COTA: Setting the Standard

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Environment, Economy, Development, and Sustainability Capstone

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Abbreviations

ADA: Americans with Disabilities Act

BRT: Bus Rapid Transit

CABS: Campus Area Bus Service (Ohio State University)

COTA: Central Ohio Transit Authority

CTA: Chicago Transit Authority

EEDS: Environment, Economy, Development, and Sustainability

GHG: Greenhouse Gas

ICLEI: International Council for Local Environmental Initiatives

ITS: Intelligent Transport Systems

RTA: Regional Transit Authority (Cleveland)

SCC: Social Cost of Carbon

SOV: Single Occupancy Vehicle

Executive Summary

This report is the result of a semester-long research project for The Ohio State University Environment, Economy, Development, and Sustainability capstone course. The focus of the report was shaped by a partnership between the university and the City of Columbus. In January 2015, the City of Columbus submitted a request for proposals to the capstone course for projects that would support The Columbus Green Community Plan: Green Memo III. Green Memo III is the guiding sustainability document for the City of Columbus from 2015 to 2020. One primary goal of the document is the reduction of greenhouse gas (GHG) emissions from city operations by 30 percent and from community sources by 20 percent by 2020.

All projects came from specific actions under the transportation and energy sections of Green Memo III. These actions were analyzed for potential impacts on GHG emissions reductions and a variety of other benefits and costs. This project is focused on Transportation Objective 5: Reduce the amount of people driving alone to work to from 79% to 70% over the next five years. More specifically, research focused on Action 5: Improve the Central Ohio Transit Authority (COTA) customer experience per the results of the COTA study, by increasing efficiency and appeal through the strategic placement of stops and shelters and the addition of on-board wifi. As the project developed, the scope of the project expanded to a quantitative analysis of the GHG reductions from increasing bus ridership and subsequently decreasing single occupancy vehicle (SOV) use, and a qualitative analysis of potential bus service improvements for COTA to implement.

Project scope and research objectives were shaped by findings from a review of Central Ohio Transit Authority (COTA) and City of Columbus publications. Various potential customer service improvements proposed in COTA planning documents were analyzed, including service

expansions and the use of intelligent transport systems (ITS). Service expansion improvements include expansions of the fixed bus route system and the addition of bus rapid transit (BRT) systems to COTA operations. ITS improvements include bus tracking systems, mobile application development, and other technological improvements to the COTA system.

In addition to the proposed COTA improvements, various other improvements were selected for further analysis from case studies of other public transportation networks, including: bus shelter improvements, wifi systems on individual buses, mobile application development, BRT, and public transportation marketing. The project framework includes four research objectives:

1. Establish a GHG emission baseline of the community transportation sector.
2. Quantitatively analyze the GHG emission reduction potential of achieving Objective 5 and establish estimates of the success of COTA service improvements.
3. Qualitatively explore the targeted customer service improvements in regards to feasibility, cost, and effectiveness in increasing ridership through an analysis of other comparable cities with public transportation fleets incorporating similar improvements.
4. Construct recommendations for prioritization of further improvements of COTA services for potential ridership increases and GHG emission reductions.

The results, as guided by the above four objectives are as follows:

- Accomplishing Objective 5: Goal C of Green Memo III is projected to result in GHG emission reductions of 0.51% to 0.69% of the 2013 community GHG baseline
- Additional SOV rate reductions to 60% and 50% can accomplish sizeable community GHG reductions of up to 1.53% and 2.36% respectively

- Specifically, currently proposed COTA improvements and service expansions are projected to reduce SOV commuting by 1.33%, resulting in GHG emission reductions of 0.10% of the 2013 community GHG baseline
- On-board wifi should not be implemented until better technology is available.
- Real-time bus arrival display signs at bus stops/shelters, public art at bus shelters, a mobile application with real-time bus arrival data, bus rapid transit, and a comprehensive marketing plan are suggested recommendations to improve contributions of Action 5 towards Objective 5: Goal C of Green Memo III and to improve the COTA customer experience.

Introduction

In 2014, the City of Columbus began the process of developing the third iteration of The Columbus Green Community Plan: Green Memo III. This document contains the framework that functions as the guide for Columbus' plethora of sustainability initiatives. Green Memo III includes a set of nine goals related to enhancing the sustainability, livability, and reputation of the city. Each goal is supported by specific objectives, with proposed city actions for accomplishing those objectives. In order to identify and prioritize the most effective actions proposed in Green Memo III, the city is working to estimate the greenhouse gas (GHG) reduction benefits from each specific action. In a partnership with The Ohio State University, the City of Columbus submitted a request for proposals to the Environment, Economy, Development, and Sustainability (EEDS) capstone class in an effort to gather insight on which actions should garner the city's limited human and financial resources. Students were given the choice of analyzing various actions under the energy and transportation sections of Green Memo III. One focus of Green Memo III is the reduction of GHG emissions from city operations by 30 percent and from community sources by 20 percent by 2020. All capstone research projects analyzed the potential contributions of specific actions to supporting their corresponding objectives, while also estimating potential GHG emission reductions of those actions.

