SMARTCOLUMBUS

Common Payment System

Benchmarking Report

THE OHIO STATE UNIVERSITY

School of Environment & Natural Resources
Spring ENR4567 Capstone

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1.0 Executive Summary

Our Ohio State student team is helping Columbus reach its goal of becoming a smart city by researching common payment systems for transportation and multi-modal applications in the United States and Europe. A common payment system is a system that allows users to pay for multiple modes of transportation through one app, card, etc. The completion of this goal is valuable to Columbus because the application will benefit residents by providing various types of transportation services including the ability to create and plan trips. The multi-modal trip planning application will provide travelers with a set of alternative transportation options, which includes routes, schedules, and dispatching options. The common payment system will allow users to have convenient access to many forms of transportation available in Columbus. We have created a benchmark analysis of five implemented payment systems from other cities: Seattle, Portland, San Francisco, Chicago, and Leipzig. We have collected qualitative and quantitative data from each city, identified barriers through a survey of the Linden area, contacted city representatives from the case cities, and collected ridership data. After collecting data from the five cities, we found information relating to ridership numbers, issues with common payment systems, ideas for accommodating disadvantaged people, obstacles each city has faced, adoption barriers, and advice for Columbus when implementing the program.

Implementing a common payment system will not likely increase the number of riders using public transportation, but the system will make transit options more accessible to customers. Many of the obstacles our case study cities faced were customer usability and adoption. Therefore, many rounds of testing were strongly recommended. Because of our research and data collection, we recommend a common payment system that includes a mobile

app and a reusable card that can be reloaded by Columbus vendors. This combination of payments will help decrease the amount of discriminatory access and benefit all types of users.

2.0 Introduction

Columbus, Ohio received a federal grant from the Department of Transportation in the summer of 2016 to transform the city into a "smart city." Columbus aims to instill innovative technology for its citizens in order to achieve smart, sustainable transportation and energy consumption. While the federal grant initiated the project, many local businesses have also contributed funds (and are still contributing) to the development of the Smart Columbus project, allowing the project to expand. The Ohio State University has been a key contributor to this development and has invited students and faculty to perform research in collaboration with Columbus city officials. The capstone course (ENR 4567, Spring 2017) for the Environment, Economy, Development, and Sustainability major at Ohio State's School of Environment and Natural Resources performed research on various components of the Smart Columbus projects.

The Smart Columbus team has identified the Linden neighborhood as an area in need of improvement for transportation access and has required a common payment system to be successful in Linden before it can be considered successful for the rest of Columbus. Our team sought to identify the needs of Linden, as our focus, and evaluated whether or not a common payment system would be beneficial. Then, our team researched other cities that have already implemented a common payment system with access to various modes of transportation. We then benchmarked and compared our findings of other cities' current payment systems. City payment systems were benchmarked based on sustainable principles such as: providing wide spread access, profitability, effectiveness, and environmental stewardship. The results have been highly informative and we found that multiple payment systems, such as a multimodal app and a

reusable card, are more accessible and may potentially be more sustainable. We found introducing a common payment system will not likely increase ridership outside of population growth, but it will likely increase transportation revenue. As a result, we have recommended that Columbus implement more than one payment system, preferably a reusable card in combination with an app. However there are more recommendations that can be found in section 7.0 Overall Recommendations.

3.0 Research

Data for this project were collected by analyzing survey results, profiling case study cities, evaluating ridership data from those cities, and interviewing city representatives. For each case city, quantitative data were collected from online sources, such as the U.S. Census Bureau and each city's regional ridership data. The Linden surveys were a collection of surveys created and distributed, by Columbus and Linden officials, in a town hall style meeting for a focus group that was held on February 10, 2017. Our team was not present at the meeting at the request of city officials to keep the focus group comfortable, but information was given to us later by a city official through email. Qualitative data were collected through personal phone interviews with experienced representatives in each case city.

4.1 Methodology

The focus of the project was to find the most appropriate common payment system for Columbus by tailoring special attention to a struggling neighborhood called Linden. Our team collected survey results from Columbus city officials in order to confirm the need for a common payment system. These survey results are discussed in section 4.23 Linden Results. Next, we choose case cities based on their current common payment systems and profiled them accordingly in comparison with Columbus, in section 4.3 Case Cities Profile. Afterwards, we

attempted to interview representatives from each case city to gather insight on the characteristics, successes, and failures of their payment systems, discussed in sections 4.31-4.35. Then we proceeded to benchmark each payment system based on parameters such as: accessibility, flexibility, profitability, safety, effectiveness, and sustainability in section 5.0 Discussion. Once the benchmarking process concluded, our team provided a recommendation for the city of Columbus to take into consideration in section 7.0 Recommendations.

