Developing a Neighborhood Electric Vehicle Program

ABSTRACT

Neighborhood Electric Vehicles (NEVs) are classified as low-speed vehicles which have been permitted on roadways where the posted speed limit is 35 mph or less. These vehicles have become increasingly popular as people become more aware of the benefits of electric vehicles. There has also been a growing trend to incorporate these electric vehicles as public transit circulator systems. This paper explores developing an implementation plan for a unique point-to-point on-demand public transit circulator system within the downtown core of Tampa, Florida, using electric vehicles.

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INTRODUCTION

Neighborhood Electric Vehicles (NEVs) are classified as low-speed vehicles which have been permitted on roadways where the posted speed limit is 35 mph or less. These vehicles have become increasingly popular in the Tampa, Florida area as people become more aware of the benefits of electric vehicles. There has also been a growing trend to incorporate these electric vehicles as transit circulator systems. This paper explores developing an implementation plan for a unique point-to-point on-demand public transit circulator system within the downtown core of Tampa, Florida, using electric vehicles.

A plan was developed for a unique point-to-point on-demand public transit circulator system within the downtown core of Tampa, Florida, using electric vehicles. The service is intended to provide visitors, employees, and residents of the downtown, convenient mobility. The Neighborhood Electric Vehicle (NEV) Program offers an environmentally friendly alternative to driving gas-powered automobiles, and a context sensitive mobility solution to parking and congestion issues downtown. Patrons will be able to access all major attractions in the downtown area without having to use private automobiles. The program would also complement the neighborhood watch activities of the Downtown Guides and complement existing transit service in the area.

A literature review was completed in order to guide the program development and a case study was explored in the Tampa area. The program development included an exploration of the study area, and a feasibility analysis based on demographic data, the existing road network and assumed performance measures.

LITERATURE REVIEW

Safety and Operations

Various studies have been done on the safety and operations of electric vehicle fleets. Previously reported issues with electric vehicle fleets include slow speeds against faster traffic, firm/bumpy rides, insufficient turning radii for longer vehicles, and the lack of crash protection especially from the sides (Arthur D. Little, Inc. 2002). In another study of NEV fleets, of the 348 electric vehicles studied, approximately 91% have not had any operating problems. The reported problems of the others included battery pack, chargers, controller boxes, front suspension and transmission problems, as well as controller failures, and malfunctioning switches (Francfort, J. and Caroll, M. 2001). Another reported concern with electric vehicles is an unconventional driving style which may be employed to achieve maximum efficiency and range (Yacobucci, B. 2004).

In 2000, the Center for Urban Transportation Research (CUTR) conducted a feasibility study for a shuttle service in Downtown Miami using electric vehicles (Volinski and Perk 2000). The CUTR report recommends fast-charging stations and extra batteries if electric vehicles are to be used. The report also recommends full training for operators and mechanics since electric vehicles have nuances that make them differ from typical gas-powered vehicles.

Electric Vehicles in Public Transit

Electric vehicles for transit are being used in Chattanooga, Tennessee; Miami Beach, Florida; Tampa, Florida; Norfolk, Virginia; Santa Barbara, California; Portland, Maine; Cape Cod, Massachusetts; and Cedar Rapids, Iowa.

In Chattanooga, the free electric shuttle buses run daily with five minute headways along a route from Shuttle Park South at the Chattanooga Choo Choo to Shuttle Park North near the Tennessee Aquarium. The route allows convenient access to downtown attractions, shopping and restaurants. Chattanooga Area Regional Transportation Authority (CARTA) runs the largest fleet of electric vehicles in the world in downtown Chattanooga. The electric shuttle has become a tourist attraction and carries more than one million passengers per year (River City Company Website).

The Norfolk Electric Transit (NET) is a free shuttle service in downtown Norfolk. This free commuting service is provided by the City of Norfolk and operated by the Hampton Roads Transit (HRT). NET buses run every six to eighteen minutes. During peak hours, additional buses are added. NET buses service over 1,800 passengers a day Monday through Friday (City of Norfolk Website).

The first electric bus system in Florida was implemented in Miami Beach in 1998. The fleet now consists of eleven 22-foot buses that run north and south along one of South Beach's busiest corridors of shops, cafes, clubs and other hot spots and a short walk from world-famous Ocean Drive (Miami Beach Transportation Management Association).