COTA: Setting the Standard explores the potential of Columbus area public transportation improvements and service expansions as a strategy for GHG reductions. More broadly, this project analyzes Objective 5: reduce the amount of people driving alone to work to 70% over the next five years. The current baseline for people driving alone to work in Columbus is 79%. As this project developed, the focus shifted to an analysis of the potential GHG emission reductions associated with reductions in single occupancy vehicles, and a broader exploration of potential customer experience improvements COTA could implement to improve service and increase ridership. Due to the limited time frame of this semester research project (approximately three months), the scope of the research was carefully limited to maintain feasibility of deliverables.

Group members conducted a review of pertinent COTA and City of Columbus publications to assist with the generation of project scope and research objectives. Proposed COTA customer service initiatives were drawn from COTA planning documents and dichotomized into two distinct categories of improvements, service expansions and Intelligent Transport Systems (ITS). Service expansion improvements included expansions of the fixed bus route system and the addition of bus rapid transit (BRT) systems to COTA operations. ITS improvements included optimized payment methods, bus tracking systems, mobile application development, and other technological improvements to the COTA system. Key customer service improvements proposed by COTA were selected from this dichotomy for further research. The practices of other regional transit systems were also considered during selection of key improvements. The list of selected transit improvements includes: bus shelter improvements, wifi systems on individual buses, mobile application development, and BRT. Through case study analysis it became clear that marketing of these improvements will be a critical dimension for increasing COTA ridership and accomplishing Objective 5: Goal C of Green Memo III. Therefore, public transportation marketing was also selected as a category of analysis. The guiding framework of the project was delineated through the construction of the following four research objectives:

1. Establish a GHG baseline of the community transportation sector.
2. Quantitatively analyze the GHG emission reduction potential of achieving Objective 5: Goal C of Green Memo III, and establish estimates of the success of COTA service improvements in achieving Objective 5.
3. Quantitatively explore the targeted customer service improvements in regards to feasibility, cost, and effectiveness in increasing ridership through an analysis of other comparable cities with public transportation fleets incorporating similar improvements.
4. Construct recommendations for prioritization of further improvements of COTA services for inducing ridership increases and GHG emission reductions.

Greenhouse Gas Quantification Methodology and Results

Due to the regional focus of COTA operations and the commuting trends of Columbus area workers, data on commuter trends for Franklin County were used to develop estimates of GHG reductions. In order to gauge the effectiveness of reducing SOV commuting as a GHG strategy, a generalized annual carbon footprint of a commuting worker in 2020 was established (Table 1). This calculation followed the guidelines of GHG accounting and reporting outlined by the International Council for Local Environmental Initiatives (ICLEI, 2014). Each worker was assumed to be traveling to and from work in a SOV, with 200 workdays per year assumed per commuter (United States Census Bureau, 2014). Calculations were made for a range of mean travel distances for work commutes, as a specific mean travel distance for commuters in the Franklin County area could not be established. The range of mean travel distances selected captures the national average mean travel distance, as reported by the United States Census Bureau. Each commuter was attributed a GHG footprint corresponding to the 2013 percentage breakdown of gasoline and diesel passenger cars and trucks operated by community members as reported by the City of Columbus in its GHG calculations prepared for Green Memo III. National fuel efficiency estimates per vehicle were sourced from Energy Information Administration projections for the 2020 vehicle stock, as well as non-CO_2 emission rates per vehicle type.

Table 1: Generalized Carbon Footprint of SOV Commuter in 2020

Calculated CO_2e Footprint per Commuter	
Mean Commuter Travel Distances (Miles)	CO_2e Footprint Per Commuter per Year (Metric Tons)
9	1.19
10	1.32
11	1.45
12	1.58

In order to generate estimates for the amount of SOV commuters in 2020, population and demographic information was gathered from the United States Census Bureau and the Ohio Development Services Agency. Labor force participation for individuals ages 16-65 was calculated and applied to the population and demographic projections for Franklin County in 2020 to generate an estimate of the regional workforce in 2020. The baseline SOV commuter rate (79%) was then applied to the 2020 workforce estimate, giving an estimate for the baseline amount of SOV commuters in 2020. Calculations of potential reductions were acquired by applying the results of Table 1 to the amounts of SOV commuters reduced with different SOV rates (Table 2). It is assumed that reductions in SOV commuting require no additional vehicle miles traveled except for those from the expanded COTA services. Therefore, the carbon footprint of COTA operation expansions was netted from the calculated GHG reductions. These net estimates of carbon reductions were monetized using a social cost of carbon (SCC) of $42 per ton. SCC is a monetary representation of the damages resulting from one metric ton of GHG pollution at a 3% discount rate (Interagency Working Group, 2013).