4.2 Columbus Transportation

In this section, our team analyzed the status of Columbus transportation offerings. Currently Columbus offers various forms of transportation, however, it does not offer a light rail, making Columbus unique for its size. Figure 1 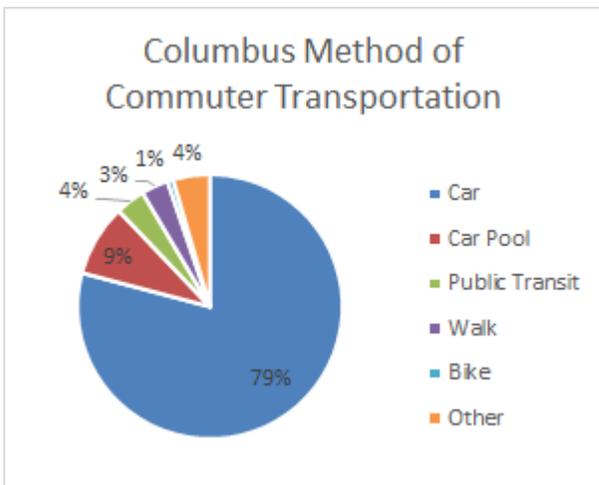represents the current trends in commuter transportation for the Columbus region; a strong majority of commuters prefer driving alone (USA Data). The Central Ohio Transit Authority (COTA) provides bus services throughout Franklin County, Delaware, Fairfield, Licking and Union Counties. In addition to their regular bus service, COTA offers CBUS, a free circulator in downtown Columbus, and COTA AirConnect, a route that connects the John Glenn International Airport and downtown (Experience Columbus, 2017). COTA is also in the midst of rerouting across the Columbus region, which may influence current ridership trends. In recent years, Columbus has expanded bike lanes and bike sharing programs such as CoGo, E.C.T. Pedicab (bike taxi) and Zagster (exclusively in the Ohio State University campus area). Moreover, Columbus also features car sharing and taxi services including: Car2Go, Uber, Lyft, Yellow Cab and Orange

Figure 1. Source: USA Data

Cab. Currently, there is a COTA app and a My Columbus app that provides trip planning but not real time tracking.

4.23 Linden Results

The Linden neighborhood lies in between I-71 and I-270, northeast of downtown Columbus. Figure 2, represents a map of Linden relative to Columbus. Linden mostly consists of low income housing, and lacks nearby grocery stores and other businesses, thus creating a need for transportation access. The city of Columbus held a meeting on February 10, 2017 where surveys concerning the Smart Columbus
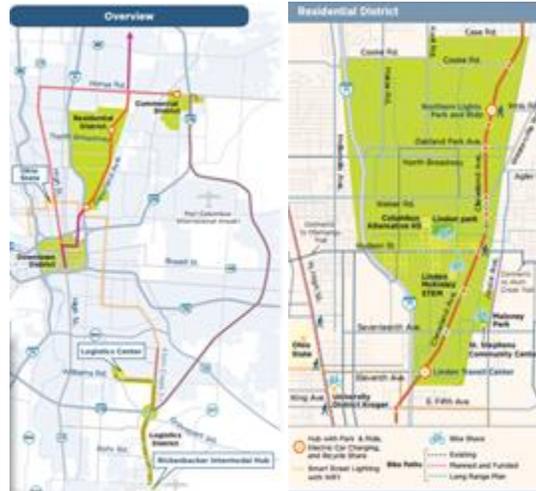
Figure 2. Source: Ryan Bollo

project were distributed. Survey results are displayed in Figure 3. The surveys revealed that a strong majority of residents have transportat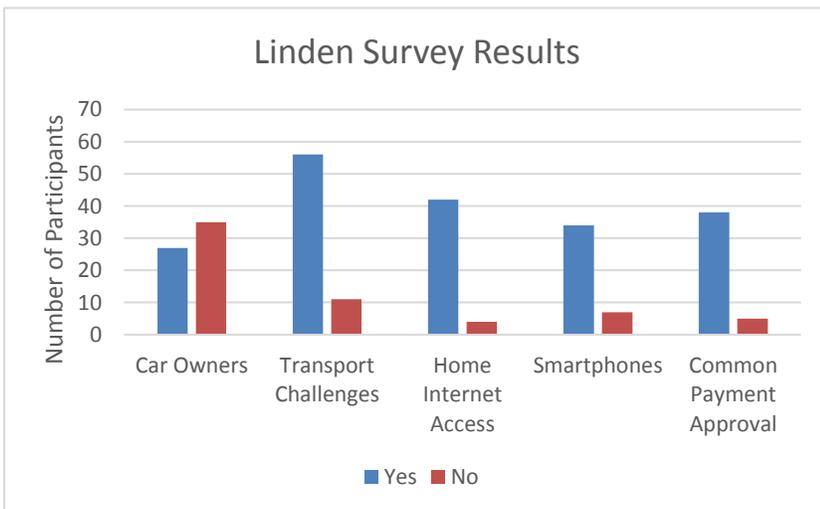ion issues in their current situation and a little more than half do not own a car. About 48% of residents are cash based rather than utilizing credit or debit cards (Linden, 2017). Those who disapproved of the app stated that they have online payment safety concerns. These

Figure 3. Source: City of Columbus Linden Town Hall Surveys

surveys only indicate a sample size of the Linden area, and for many questions including payment methods, smartphone users, and home Internet access, about ⅓ to ½ of participants did not respond to these portions of the survey. Many of the respondents also reported public

transportation as unaffordable and claimed to have safety concerns with public transportation in Linden (Linden, 2017). These concerns reveal deeper issues that need a remedy beyond a common payment system's capabilities.