The recently developed NEV service in Downtown Tampa, Florida is unique because the electric shuttles operate as point-to-point and demand responsive. They are currently being run by several private companies.

Demand Responsive Transportation

There are six basic types of demand responsive transportation systems (Koffman, D. 2004):

Route deviation—Vehicles operate on a regular schedule along a well-defined path, with or without marked bus stops, and deviate to serve demand-responsive requests within a zone around the path. The width or extent of the zone may be precisely established or flexible.

Point deviation—Vehicles serve demand-responsive requests within a zone and also serve a limited number of stops within the zone without any regular path between the stops.

Demand-responsive connector—Vehicles operate in demand-responsive mode within a zone, with one or more scheduled transfer points that connect with a fixed-route network. A high percentage of ridership consists of trips to or from the transfer points.

Request stops—Vehicles operate in conventional fixed-route, fixed-schedule mode and also serve a limited number of defined stops near the route in response to passenger requests. (Request stops differ from flag stops in not being directly on the route.)

Flexible-route segments—Vehicles operate in conventional fixed-route, fixed-schedule mode, but switch to demand-responsive operation for a limited portion of the route.

Zone route—Vehicles operate in demand-responsive mode along a corridor with established departure and arrival times at one or more end points.

All of the flexible services studied had some fixed operating schedule. In route and point deviation systems, for request stop service, and for routes with flexible segments, the schedules list a series of time points with departures. For the single example of a zone route, the schedule consists of one established departure time each day. Other services that have been called zone routes also included approximate times in successive portions of the corridor of travel (Koffman 2006).

Some demand responsive systems require advance notice from the previous day for a pick-up; others accept short-notice requests including some that allow 30-min, 20-min, 15-min, and even 10-min advance notice. There was no obvious connection between service type and the length of the advance-notice period. Short- notice situations generally occurred in small cities, large metropolitan areas, and rural areas. Very few transit systems appear to have standards that define acceptable performance levels for flexible service (Koffman 2006).

Demand-responsive scheduling and dispatching are usually accomplished through some combination of telephone reservations, printed manifests with lists of reserved deviations, voice radios and/or cell phones for changes or insertions on the day of operation, and scheduling on route by drivers in response to on-board requests. For same-day requests, some systems, such as Mason County Transit, give drivers the discretion to accept a deviation request or not, including requests made through the dispatch office. The Ottumwa Transit Authority (OTA) has the opposite division of responsibility: when drivers receive an on-board deviation request, they must obtain clearance to accept it from dispatch (Koffman 2006).

A review of approaches for estimating the number of vehicles needed to provide demand responsive transportation (DRT) service, done by Schofer et al (2003), found no consistently used formal tools or models. The general strategy for fleet planning for spatially distributed on-demand services—including public transit, emergency services, and private services such as express package delivery—is to divide estimated demand for service by estimated service rate (Schofer et al 2003).

In the simplest terms, fleet size is a function of the demand per time period and the service rate (time to serve a demand) per time period (Schofer et al 2003).

USF Safe Team Case Study

University of South Florida (USF) Safe Team started back in the 1970s as a response to safety concerns on campus at night. Golf carts were not employed as part of the system until the 1990s.

Today, Safe Team operates as a demand-responsive, point-to-point, escort system where students are able to call for a pick-up and drop-off anywhere on campus, free of charge. The wait time between vehicle dispatch and pick-up is typically 10 minutes. The fleet consists of 20 gas-powered golf carts, 12 of which are being used at any given time. Safe Team received 200 to 300 calls per night for their service.

The USF Tampa Campus is over 1,500 acres with 240 buildings and has almost 39,000 students. USF Comparatively, Downtown Tampa is 760 acres with 67,000 employees in 6.1 million square feet of office space and 764,000 square feet of retail space. Previous estimates identified approximately 600 residents in the downtown core, but that value has been increasing and was projected to have 1,200 residents in 2007. Based on dialogue with USF safe team staff, important logistical considerations for a NEV program include vehicle holding/charging locations, and dispatcher equipment and communications.