Table 2: GHG Reductions Accomplished Through SOV Reduction with Varying Mean Travel Distances

CO_2e Reduced in Different Solo Occupancy Vehicle Scenarios in 2020 (Mean Distance Traveled in Parenthesis), (Cost of Carbon = $42/ton)			
Solo Occupancy Vehicle	70%	60%	50%
CO_2e Reduced Tons (9)	55,708.02	123,618.37	191,528.73
CO_2e Reduced Tons (10)	62,499.05	137,955.00	213,410.95
CO_2e Reduced Tons (11)	69,290.09	152,291.63	235,293.18
CO_2e Reduced Tons (12)	76,081.12	166,628.27	257,175.41
CO_2e Reduced $ (9)	$2,339,736.77	$5,191,971.69	$8,044,206.61
CO_2e Reduced $ (10)	$2,624,960.26	$5,794,110.17	$8,963,260.08
CO_2e Reduced $ (11)	$2,910,183.75	$6,396,248.65	$9,882,313.56
CO_2e Reduced $ (12)	$3,195,407.24	$6,998,387.14	$10,801,367.03

The 2013 community GHG baseline, as reported in Green Memo III, was 10,901,086 metric tons of CO_2 equivalents (CO_2e). Transportation-related GHG emissions accounted for 3,094,670 metric tons of this overall carbon footprint. Projections for CO_2e reductions accomplished by reducing SOV commuting rates from 79% to 70% ranged from 55,708 to 76,081 metric tons (Table 2), given varying assumptions for mean travel distances. Therefore, this report projects that accomplishing Objective 5: Goal C of Green Memo III will lead to GHG emission reductions of 1.80% to 2.46% from the 2013 community ***transportation*** GHG baseline, corresponding to modest GHG reductions of 0.51% to 0.69% from the ***overall*** community GHG baseline. However, if COTA service improvements and other actions under Objective 5 can reduce SOV commuting beyond 70%, subsequently larger GHG reductions can be accomplished (Table 3).

Table 3: Percent Reductions of GHG Emissions with Different SOV Rates

Percent Reductions of GHG Emissions in 2020 from 2013 Community GHG Baseline (Mean Distance Traveled in Parenthesis)			
SOV Commuting Rate	70%	60%	50%
Percent Reduction from 2013 Community GHG Baseline (9)	0.51%	1.13%	1.76%
Percent Reduction from 2013 Community GHG Baseline (10)	0.57%	1.27%	1.96%
Percent Reduction from 2013 Community GHG Baseline (11)	0.64%	1.40%	2.16%
Percent Reduction from 2013 Community GHG Baseline (12)	0.70%	1.53%	2.36%

The results reported in Table 2 and Table 3 estimate the GHG reduction potential of accomplishing and surpassing Objective 5: Goal C of Green Memo III. In order to predict the potential SOV commuting and subsequent GHG reduction potential of Action 5 specifically, further calculations were developed. COTA's 2015-2019 Short Range Transit Plan provided estimates for projected ridership increases from currently proposed COTA expansions and improvements. Estimates for increased commuter trips in years 2015-2020 were derived from these COTA estimates. Survey results collected by COTA found that 54% of COTA trips were related to daily commuting (Central Ohio Transit Authority 2015). Therefore, 54% of the projected ridership increases in years 2015-2020 were assumed to be additional work based trips from the 2013 baseline.

Table 4: GHG Reductions Accomplished by COTA Service Expansion and Improvements

COTA Ridership Projections and GHG Emission Reductions from SOV Reductions						
	2015	2016	2017	2018	2019	2020
Trips per Year	20,097,113	21,825,172	23,663,493	23,158,722	23,663,493	24,000,000
Trip Increase from 2013	1,797,113	3,525,172	5,363,493	4,858,722	5,363,493	5,700,000
Additional Work Based Trips	970,441	1,903,593	2,896,286	2,623,710	2,896,286	3,078,000
SOV Commuters Reduced From 2013 Baseline	2,426.10	4,758.98	7,240.72	6,559.27	7,240.72	7,695.00
Metric Tons CO_2e Reduced	3,518.84	6,902.46	10,501.98	9,513.61	10,501.98	11,160.88

An annual reduction of 7,695 SOV commuters is projected by 2020. Given that the 2013 baseline of SOV commuters in the region was 576,846, this corresponds to a 1.33% reduction in SOV commuting from the 2013 baseline. From this result, it is estimated that COTA service expansions and improvements can accomplish an annual GHG reduction of 11,160.88 metric tons of CO_2e from projected SOV commuting reductions by 2020, corresponding to 0.36% of the 2013 community ***transportation*** GHG baseline and 0.10% of the ***overall*** community GHG baseline. By monetizing the CO_2e reductions projected in years 2015-2020 in Table 4 with the SCC at 3% discount rate ($42 per ton), it is shown that the SOV reductions achieved by increased ridership of COTA generate climate benefits of approximately $2.2 million dollars (Interagency Working Group 2013). It must be noted that GHG reduction estimates apply to SOV reductions only; GHG reductions from non-commuter ridership increases are predicted, but beyond the scope of this research due to the complexity of identifying subsequent VMT shifts.