4.3 Case Cities Profiles

Each case city was chosen based on their current common payment system. Descriptions of each city's demographic, transportation, and economic profiles were gathered to compare and contrast with Columbus. While Midwestern cities would have been preferred, most Midwestern cities do not have a common payment program; this forced our search to expand to other areas of the United States. Three out of the five cities (San Francisco, Seattle, and Portland) chosen are located along the west coast. One city Chicago, is a mega-city, and the only city located in the Midwest. Lastly, the one international city chosen was Leipzig, located in Germany, in hopes to gain foreign insight and ideas. Table 1 illustrates the demographic quantitative data collected to compare to the city of Columbus. These statistics help identify variables that might influence

Table 1: City Demographics

	Columbus	Portland	Chicago	Seattle	Leipzig	San Fran
Population	850,106	632,309	2,720,546	684,451	579,530	864,816
Average Income/capita	$24,990	$32,938	$31,641	$45,673	€ 65,208	$52,220
Poverty Rate	21.7%	18.0%	27.3%	13.5%	N/A	13.2%
Unemployment Rate	3.8%	4.4%	6.0%	4.9%	8.7%	3.0%
Avg. Commute Time (min)	21	24.2	33.4	26.5	N/A	31.7
Method of Travel (Car%)	79.1%	57.2%	49.5%	48.5%	N/A	49.0%
MoT (Car Pool%)	8.8%	8.2%	7.6%	7.4%	N/A	18.0%
MoT (Public Transit%)	3.6%	13.4%	28.3%	21.0%	N/A	28.0%
MoT (Walk%)	3.3%	6.0%	6.7%	6.8%	N/A	19.0%
MoT (Bike%)	0.7%	7.0%	1.8%	4.0%	N/A	1.0%

Sources: U.S. Census Bureau, USA Data, U.S. Bureau of Labor Statistics, Leipzig Facts and Figures

residents' transportation preferences outside a common payment system's influence. These statistics also provide baseline comparisons to Columbus. Unfortunately, it was not possible to find a breakdown of the different travel methods used by Leipzig residents; however, based on the number of residents and registered cars it can be assumed that every third person in Leipzig

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owns a car (Leipzig Facts and Figures, 2016). Portland shows more similarities to Columbus than the other case cities, except for size.

For qualitative data collection, only three of the chosen cities (Portland, Chicago, and Leipzig) were successfully contacted and interviewed. These qualitative data are discussed below.

4.31 Portland, Oregon

Portland, Oregon is well known for being a progressive west coast city that invests heavily in sustainable initiatives. Portland has no shortage of transportation options for this growing city including: bus, light rail (MAX), commuter rail (WES), streetcar, and paratransit, which are all managed by TriMet (TriMet, 2017). Other services available include: bike sharing (BIKETOWN by Portland Dep. of Transportation), car sharing (Car2Go, zipcar, Getaround, and RelayRides), Uber, Lyft, and taxis (4 Best, 2015; TriMet, 2016).
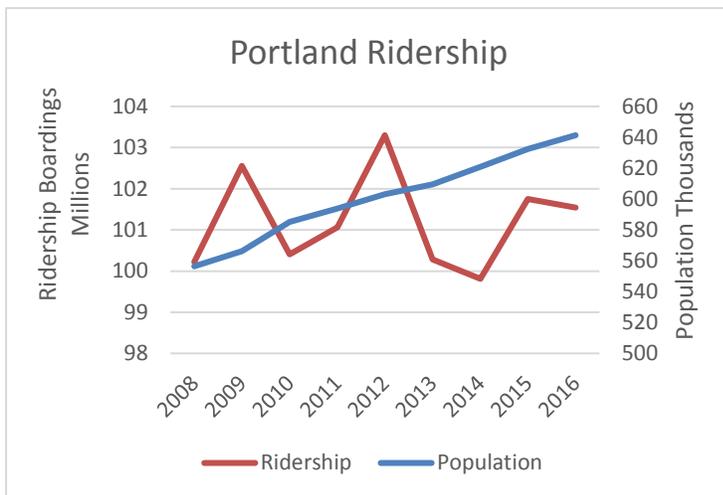

Figure 4. Source: U.S. Census Bureau, TriMet Ridership Performance

Portland currently has a common payment application called the TriMet app. The TriMet app was an idea proposed by a local software developer (Mooval North America, formerly GlobeSherpa) in Portland who approached TriMet with the idea of mobile ticketing through electronic devices (TriMet, 2014). From an interview with a TriMet employee (TriMet administrative office employee who works with the app; name not obtained), the initiative for this innovation was to support the local business and try a new product. The app was launched in 2013, and required little effort to implement city-wide since

thousands of users downloaded the app in a short period of time (TriMet, 2014). Payment to purchase tickets must be made by card, (Visa, Mastercard, or American Express) while other
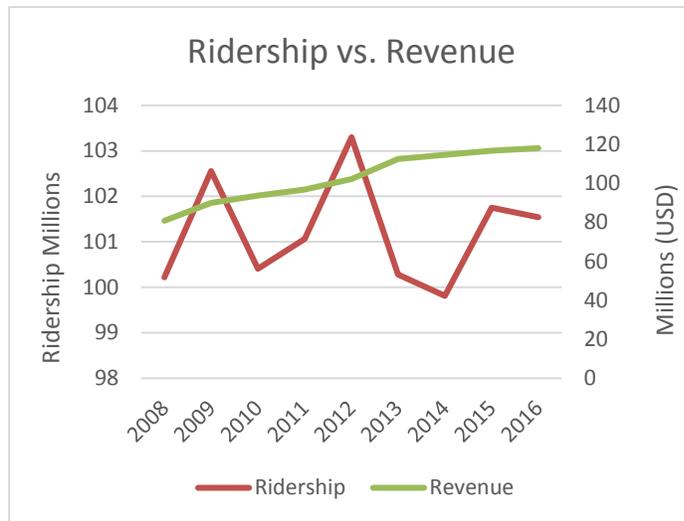