NEV PROGRAM DEVELOPMENT

An analysis was conducted to determine the feasibility of a Demand Responsive Transportation (DRT) system using electric vehicles to provide a point to point service within the downtown core of the City of Tampa. The primary considerations for the NEV Program include:

- Study Area;
- Existing transit facilities in the study area;
- Major attractions/destinations;
- Origin – destination & travel time determination;
- Suggested number of vehicles in fleet;
- Suggested vehicle model; and
- Vehicle holding/charging stations.

Study Area

The study area for the NEV program spans the neighborhoods, generally bounded by I-275 to the North; North/South Boulevard to the west; Bayshore Boulevard / Knights Run Avenue to the south; and Channelside Drive to the east.

Existing Transit Facilities

The Hillsborough Area Regional Transit (HART) currently provides transit services throughout Downtown, Channelside District, Ybor City and North Harbour Island. In addition to the intra-city service, there are two bus routes called the In-Town Trolley Purple and Green lines, as well as a streetcar system.

Major Attractions and Destinations

An inventory of the major attractions and destinations in the study area was compiled. These locations can be anticipated as primary pick up and drop off locations for the Neighborhood Electric Vehicle Program. Table 1 shows the properties of the major attractions and destinations in the downtown core of Tampa.

Table 1 - Major Attractions and Destinations

Attraction	Purpose	Location	Size		Time Periods of Major Activities
Tampa Convention Center	Special Events, Meetings	Franklin Street	600,000	Sq Ft	Varies
Court Houses	Business	Twiggs Ave and Florida Ave	N/A		Weekday Business Hours
University of Tampa	Business/Education	Kennedy Blvd	100	Acres	Varies
			5,600	Students	
St. Pete Times Forum	Entertainment	Channelside Dr	660,000	Sq Ft	Varies
Tampa Theatre	Entertainment	Franklin St	1,446	Seats	Evenings
Florida Aquarium	Entertainment	Channelside Dr	250,000	Sq Ft	Every day, Business Hours
Channelside Bay Plaza	Entertainment, Dining	Channelside Dr	230,532	Sq Ft	Varies
Port of Tampa	Recreation	Channelside Dr	N/A		Varies
Major Residential Developments	Residential	Various	1,351	Units	Varies
Hotels	Lodging	Various	2,487	Rooms	Varies
Tampa Bay Performing Arts Center	Entertainment	MacInnes Place	335,000	Sq Ft	Evenings
Major Office Buildings	Business	Various	6,105,227	Sq Ft	Weekday Business Hours
			66,475	Employees	

Origin – Destination and Travel Time Determination

In developing a conceptual DRT system for Downtown Tampa, the existing land uses and the origin/destination information for the downtown area was reviewed. Documentation of existing HART transit service for the downtown area, travel time information, activity level information was also reviewed to assist with the analysis. The major attractions and destinations in the study area which can be anticipated as primary pick up and drop off locations for the Neighborhood Electric Vehicle Program was tabulated and an origin-destination, vehicle time matrix was developed.

Typical origin and destinations pairs for each of the service periods were identified. In addition, the typical time a vehicle will be occupied for each service call was been determined. There are four components of the total time a vehicle will be used for a trip. The first component is the time taken by the vehicle to respond to and arrive at the origin of the trip. This has been assumed as 10 minutes on average. Second is the average time for the passengers to board the vehicle. This has been assumed as three minutes including the possible time spent by the passenger to identify and arrive at the vehicle. Third is the actual time taken by the vehicle to drive to the destination. For this, a total average travel speed of 10 mph has been assumed for calculation purposes for the NEV. The average speed is a logical assumption considering the study area is in a central business district, where there are many traffic signals throughout the grid, and that NEVs usually run at a lower speed than other vehicles on the road. The fourth, and last component is the passenger alighting time (time taken to exit the vehicle). This has been assumed as two minutes for the purposes of this study.

The origin-destination travel time matrix developed showed vehicle occupancy times ranging from 16 to 28 minutes for the 10 typical attraction centers analyzed.

Vehicle Fleet Estimation

Under the Transit Cooperative Research Program Project B-2, the Northwestern University Transportation Center developed the Northwestern University Demand Responsive Transportation (NU DRT) software to aide in designing, replacing or substantially modifying a DRT service. The software provides rough-cut estimates of the number of DRT vehicles needed to carry a specified number of trips at varying service levels, given the numbers and types of riders to be served, vehicle characteristics, and the boundaries of the service area as provided by the software user. The software uses 2000 census data, which can be edited to reflect specific census block groups.