Benchmarking Methodology and Results

The calculations above serve to inform decision makers of the projected GHG benefits of COTA improvement and expansion given current ridership projections. However, as shown in Table 2 and Table 3, if SOV commuting is reduced to 70% or lower, subsequently larger GHG reduction benefits can be achieved. The following section explores transit service improvement strategies proposed by COTA and/or utilized by other comparable cities that could be implemented by COTA to induce ridership impacts beyond those predicted in the Short Range

Transit Plan. The following section relied on in-depth benchmarking analysis of carefully selected public transportation networks. The cities that were analyzed were chosen according to demographic and geographic comparability to Columbus. To avoid bias, this report assigned one researcher to each improvement area and required them to identify a best-in-practice improvement strategy. Benchmarks were set using a general set of parameters including public reception, cost, feasibility, and effectiveness. The benchmarks were created in an effort to construct recommendations for prioritization of further COTA improvements and were selected according to their alignment with Action 5: Objective 5: Goal C of Green Memo III. The following strategies could potentially be utilized in tandem with COTA's current improvement plan to improve bus ridership.

Bus Stop Development: Use of Intelligent Transport Systems (ITS) for Real-Time Bus Arrival Display Signs at Stops/Shelters

In 2012, COTA conducted surveys in an attempt to reveal which potential customer service improvements its community stakeholders would most prefer. The results of the survey show that displaying real-time bus arrival times at major bus stops (Figure 1) is the most desired potential customer service improvement (COTA Short Range Transit Plan, 2015). Additionally, the third most preferred service improvement for COTA is the inclusion of real-time bus arrival data accessible through a mobile application.

Figure 1: COTA Customer Service Improvement Survey Results, 2012

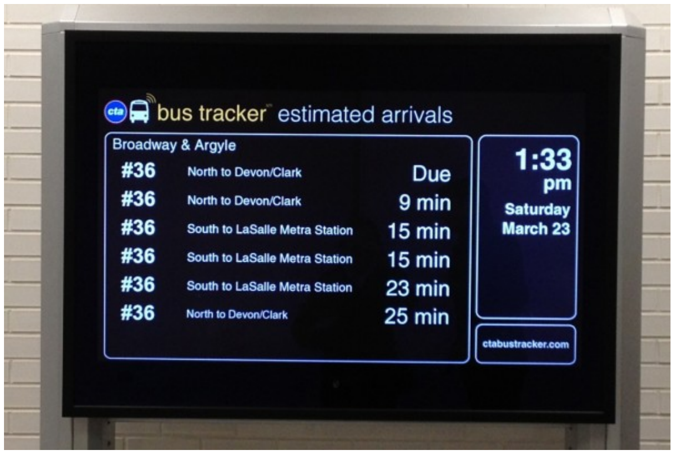
	TOTAL	Transit Users	Non-Personal Vehicle Users	Personal Vehicle Users	Non-Transit Users
Real-time bus arrival times at major bus stops (actual time when the next bus will arrive)	317	188	119	182	*113*
Improved fare payment system (eg. reloadable cards, direct charge "tap" or "swipe" cards)	289	162	90	185	*113*
Real-time bus arrival time data available on the	251	154	90	150	86
More bus stops with shelters	174	120	92	69	41
Improved safety at more bus stops (lighting,	130	73	50	69	46
Benches at bus stops that do not have shelters	90	59	37	47	25
Expanded bicycle capacity on buses	76	48	29	42	23
Expanded use of freeway shoulders for express lines	68	29	20	44	35
More presence of safety personnel on buses and at	64	30	22	36	28
Improved over-the-phone customer service system	43	29	19	22	12
I do not have a preference	39	16	10	27	21

COTA Long Range Transit Plan, 2012.

The technology service required to provide this data to customers (Intelligent Transportation Systems) has recently become more widely accessible and affordable for public transportation networks. The Chicago Transit Authority (CTA) is a leader in the development and installation of ITS supported bus-arrival signs at bus stops and shelters. The CTA currently has 280 CTA Bus Trackers^{SM} installed, and plans to have 420 installed by the end of 2015. The CTA is strategically installing the arrival signs at bus stops and shelters that serve multiple routes and high numbers of riders. It is estimated that the signs installed by the end of 2015 will serve 80% of CTA riders (CTA, 2015).

A recent study from the University of Illinois at Chicago analyzed the impacts of CTA Bus Tracker^{SM} on ridership. The researchers found that the availability of real-time data has increased CTA ridership by approximately 2.2% (Tang, 2012). Though the researchers found that the impacts of ITS supported real-time bus arrival signs only increased ridership by a modest amount, they concluded that the installation of the display signs are important for maintaining current ridership levels. The researchers suggested that modest ridership impacts from real-time services resulted from non-transit users being mostly unaware of the project. For ITS to make a significant positive impact on COTA ridership, it is critical that the real-time arrival bus display installations are advertised to non-users.

Figure 2: CTA Bus Tracker[SM] display signs have had positive impacts on ridership



BlinkTag, 2015

As of 2012, 97 COTA buses have been equipped with the necessary technology to provide real time bus arrival information. However, due to a conversion between two incompatible intelligent transportation systems, the project was never finished. According to the 2012 COTA Long Range Transit Plan, a new system (Trapeze ITS) is under development and will allow for COTA to display real time arrival data at bus stops and shelters. According to the COTA Short Range Transit Plan, "As the Trapeze ITS installation comes to completion, COTA will display 'next bus' information at main transit hubs, transit centers, and other high volume passenger shelters via display panels" (2015). Updates regarding the timeline for the Trapeze ITS project are currently unavailable.