Figure 5. Source: TriMet Ridership Performance

forms require a kiosk. The TriMet app also provides trip planning and real time service for its users. Various ticket packages are available spanning from hourly rates to 1 year (TriMet). Initially, the app allowed riders to purchase only from TriMet services, such as bus and train. However in the last year, RideTap was launched within the app to allow riders' access to Lyft, Car2Go, and BIKETOWN (TriMet, 2016). TriMet has profited in the last 3½ years (Figure 5); however, ridership has not increased drastically in comparison to population growth, indicating ineffectiveness (Figure 4) (TriMet, 2016). Although the app has been fairly successful, the TriMet representative did report functional issues with a third party's inability to pay for the primary user's ticket. Additionally, the city had issues with anonymous users requesting a refund. Even though the app has been useful and expansive, a new e-fare system called Hop Fastpass will launch soon in 2017 (T, 2017). This new common payment system will allow users to load money on a reusable card through electronic devices and by local retailers (T, 2017). Since this new system has yet to launch in the near future, many of its effects are yet to be determined and will need further research.

4.32 San Francisco, California

The west coast city of San Francisco California is a famous tourist destination and known for its sustainable values, which transfer into wide use of public transportation. San Francisco is a high tourism city that receives much more traffic than Columbus; although some statistics are similar, the infrastructure in San Francisco is more established. The transit options covered by the San Francisco Municipal Transit Agency (SFMTA) include: 54 bus lines, 17 trolley bus lines, 7 light rail lines, 3 cable car lines, 2 street car lines (SFMTA), as well as 35 bike share stations. There are also 24 taxi companies and ride sharing programs such as Uber and Lyft, which are very popular in the area. Most of these transit options can be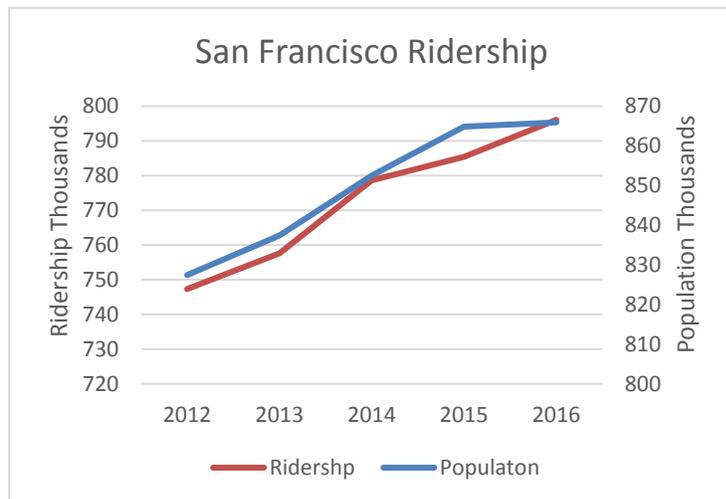 paid and planned for by using the Munimobile app or the Clipper Card, which is available for online purchase or at certified retailers.

The Munimobile app gives you the ability to pay for single-ride fares, cable car rides, and one-day, three-day and seven-day passports. It also allows for trip planning through the app using Google technology (SFMTA 2015). The Clipper Card is an all-in-one transit card for the whole Bay Area; this means that the card holds transit passes, cash value, parking value or any combination of

Figure 6. Sources: U.S. Census Bureau, SFMTA

Figure 7. Source: SFMTA

the three. The card also works on multiple transit systems, such as Muni transit in the downtown area and outside the city with companies like Caltrain and BART. Clipper also offers discounts for youth, seniors, and people with disabilities (Clipper, 2017). These two items work together in San Francisco to make transit easier to pay for and navigate. Furthermore, there is potential for the clipper information and the Munimobile app to be combined in order to further streamline transit in the area. Unfortunately, we were unable to establish contact with any San Francisco representatives to collect details of insight on their common payment systems.

4.33 Seattle, Washington

Seattle, Washington is one of America's largest Northwestern cities. The public transportation options available in Seattle are bus, ferry, rail, and train. Seattle offers a reusable card called ORCA, which can be obtained through a kiosk, as their transportation common payment system. The ORCA card allows you to use commuter options in any combination. It is accepted on Community Transit, Everett Transit, King County Metro Transit, Kitsap Transit, Pierce Transit, Sound Transit, and Washington State Ferries (Accountability KCM). The ORCA card is a value-added, reusable card that you can use to pay for the previously stated transportation options. There are multiple loading options with the ORCA card; one option is the

E-purse. This allows you to put as much money as you would like onto the card, and it is used like a debit card – every fare due for your ride is deducted from your card balance ("Orca Product," 2016). The E-purse option can be used in combination

Figure 8. Sources: U.S. Census Bureau, King County Metro

Figure 9. Source: King County Metro

with a pass. A regional pass allows you to travel on any of the transportation services in the region for one calendar month. There are various trip values you can chose from for unlimited rides throughout each of the transits and ferries. ORCA also offers a regional day pass. They also offer a regional day pass at a reduced fare for eligible seniors, disabled persons, low income residents, or youth riders. Finally, ORCA allows the purchase of agency passes. These passes allow payment only on designated systems, such as Everett Transit, Kitsap Transit, King County Metro Transit, Pierce Transit, and Washington State Ferries ("Orca Product," 2016).