The NU DRT software was used to conduct a feasibility analysis for a point-to-point demand responsive transportation system to the serve the downtown core of Tampa, Florida.

The Trip Simulation element of the software allocates a census block group origin and block group destination to every trip and selects trip departure and arrival times. The simulated weekday trips reflect the types of riders to be carried, the proposed hours of service, and the location of households and employment trip attractions in the service area. Multiple sets of daily trips are simulated to ensure that the final results are reasonably representative of average weekday trip patterns (Schofer etc al 2003).

Five seats were used in the software analysis to represent the maximum number of seats available. The productivity standard adopted by HART is passengers per revenue hour, which is defined as the number of passenger trips divided by the revenue hours of service provided. For ridership projections on the In-Town Trolley, HART used 6 passengers per revenue hour. The 2007 ridership data for the Hillsborough Area Regional Transit (HART) Channelside shuttle, Hyde Park Trolley and Uptown/Downtown Connector was reviewed to identify a potential estimate for the passengers per revenue hour on the NEV program. Using five passengers per revenue hour, the number of seats as five, the pick-up and drop-off time window as 10 minutes, boarding time and alighting time as 3 minutes and 2 minutes respectively, and assuming that the service will run from 7:30 AM to 10:30 PM from Monday to Friday, the following results were obtained:

Figure 1 - Demand Fulfillment Using 5-Passenger Vehicle

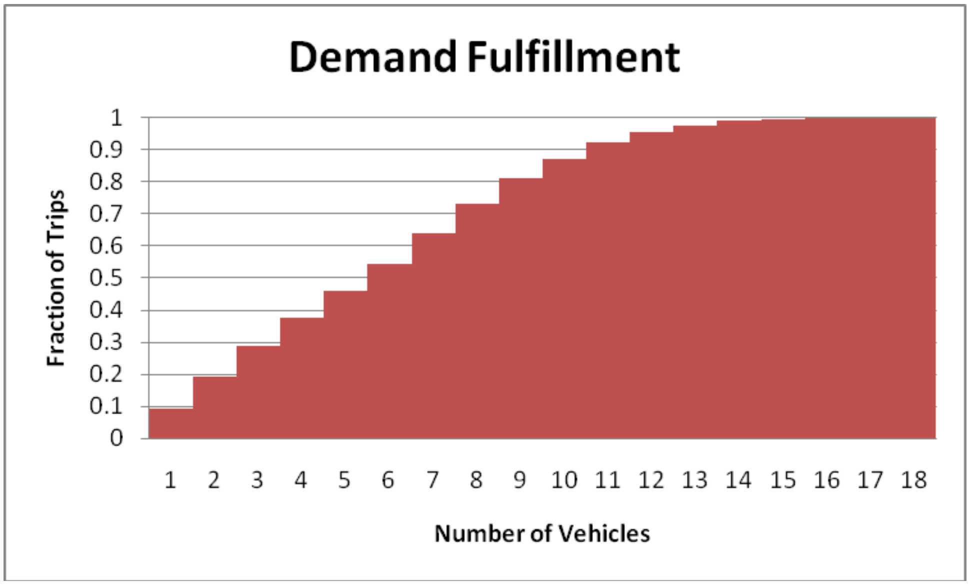


Figure 2 – Maximum Number of Passengers on Board

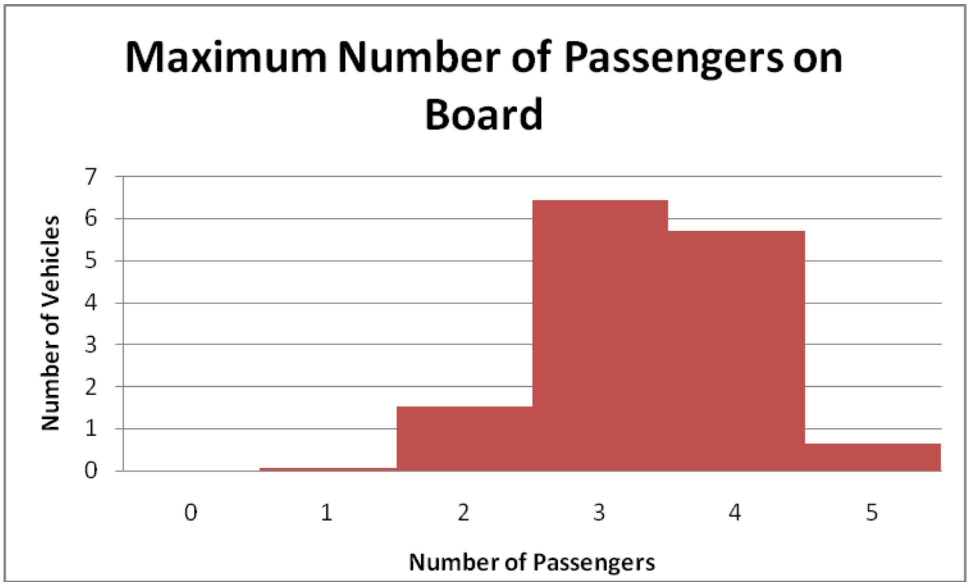


Figure 1 shows the fraction of total trip demand that can be fulfilled by a specific number of vehicles, averaged over the simulated days of service. Based on the simulation, 15 vehicles will serve 99 % of trips.

Figure 2 shows the average number of vehicles experiencing a specific maximum numbers of passengers on board during a service day, based on averaging the simulation of the service days. Approximately seven vehicles have a maximum of four or five passengers on board within a service day and approximately eight vehicles will have a maximum of three passengers on board at any one time under the assumptions underlying this simulation run. This suggests that a maximum of seven 6-

passenger vehicles and eight 4-passenger vehicles is necessary to satisfy almost all of the assumed demand.

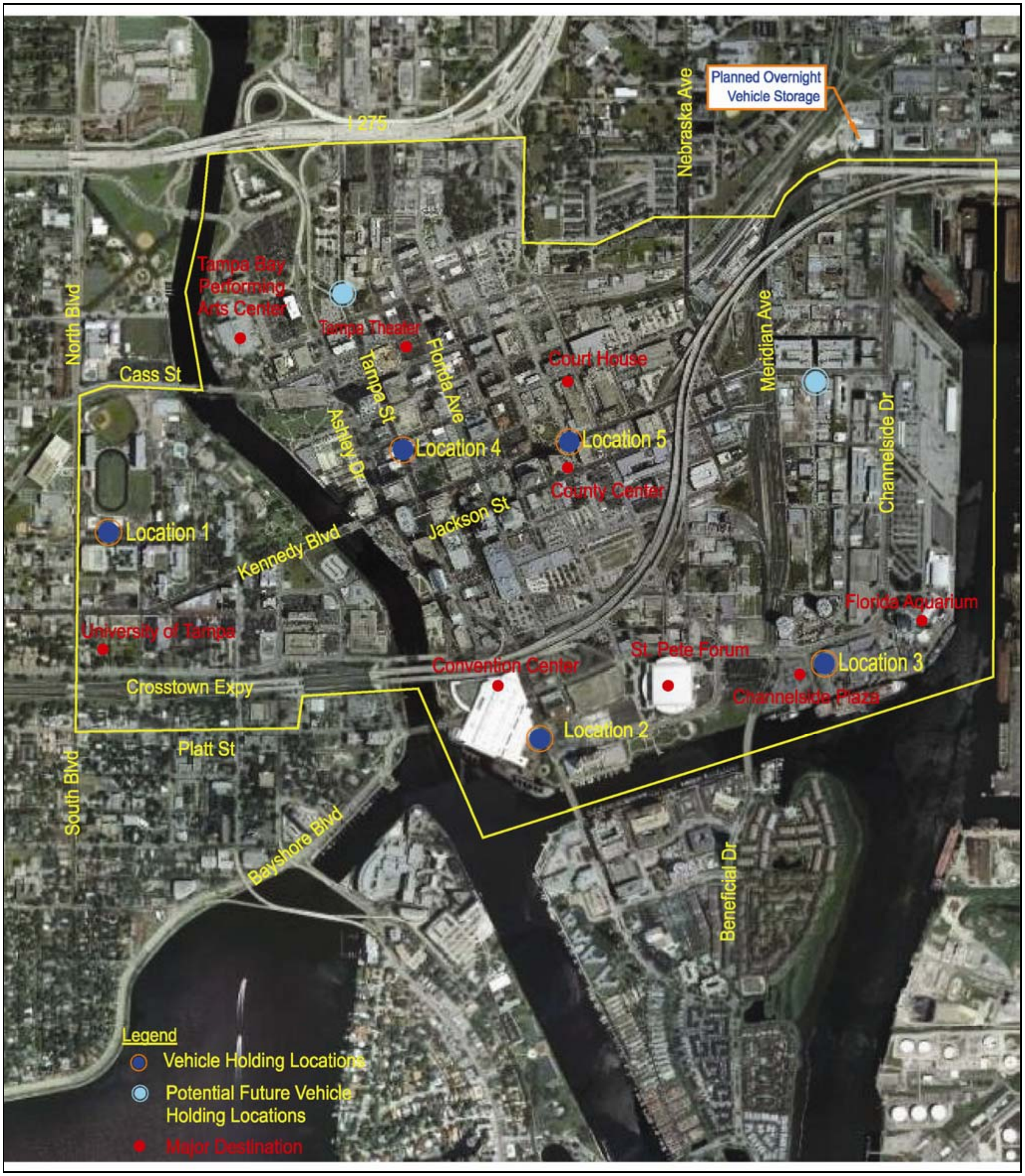
The DRT software does have limitations. There is no input for weekend service or variable weekday service. The software also makes use of US Census Bureau 2000 data; therefore it does not reflect the most current census data. Also, since the software was just developed in 2003, there are no known cases where it was used to develop a new DRT program. The software, however, is based on commonly used methods of estimating the number of vehicles needed for DRT systems around North America.