Bus Stop Development: Incorporation of Public Art

The CTA is also a leader in the development of bus stop and shelter aesthetic design. With funding from the Federal Transit Administration, and a partnership with the City of Chicago's Department of Tourism and Culture, the CTA has successfully installed over 50 pieces of public art at bus stations. CTA riders can expect to see mosaics, sculptures, paintings, and other forms of art at various bus stops and shelters. Local artists completed many of the art projects and some have been the result of community engagement projects.

According to the CTA, "The original pieces of artwork contribute to each station's identity and enhance travel for customers. Art promotes a friendly, inviting atmosphere for these stations, which serve as gateways to the communities they serve" (2015). Public artwork is an excellent way to visually enhance the public transportation experience, serve as an education platform, and celebrate culture. It gives communities and the city a sense of identity that bridges gaps between periods of time, people, and ideas. The use of public art at CTA stops and shelters contributes social, economic, and cultural value to both the transportation service and to the city of Chicago. According to the nonprofit organization Americans for the Arts, "Public art activates the imagination and encourages people to pay attention and perceive more deeply the environment they occupy. Public art stimulates learning and thought about art and society, about our interconnected lives, and about the social sphere as a whole" (2010). The benefits of public art could not be captured quantitatively given the scope of this research project, but the positive impacts of art on a community should be recognized as significant and long-lasting.

The financial cost of planning and installing public art specific to the Columbus public transportation network was not calculated for this project due to the wide array of possibilities in regards to funding and project options. A public artwork cost-benefit analysis could be a potential area of future research for COTA. Public art project costs can range from below $60,000 to over $1 million. The CTA has funded many of these projects through grants from the US Federal Transit Administration (CTA, 2015). COTA has a variety of options available to fund these projects. For more detailed information regarding recommendations for COTA to implement public art, see the recommendations section of this report.

Figure 3: Untitled mural at CTA Pulaski Station. Local artist Hector Duarte and Curie High School students painted the mural.

Chicago Transit Authority, 2015

Onboard Wifi

According to the 2012 customer service improvement survey (Figure 1), COTA found wifi to be a top customer service improvement preference. Wifi could contribute to the productivity of commuters by giving them productive work time during their commutes, as opposed to sitting in rush hour traffic. COTA planning documents have suggested that retrofitting the buses with wifi capability could increase ridership, and therefore decrease reliance on SOV travel.

There is not currently a city that has successfully implemented wifi throughout a public bus transportation network. Cities such as San Francisco and Cincinnati tried implementing onboard wifi but eventually removed the systems within two years. Despite the relatively low cost of wifi technology installation ($1,000- $2,000 per bus), there is a significant technological barrier to successful implementation and customer use (Kurtzman, 2008). One key reason that onboard wifi has failed is the unreliable nature of 3G networks (Kapustka, 2012). 3G has typically been plagued by connectivity losses along both short and long distances, especially with even minor elevation changes along bus routes. Wifi connectivity difficulties can potentially make customers frustrated or disappointed with bus service overall.

Kansas City is in the process of implementing a 4G wireless network for the KC Area Transportation Authority buses (Metro Buses Adding WiFi Service To Area Commutes, 2014). With the development of stronger 4G networks, this technology could potentially be a wise investment for COTA, but considering the state of wifi technology for buses, COTA should keep onboard wifi as a low priority until this development has proven successful. COTA should continue to monitor the development of 4G networks in Kanas City.

Mobile Application

The third most desirable customer service improvement for COTA customers (Figure 1) is the development of a mobile application with real-time bus data. COTA should look to partner with Transit App, a private application company that already has a platform built with estimated COTA bus arrival data. Transit App recently added real time data for Baltimore's transit system application and estimated that if Baltimore had allowed access to their ITS data, Transit App could have saved the city about $600,000 by partnering to develop an app. Overall, Baltimore spent $2.7 million to add the technology to the buses so the city could offer an app. If COTA were to retrofit their buses and then try to develop a mobile application, Transit App could potentially save COTA $600,000 if the data were made public (Transit App, 2015). This would keep COTA under budget from the initial allocation of $1 million for ITS improvements (Central Ohio Transit Authority, 2015).

Another option is for COTA to create a partnership with The Ohio State University and work with a capstone class to develop a public transportation real-time arrival app that is specific to COTA. Similar to the EEDS capstone, an engineering, computer science, or transportationoriented capstone course could work on the development of a mobile application that could be implemented by COTA. The most recent COTA planning documents do not contain information regarding the development of a mobile app, and this project could potentially be supported through a strategic partnership with OSU students and the Campus Area Bus Service (which has successfully developed an app that provides real-time bus arrival data to students).