ORCA was implemented in 2009. As seen in figure 8, the ORCA card has not affected ridership behavior and appears to grow at a similar rate to population growth. The relationship between revenue and ridership is shown in Figure 9, where ridership appears to grow faster than revenue (Accountability KCM). This could mean that transportation is getting cheaper and could be attributed to the ORCA card and its economically conscious options.

ORCA utilizes retailers and ticket vending machines in order to add value to the card. Value can also be added to the card online or by participating retailers throughout each county. It takes 24-48 hours for the value added online, by phone, or by mail to be available for use. Kiosks are located at transit centers, surrounding commuter rail station, and link light rail stations. Kiosks also allow you to buy a single trip or round trip train ticket (King County Metro).

There currently isn't an app that is linked to the ORCA card. However, according to Seattle Transit Blog, the second generation of ORCA, or ORCA2, will go into effect in 2020 (Viriyincy, 2015). The biggest change will be the switch to an account-based system. This allows transactions to be processed in real time. This could potentially call for the creation of an app, similar to apps connected to bank accounts where you can deposit money and make payments (Viriyincy, 2015). Unfortunately, we were unable to establish contact with Seattle representatives to gain further insight on the ORCA card.

4.34 Chicago, Illinois

The Midwestern city of Chicago, Illinois is well-known for their use of public transportation to and around the metro area. The transportation options available in Chicago are: CTA, Metra, and Pace. Other transportation services include: bike sharing (Divvy), car sharing, Uber, Lyft, and taxis.

The common payment system available in Chicago is called Ventra. Currently, Ventra includes the Metra, Chicago Transit Authority, and Pace buses (Ventra Chicago). In the next year, they will be adding a bike-sharing program called Divvy to the common payment system. Additionally, the Chicago Transit Authority has considered Uber and Lyft, but that is far away from being implemented due to the nature of the relationship. When Ventra was first launched, the system was simply account based. A customer could use a contactless bankcard, a reloadable Ventra card, or paper tickets from a kiosk (Ventra Chicago). Fortunately, we were able to reach a Chicago representative who was willing to share their insight on implementing a common payment system. In November 2015, they implemented a phone application to complement the system. The common payment system did not increase ridership, but it did change the way users pay. Ventra increased the different modes of transportation that riders utilized. Since Ventra was

one of the first common payment systems, they endured many problems with customer behavior and adoption. Because there are many forms of payment, the Ventra system could not differentiate between payments cards when customers simply tapped their wallet on the screen. Therefore, Ventra implemented more communication to the user to pull out which card they would like to use. The Chicago representative, Jackie Diaz from Chicago Transit Authority,
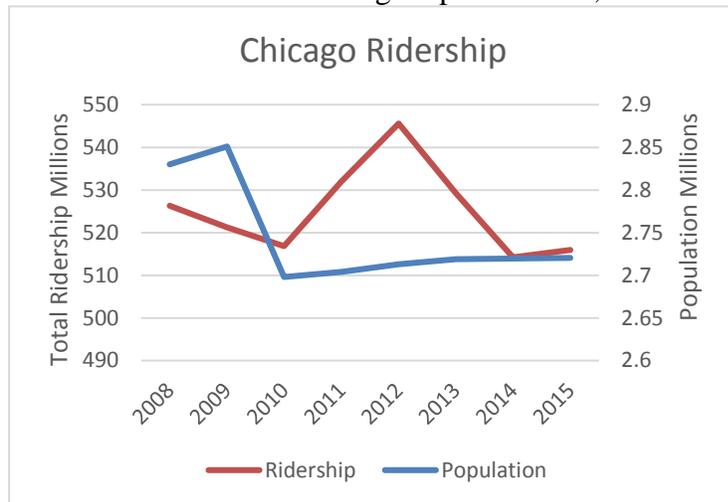

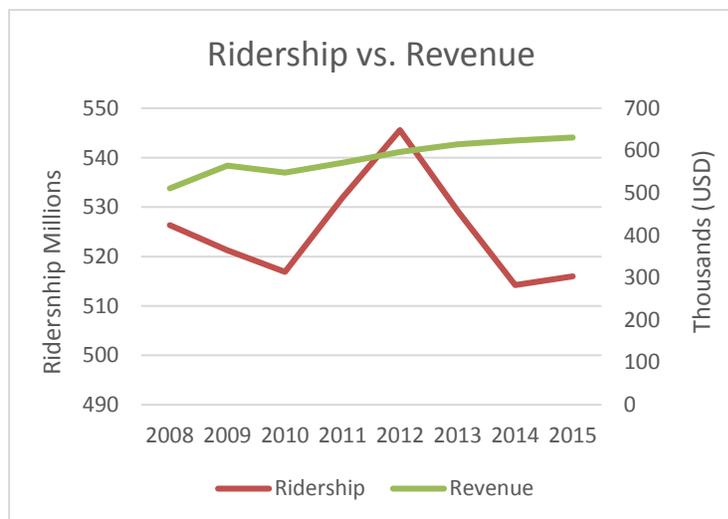Figure 10. Sources: U.S. Census Bureau, Chicago Transit Authority

advised that cities utilizing this technology should ramp up beta testing to ensure there are no issues. Their residents were frustrated by all of Ventra's adoption mistakes, and they were not happy in the beginning processes. On the other hand, Chicago's Ventra system did incorporate many social aspects to their program. Ventra accommodates disadvantaged people, such as senior citizens, cash-based individuals, and low-income citizens through a series of programs. Ventra adapted to cash-based individuals through a reusable

