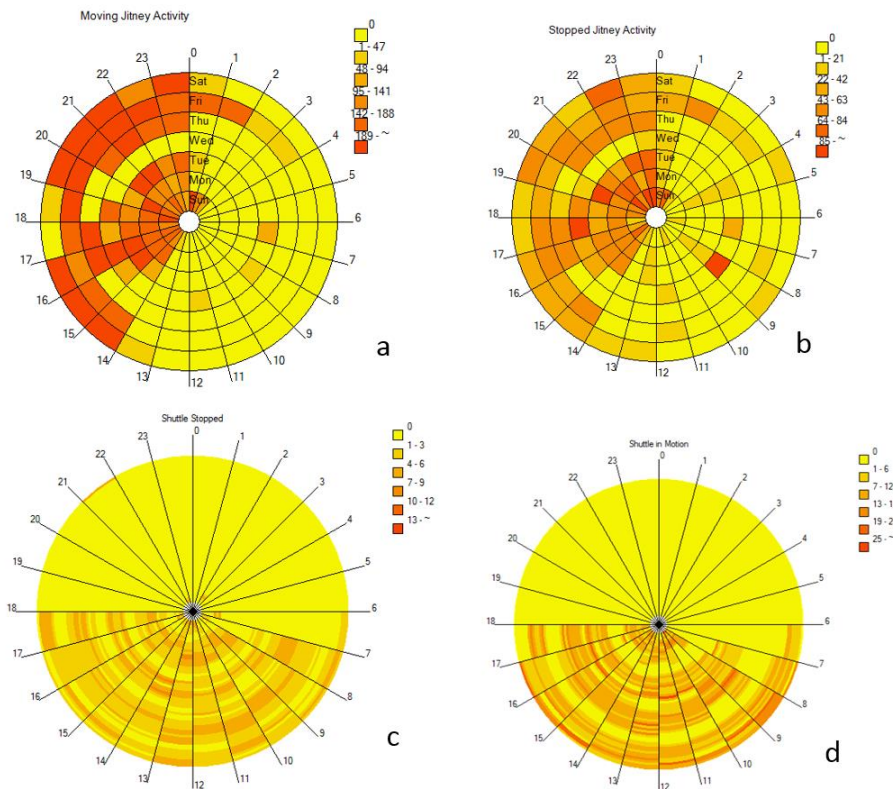Figure 7. Graph showing the average Jitney and Downtown Shuttle ridership by time of day.

Figure 8. Figure 5. Time clock showing the number of points transmitted by the GPS unit while the a) Jitney was stopped, b) Jitney was moving, c) Shuttle was stopped, and d) Shuttle was moving.

Discussion

The Jitney and Shuttle routes consist of overlap in the Waterville Downtown. The differences in ridership shows that the Jitney is much more highly favored, even when going to a location that the shuttle also stops at, which could be due to perceived ease of access, running hours, or days in operation. The Data Clocks help to visualize the amount of time each vehicle spends stopped and in motion. Often, the Jitney is seen idling outside of the Pugh Center waiting for passengers. While it does spend more time in motion than stopped, there are periods of up to 42 minutes of stopped time recorded. The high use of the Jitney during the evening also suggests that the extension of shuttle hours would likely be useful to the student body. The suggested expanded shuttle route could perhaps eliminate the need for both a Jitney and a Shuttle as it stops at all the places students really need to go. Over the course of the week, the Jitney traveled 829 miles for an average of 118 miles per day. The Downtown Shuttle traveled 214 miles over the three day study period, for an average of 71 miles per day. If the Shuttle loop is approximately 5 miles, it is making 14 trips per day. If the College were to combine these routes and use the 8.5 mile loop, the shuttle could traverse this loop 22 times for the same amount of mileage used by the Downtown Shuttle and Jitney together.

Not included in this analysis due to a lack of access to data is the SGA Shuttle, which only runs on weekends to most locations covered by the Jitney. In a future analysis, this vehicle should be included to determine if it could sufficiently fill the niche of the Jitney in transporting students throughout Waterville, perhaps expanding its route to cover the stops identified in the Kernel Density analysis, and thus eliminating the need for the Jitney altogether and removing a vehicle from the road.

Acknowledgments

Citations

Esri. County and Town Basemaps. 2018.

Maine Office of GIS. Road Basemap. 2018.

University of Wisconsin- Madison. Campus Transportation System Evaluation. Nelson\Nygaard Consulting Associates. 2013.