Bus Rapid Transit

Bus Rapid Transit (BRT) is a public bus system that increases the efficiency of bus transportation through a combination of accessible bus stations, dedicated bus lanes, efficient fare collection, passenger information systems, route length and structure, and successful marketing (Community Planning Workshop, 2009). Effective BRT can mimic light rail transit but with lower capital costs and without rail infrastructure (Community Planning Workshop, 2009).

Cleveland began construction on the Euclid Ave BRT in 2008, and currently, the BRT HealthLine has 58 stops within 6.8 miles (Community Planning Workshop, 2009). The three goals for the HealthLine are to: improve transit system efficiency, promote long-term economic and community development, and improve quality of life along Euclid Corridor. Since BRT uses dedicated bus lanes on roadways, traffic congestion has been significantly alleviated along this corridor (Community Planning Workshop, 2009). The implementation of raised platforms for loading and unloading has supported both efficiency and effectiveness of the HealthLine. These platforms are also compliant with the Americans with Disabilities Act, which means that buses no longer have to be hydraulically lowered for disabled riders. Off-board fare collection has significantly increased bus efficiency, as riders are able to pay before bus arrival, and this reduces the time that the bus is stopped. The buses used for the HealthLine are specialized vehicles; there are 21 diesel-electric buses at 62 feet long (Community Planning Workshop, 2009). Other components of the HealthLine include intelligent transportation systems and a strong marketing campaign.

The HealthLine has approximately 15,000-18,000 riders per day and there was an average increase in ridership of 39% overall in the first 13 months of installing the line. The line runs 24 hours a day and the frequencies range from five to thirty minutes depending on the time of day (Community Planning Workshop, 2009).

The extensive nature of the Euclid Avenue BRT project resulted in substantial financial costs. The project cost approximately $168.4 million to install, of which 49% ($82.8 million) came from the Federal Transit Authority (Community Planning Workshop, 2009). The next largest funder was the State of Ohio, which funded 30% ($50 million) of the project. The Cleveland RTA paid for 10% ($17.6 million) and the Northeast Ohio Areawide Coordinating Agency funded 6% ($10 million) of the BRT. The City of Cleveland itself spent 5% ($8 million) to support the project. The Cleveland Clinic and University Hospitals bought the naming rights of the route. These entities will pay $6.25 million a year for the next 25 years to keep the namesake, and these funds will be used for maintenance of the BRT (Community Planning Workshop, 2009).

The development and installation of the BRT in Cleveland required significant planning and financial support, and the city has already seen tremendous results. The BRT has increased public transportation ridership and the Institute for Transportation & Development Policy has recognized Cleveland nationally as a leader in public transit. According to the Institute, the HealthLine is “the best example of the BRT concept in the United States” (Miller, 2013). As COTA moves forward, developers should continue to look to Cleveland’s BRT as a practical case study in implementing a successful BRT program. If ridership increases due to BRT, then it would be expected that GHG emissions for the city would be reduced.

Comprehensive Marketing Plan

COTA planning documents do not yet have a comprehensive marketing campaign for the proposed customer service improvements to the bus system. COTA plans to develop bus service amenities in order to increase ridership, but these improvements will not be recognized or utilized without a successful marketing plan aimed at non-users. The Greater Cleveland Regional Transit Authority (RTA) has an extensive marketing plan that has been credited with significantly improving bus ridership. Marketing is a critical component for COTA to capitalize on the benefits of implementing customer service improvements.

Cleveland's marketing campaign branded the new BRT line with two main components: the BRT system would be similar to a light rail system and BRT stands for "Better Rapid Transit" instead of Bus Rapid Transit (Bitto, 2011). The rail-like aspect of the BRT was branded as a first-class way of travel; as a simpler, faster, and more convenient mode of transportation that promotes economic development (Bitto, 2011). The Cleveland RTA worked on branding the name of the BRT in attempt to increase ridership. Before the HealthLine was the designated name of the BRT the route was called the "Silver Line" (Bitto, 2011), which Cleveland thought would give the line a futuristic sound and imply that premium service would be provided (Bitto, 2011). The images used to convey the similarities between rail and the new BRT used the new buses as a focal point and promoted BRT as futuristic.

Figure 4: BRT Image

Bitto, 2011

It is imperative that COTA develop specific advertisements for service improvements for ridership to increase as a result of the improvements. More people will ride only if they are made aware of the new service improvements.

Recommendations

COTA: Setting the Standard recommends that COTA focus on the following strategies:

- Installation of real-time arrival signs at bus stops and shelters. The installation of ITS supported real-time bus arrival display signs has proven to increase ridership for public bus systems (CTA, 2015). According to COTA customer surveys, this has continued to be the top requested customer service improvement.
- Furnishing public artwork at COTA stops and shelters. COTA could implement public art at stops and shelters through a partnership with Transit Arts. Transit Arts is a program of the Columbus Central Community House that promotes youth involvement and education in creative arts. There is also potential for COTA to work with local Columbus artists, art/design colleges, and the Greater Columbus Arts Council. The Federal Transit Administration has funded recent CTA art projects, and COTA could pursue a similar strategy for financing public art installations in Franklin County. Additionally COTA could pursue a percent for art program, which is a program for development projects (such as

transportation projects) that set aside a specific percentage of the budget (typically 1%) for the development of art works (SheppardMullin, 2015).