Figure 11. Source: Chicago Transit Authority

Ventra card that can be reloaded at 1,300 different retail stores. All of these retail stores are located within 1/3 of a mile of bus and train stops. Additionally, there are specifically mandated reduced fare programs through the Regional Transit Authority to accommodate lower-income

populations and senior citizens (Diaz). In conclusion, the city representative recommended an app because "everyone loves an app," but she also recommended spending time testing the app and the payment system because it can only be launched once. She emphasized starting small and avoiding unobtainable deadlines. The city representative recommended controlling the launch and then adding bike-sharing, Uber, Lyft, taxis, etc. Chicago believes they started too strong, which created more problems than they expected (Diaz).

4.35 Leipzig, Germany

The city of Leipzig in located on the east side of Germany. The Leipziger Verkehrsbetriebe (LVB) (engl.: Leipzig Transportation Company) is the mobility service provider for the city of Leipzig. This company works alongside the Mitteldeutscher Verkehrsverbund (MDV) (Central German Transit Association), a subsidiary of the Deutsche Bahn (DB). The LVB has different ways to provide its users with access to transportation and ticketing information and purchase options. Although tickets can be purchased at every ticketing outlet, the city has been advertising different types of subscriptions to make a shift to a less cash-based system. In conjunction with these subscriptions, the city introduced chip-cards, which are given out when a person registers for an account. The most basic and also noteworthy option is the ABO Flex. This comes with a chip-card that allows for cash-free payments as customers receive monthly direct debit card orders listing the purchases made. Subscription payments can be made by any other person or entity and are not tied to the user of the card/account (Leipziger, 2017). The Abo Flex gives at least a 25% discount on single and short trip tickets compared to regular tickets, and provides, even those without a smartphone, a financial incentive to switch from cash-based to cash-free payments. In addition to the ABO Flex, the LVB also provides subscriptions for frequent riders and specific age groups. For example, there are Baby and Kids

Cards, as well as subscriptions specifically tailored for students going to school and seniors (Leipziger, 2017).

In 2009, the city first introduced the mobile app "easy.GO" which is similar to the Munimobile app available in San Francisco as it can be adjust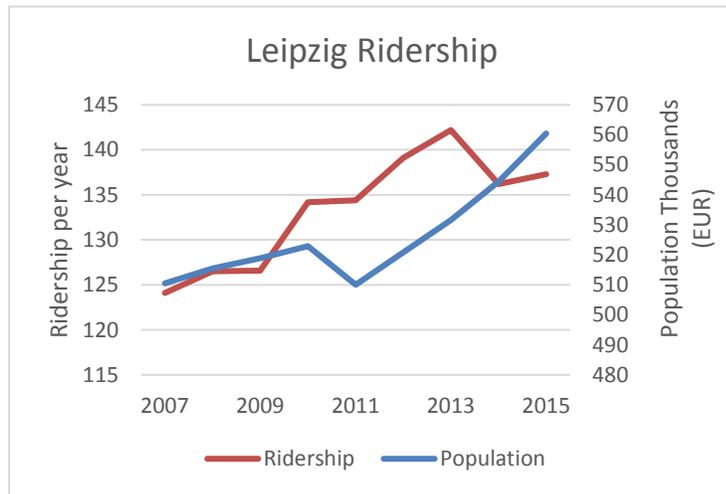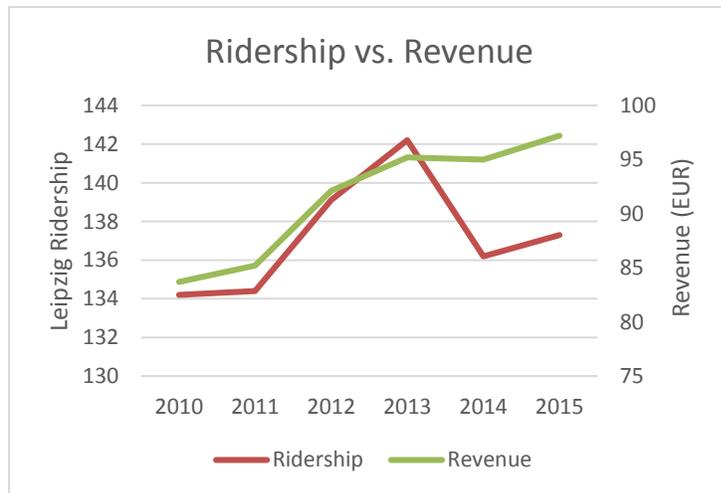ed for different regions. The app provides access to local bus and rail services. It enables users to view trip itineraries, receive real-time information and buy tickets cash-free. Tickets can be purchased with and without registration, and can be paid by the user's monthly phone bill or money order (Easy.GO, 2017). In a phone interview with the LVB representative Armin Raupbach, he said that the city initially adopted this technology because the city wanted to keep pace with modern digital developments. Mr. Raupbach noted that it became an increasing channel