The maximum number of vehicles required to serve 100 per cent of trips over all of the simulated days is 18, however, the number of vehicles in use, which represents the average number of vehicles needed is 15 according to the NU DRT software simulation. Based on the software, 15 vehicles would be adequate to carry almost 100 % of the trips, based on a demand of five passengers per revenue hour; however, additional vehicles would be suggested so that reserve vehicles would be on hand at charging stations.

Vehicle Holding Locations

The proposed NEV program is expected to consist of a fleet of electric vehicles; therefore it was necessary to identify locations where the vehicle batteries can be charged. Holding locations were determined based upon where the vehicle could be located safely away from moving traffic and obtain an electric charge, while also providing visibility to pedestrians. Five locations were chosen that had high visibility and the potential for an electrical outlet or fast charging station. Figure 3 shows the study area with major attractions and vehicle charging locations.

Figure 3 - Vehicle Holding Locations and Major Destinations



CONCLUSION

Neighborhood Electric Vehicles (NEVs) have become increasingly popular in the Tampa, Florida area as people become more aware of the benefits of electric vehicles. There has also been a growing trend to incorporate these electric vehicles as circulator systems. These vehicles are being used in Tampa to shuttle patrons from remote parking to special events, and also in the downtown area to connect points of interest. This paper explores developing an implementation plan for a unique point-to-point on-demand public transit circulator system within the downtown core of Tampa, Florida, using electric vehicles.

The service is intended to provide visitors, employees, and residents of the downtown, convenient mobility. The Neighborhood Electric Vehicle (NEV) Program offers an environmentally friendly alternative to driving gas-powered automobiles, and a context sensitive mobility solution to parking and congestion issues downtown. Patrons will be able to access all major attractions in the downtown area without having to use private automobiles. The program would also complement the neighborhood watch activities of the Downtown Guides and complement existing transit service in the area. In-vehicle travel times are expected to be between 16 and 28 minutes for various origins and destinations throughout the downtown core.

An initial Neighborhood Electric Vehicle Program for the downtown core of Tampa, Florida, may consist of a fleet of 15 vehicles, equipped with GPS technology to communicate with drivers and track vehicles. Detailed ridership goals may be established to determine a more detailed estimate of vehicles needed.

A major component of the NEV program will be the dispatcher who is responsible for on-the-spot scheduling of trips when requests are received via telephone or the internet. Both the drivers and the dispatchers must be knowledgeable and costumer oriented in order to facilitate both local patrons and visitors.

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