- Utilize Transit App's mobile platform or work with Ohio State capstone students to develop a similar mobile application. This app should offer real-time data and specific bus route details and maps and could be based off the OSU CABS mobile application.
- Plan and develop more BRT lines. Bus Rapid Transit has been extremely successful in Cleveland and contributes to the efficiency, effectiveness, and appeal of public transportation. BRT development could have significant positive impacts on COTA ridership.
- Develop a comprehensive marketing plan. COTA should couple customer service improvements with a strong marketing campaign to improve ridership.

Despite initial interest expressed within the COTA customer survey, this report suggests that COTA not implement on-board wifi until the technology and service become more reliable.

Conclusions

Improving the COTA customer experience is expected to increase public transportation use and subsequently decrease the number of commuters who drive to work alone. This report projects an *overall* 0.51% to 0.96% reduction in community GHG emissions from the 2013 baseline. Of the ultimate goal of a 9% reduction from 79% to 70% in SOV commuters, COTA improvements could potentially decrease the SOV commuters by 1.33% and GHG emissions by 0.10%. Further expansion and more improvements could generate additional ridership increases, expanding COTA's contribution to Objective 5 and potentially reducing SOV commuter rates to levels that accomplish higher GHG reductions (Table 2 and 3).

In order to maximize COTA's contributions to achieving Objective 5 and beyond, this report benchmarked comparable cities to Columbus, Ohio. These benchmarks have been created in an effort to construct recommendations for prioritization of further COTA improvements. The following table outlines the improvements that were benchmarked alongside their correlating city and priority level.

Table 5: Comparison of COTA improvements by priority level and cost with case study suggestions

Improvement	**Priority Level**	**Cost**	**Case Study**
Bus Stop Development: Use of (ITS) for Real-Time Bus Arrival Display Signs at Stops/Shelters	High	Medium	Chicago (CTA)
Bus Stop Development: Incorporation of Public Art	High	Potentially low	Chicago (CTA)
Onboard Wifi	Low	Medium	Kansas City (KCATA), Cincinnati (Metro), San Francisco (SFMTA)
Mobile Application	High	Medium	Baltimore (MTA), OSU (CABS)
Bus Rapid Transit	High	High	Cleveland (RTA)
Comprehensive Marketing Plan	High	Low	Cleveland (RTA)

Improving customer experience will also encourage qualitative benefits not reflected in the social savings from GHG emissions reductions. By benchmarking comparable cities to Columbus, this project has highlighted some of the more intangible benefits of increased bus transit ridership. In most cases, public transit improvements have encouraged economic development and job growth while residents enjoy the benefits of less congestion and more community interaction. It should be noted that these benefits are not explored exhaustively within this report but they serve as important factors in the decision to improve the COTA customer experience.

Due to time constraints the scope of this project was kept fairly narrow. The authors openly acknowledge that further research must be completed in order to accurately describe the full benefits associated with a highly utilized bus service.

Areas of further research

- A more comprehensive study to determine how strategic stop placement may impact community access to COTA and COTA services.
- Investigate possible partnerships and funding opportunities to support public art installations at COTA bus stops and shelters. Perform a public artwork cost-benefit analysis.
- Determine if COTA can partner with OSU capstone students to develop a mobile application that provides users with real-time bus arrival data.
- Perform research on the feasibility of commuters to work while in-transit on the bus. If wifi were available on buses, it would represent significant time savings associated with traffic avoidance.
- Identify the potential for community engagement beyond marketing (Cleveland) through concert events, ribbon cutting events, and new bus displays.
- Research social equity discrepancies associated with an increase in COTA ridership. Will an increase of ridership push out people who solely depend on COTA for transportation?

- Identify avenues to increase ridership further from the city by building more park and ride areas and making stops more available.
- Develop and submit a survey to large employers in downtown Columbus that can be distributed to employees who currently commute to work from outside of the city. This survey can be used to better understand the SOV commuter mindset for marketing purposes. Columbus companies could also use the survey to develop public transportation incentive programs for employees.
- Research programs for companies to incentivize employee use of public transportation instead of single occupancy vehicle travel to and from work.

Literature Cited

Bitto, Stephen J. BRT Branding Strategy "The HealthLine." Retrieved March 29, 2015, From: http://sustainablecommunitiesleadershipacademy.org/resource_files/documents/Bitto-BRT-Branding-Strategy.pdf

BRT Branding, Imaging and Marketing. (2010, March 1). Retrieved January 29, 2015, from http://www.apta.com/resources/standards/Documents/APTA BTS-BRT-RP-001-10.pdf

Central Ohio Transit Authority. (2015). Short-Range Transit Plan 2015-2019 Draft. Retrieved March 1, 2015, from http://www.cota.com/COTA/media/PDF/SRTP/SRTP_All_Sections-v12_DRAFT.pdf

Energy Information Administration. (2015). *Annual Energy Outlook 2014*. Retrieved from website http://www.eia.gov/forecasts/archive/aeo14/.