Figure 12. Sources: Leipzig Facts and Figures, Leipzig Statistik

Figure 13. Sources: Leipzig Statistik

for revenue as certain target groups have adopted it. However, he also admitted that it bears some adoption problems for people without smartphones. In 2015, the LVB initiated their own transportation platform "Leipzig mobil". This is a common payment, multimodal service that combines the products of ABO Flex (bus and rail/streetcar) with car and bike sharing (the service

providers are teilAuto and nextbike, respectively) all in one app. In the interview Armin Raupach, after being asked why the LVB created such a multimodal system, said that it seemed like the next logical step because the LVB shifted its focus from being a transportation provider to a mobility provider (Raupbach). This included realizing that customers engage in various modes of transportation that do not just include bus or streetcar. Since the "Leipzig mobil" app was introduced in August of 2015, it was not possible to find reliable user data on how this app impacted ridership (Stadt, 2017). Nevertheless, when comparing ridership and population data in Figure 6, one can see an increase of ridership after the introduction of easy.GO in 2009. The LVB representative, however, was hesitant to attribute this increase solely to the introduction of the app.

When asked about problems or obstacles that had to be overcome when initially introducing the smartphone app, Mr. Raupbach named technical issues as well as design problems. Furthermore, he also mentioned that the creation of such a system takes a lot of continuous effort to keep it up-to-date with both transportation and smartphone changes. Lastly, he emphasized the importance of involving end users in early stages of the design process as it can save a lot of time and resources (Raupbach). Although the "Leipzig mobil" app has been awarded with the blue angel certificate for providing environmentally friendly transportation services, it lacks a direct incentive for users to choose eco-friendly routes or means of transportation.

Ultimately, it is clear that European cities have different transportation structures than mid-western cities like Columbus. Nevertheless, are there important insights from Leipzig, such as having a diversified subscription system that can help retain long-term revenue. In addition,

involving stakeholders in the development process of a common payment system was helpful as it eliminated adoption problems right from the start.

5.0 Discussion

Each common payment system has its own distinct characteristic, however, certain patterns have been identified in each common payment system. A few common themes were identified: none of the cities displayed a drastic increase of ridership post-implementation, many cities did increase revenue, and many cities added more payment systems throughout time. The most interesting pattern is the added payment systems over time. For example, Portland introduced an app and is now adding a reusable card, while Chicago had a reusable card before it introduced an app. Nevertheless, more payment systems are being adopted to accommodate all users regardless of what system was already in place.

Table 2: Common Payment Benchmark

Common Payment Types	All Access	Flexibility	Profitable	Safety	Effective Ridership	Sustainable
App Only	X	✓	✓	TBD	X	X
App & Kiosk	✓	✓	✓	X	X	X
Kiosk & Reusable Card	✓	✓	✓	X	X	X
App & Reusable Card	✓	✓	✓	TBD	TBD	TBD
All 3	✓	✓	✓	TBD	TBD	TBD

Table 2 represents the parameters considered for benchmarking certain payment systems. The check marks represent a "pass" in parameter requirements. TBD stands for "to be determined" as some of the cities are in progress of implementing newer common payment systems. "All 3" represents the ability for any user (card/cash/other) to use the payment system. It was our team's conclusion that an app cannot accommodate every user since there are users without smartphones and/or home Internet access, as indicated in the Linden results. All other methods in combination with an app are more likely open payment access to 100% of its users.

Flexibility represents the ability to allow 3rd parties (employers/family/friends/etc.) to pay for the primary user's transportation. Considering that many current payment systems in various case cities are fairly flexible, we found all payment system types observed in Table 1 can easily fulfill this parameter. For profitability, all system types seem to have shown patterns of increased revenue as a result of system adoption; therefore, all systems received a pass. As for safety, none of the cities reported an increase in safety (technological or physically); however, that was also not the aim for implementation. It should also be mentioned that smart street lights are a potential project in Linden, which may aid residents' sense of safety at COTA bus stops. For effective ridership, it was difficult to attribute any overall increase in ridership directly towards a common payment system since gas prices or other variables can influence ridership behavior. Chicago and Leipzig did initially display an increase in ridership, but that increase was not sustained over time.

Sustainability represents conscious and effective efforts to promote environmental stewardship, economic stability, and social accommodations, and none of the systems researched fulfilled the requirements of this parameter. Our team does believe that technology is ripe for a common payment system to be ruled as sustainable, and we fully believe Columbus can become the first city to achieve this rating (see section 7.0 Recommendations). It has come to our attention that Columbus could pilot an incentive program for environmental stewardship and even allow the payment system to be used at electric charging station. Our team's conclusion is that the best common payment system is not one singular system, but a combination of systems. We believe an app and a reusable card combination system is likely the best common payment system that can be offered.

6.0 Limitations

Our group's research needs to be considered in light of certain limitations. First, researching selected cities came with some obstacles, such as that members of the team were at the mercy of establishing contact with specific city officials to complete qualitative data collection. In the cases of Seattle and San Francisco our team members were not able to conduct an interview with city representatives to receive information about the adoption process of common payment and multimodal systems. Furthermore, there is the possibility that city officials did not provide the team members with full information in order to retain a competitive advantage for their city. Some of the benchmarking evaluations are somewhat hypothetical due to limited contact, information, and uniqueness of the procedure.