Energy Information Administration. (2015).*Environment*. Retrieved from website: http://www.eia.gov/environment/

Engineering & Project Management Division Programming & Planning Department. (2004, December 1). TRANSIT 2025 Long Range Plan. Retrieved February 1, 2015, from http://www.riderta.com/sites/default/files/pdf/transit2025/TRANSIT_2025_March_2006_Final.pdf

ICLEI (2014). *U.S. community protocol for accounting and reporting of greenhouse gas emissions.* Retrieved from website: http://www.icleiusa.org/tools/ghg-protocol/community-protocol

IBI Group (2014). *Transit System Review Service and Bus Network Plan*. Retrieved from http://www.cota.com/COTA/media/PDF/TSR/TSR_COTA_-Final-Report_2014-corrected-12_9_2014.pdf

Interagency Working Group on Social Cost of Carbon, United States Government (2013) Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis -Under Executive Order 12866. Retrieved from website: https://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf

Kapustka, P. (2012, August 16). Wi-Fi on Buses and Trains: Better Service Ahead. Retrieved March 29, 2015, from http://www.pcworld.com/article/260976/wi_fi_on_buses_and_trains_better_service_ahead.html

Kurtzman, L. (2008, April 11). More cities offer Wi-Fi on buses - USATODAY.com. Retrieved February 24, 2015, from http://usatoday30.usatoday.com/tech/wireless/2008-04-10-wifi_N.htm

Metro Buses Adding WiFi Service To Area Commutes. (2014, February 27). Retrieved March 19, 2015, from http://www.kcata.org/news/metro_buses_adding_wifi_service_to_area_commute

Mid-Ohio Regional Planning Commission. (2013). *2012-2035 Metropolitan Transportation Plan*.

Miller, J. (2013, November 10). Greater Cleveland RTA is riding wave of momentum. Retrieved March 28, 2015, from: http://www.crainscleveland.com/article/20131110/SUB1/311109977/greater-cleveland-rta-is-riding-wave-of-momentum.

RTA. (2012, January 1). Imagine RTA - Strategic Plan 2010 - 2020. Retrieved February 1, 2015, from http://www.riderta.com/strategicplan.

SheppardMullin. Public Art Programs: 1% for the 99% - Part One | Art Law Blog. (2012, October 10). Retrieved April 27, 2015, from http://www.artlawgallery.com/2012/10/articles/artists/public-art-programs-1-for-the-99-art-one/.

State of Ohio, Development Services Agency. (2013).*Population characteristics and projections*.
Retrieved from website: http://development.ohio.gov/reports/reports_pop_proj_map.htm

Tang, L., & Thakuria, P. (2012). Ridership effects of real-time bus information system: A case study in the City of Chicago. *Transportation Research Part C: Emerging Technologies*, *2*, 146-161.

Transit App. How We Saved Baltimore Taxpayers $600,000 in One Day. (2015, February 24). Retrieved March 27, 2015, from http://transitapp.com/blog/saved-baltimore-600k

University of Cincinnati Economics Center. (2013.*A Peer City Public Transportation Review: Evaluating Metro's Operational Efficiency, Service Capacity, and Fiscal Impact*. Southwest Ohio Regional Transit Authority.

United States Census Bureau, American Community Survey Office. (2015). *American community survey*. Retrieved from website: http://www.census.gov/acs/www.

Why Public Art Matters. (2012). Retrieved April 27, 2015, from http://blog.artsusa.org/artsblog/wp-content/uploads/greenpapers/documents/PublicArNetwork_GreenPaper.pdf.

Appendices

- Dataset #1: Pop_And_Commuter_Trends.xlsx
  - Sources: http://development.ohio.gov/reports/reports_pop_proj_map.html
  - http://www.census.gov/en.html
  - ICLEI City of Columbus Online Database
  - Description: Population and demographic projections for Franklin County in years 2013 and 2020, along with assumptions for percentage breakdown of light duty vehicle ownership.
- Dataset #2: greenhousegas.xlsx
  - Sources: https://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/technical-update-social-cost-of-carbon-for-regulator-impact-analysis.pdf
  - http://www.eia.gov/environment/
  - ICLEI City of Columbus Online Database
  - Description: Data on greenhouse gas emissions, including the social cost of carbon, utilized in the construction of commuter carbon footprint estimates. Also includes estimates of non-CO_2 GHG emission rates and CO_2 intensity per gallon of fuel.
- Dataset #3: LDVFuel_Efficiency.xlsx
  - Sources: http://www.eia.gov/forecasts/archive/aeo14/
  - Description: Projections for vehicle fuel efficiency in years 2013-2040, including estimates for MPG of new vehicles and existing vehicle stock.
- Dataset #4: COTA_Expansion
  - Sources: http://www.cota.com/COTA/media/PDF/TSR/TSR_COTA_-Final-Report_2014-corrected-12_9_2014.pdf
  - http://www.cota.com/COTA/media/PDF/SRTP/SRTP_All_Sections-v12_DRAFT.pdf
  - Description: Estimates for increased service hours and ridership from planned service expansions by COTA in years 2015-2019.