Second, due to the differences in city sizes, demographics, infrastructure and data availability, our research results have certain limitations. One difference between all case study cities and Columbus is they all have multiple public transportation systems and more infrastructure, such as streetcar or (light) rail which is able to connect multiple parts of each city in a more efficient way. Another limitation is that our team was not able to assess or account for possible changes in external factors such as gas prices, long-term road constructions, shifts in mindsets among residents, changes in fare prices and others that might have affected ridership data in the case cities.

As mentioned earlier, although Linden residents did not seem to be averse to an introduction of a common payment or multimodal system, survey results revealed that some people in the area are reluctant to use public transportation due to high (physical) safety concerns, affordability and efficiency problems. Also, many of the surveys were not answered in full, thus some data collection was hindered based on blank or inconclusive responses to

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questions. Therefore, we conclude that the success of the proposed new systems in the Linden neighborhood may depend on parameters other than methods of payment.

7.0 Overall Recommendations

After extensive research and careful evaluation, our team has provided a series of recommendations for the city of Columbus to consider when developing their own system:

1. A combination of two systems would be the most beneficial. An app would provide the most convenience to consumers but a reusable card would fill in any gaps that an app may not be able to provide (see section 5.0).

2. Allow account-based systems, and avoid anonymous accounts if possible (see section 4.31).

3. Provide services slowly, such as COTA and COGO, then Car2Go, Uber, or Lyft (see section 4.34).

4. Consider subscription programs to accommodate certain consumers such as students, seniors, and lower income residents (see section 4.35).

5. Provide an incentive/rewards program for users who choose a lower carbon service (bike over bus, bus over car etc.)

6. Expand the payment system to be used at electric charging stations.

7. Include kiosks in strategic locations for city visitors/tourists (see sections 4.32, 4.33).

8. Maintain close contact with Linden residents as the common payment systems are being tailored towards their needs.

9. Further research opportunities include exploring payment option programs, reusable card costs and benefits, strategic kiosk placement, and Linden preferences.

8.0 Conclusion

Our research team found that a common payment system would be beneficial for Linden and the rest of Columbus. We believe, after our benchmarking procedure, that a combination of payment systems would increase access to almost 100% of residents in Linden and Columbus. Implementing a common payment system has great potential to improve some of the socioeconomic conditions for residents by improving connection to grocery stores, hospitals, jobs, and schools. Not only that, but we feel strongly that Columbus can pilot environmental stewardship incentives within their common payment system. We found that a combination of a reusable card and an app is preferred among other alternatives. It is critical that the city of Columbus maintain its connections with key stakeholders, and implement the payment system slowly. Due to our limited time frame, much of our research was limited by available data and established connections with case city officials. Thus, we encourage further research for Columbus to achieve the best possible outcome of implementation. Columbus has the potential to become a smart city with a common payment system as a tool, and we as a team fully encourage the city to push forward on this idea.

7.0 Works Cited/Sources Consulted

Accountability Center. (n.d.). Retrieved March 30, 2017, from

> http://metro.kingcounty.gov/am/reports/monthly-measures/ridership.html

Agency, S. F. (2015, August 10). MuniMobile. Retrieved April 18, 2017, from

> https://www.sfmta.com/getting-around/transit/munimobile

Bundesagentur für politische Bildung. Zahlen und Fakten. Arbeitslose und Arbeitslosenquote.

> (March 9, 2017) Retrieved on April 9, 2017 http://www.bpb.de/nachschlagen/zahlen
>
> und-fakten/soziale-situation-indeutschland/61718/arbeitslose-und-arbeitslosenquote

Bureau of Labor Statistics. Databases, Tables & Calculators by Subject. Columbus, OH

> Metropolitan Statistical Area. Retrieved April 10, 2017 (2:01 PM)
>
> https://data.bls.gov/pdq/SurveyOutputServlet

Clipper. (n.d.). Retrieved April 12, 2017, from

> https://www.clippercard.com/ClipperWeb/whatsTranslink.do

Corey, Canapary & Galanis Research. (2015). SFMTA: Travel Decision Survey 2015. Retrieved

> March 20, 2017.

CTA Financial Statements. (n.d.) Retrieved March 30, 2017.

> http://www.transitchicago.com/business/financebudget.aspx#financialstatements

CTA Ridership. (n.d) Retrieved March 30, 2017. https://data.cityofchicago.org

> /Transportation/CTA-Ridership-Annual-Boarding-Totals/w8km-9pzd

Data Center. (n.d.). Retrieved March 30, 2017, from http://www.vitalsigns.mtc.ca.gov/data/81

Easy.GO. Home. (n.d.) Retrieved on April 9, 2017 http://www.myeasygo.de/home.html

Experience Columbus. Get around Cbus. (2017) Retrieved April 10, 2017.

> https://www.experiencecolumbus.com/travel-tools/get-around-cbus/

Leipzig. Facts and Figures. (2016) Retrieved on April 9, 2017

      http://english.leipzig.de/science-and-economy/investing-in-leipzig/business-location

      leipzig/facts-and-figures/

Leipziger Gruppe. Leipziger Verkehrsbetriebe. Produkte. (2017) Retrieved on April 9, 2017

      https://www.l.de/verkehrsbetriebe/produkte

Leipzig Statistik. Stadt-Daten. Bevölkerung. (n.d.)

      http://statistik.leipzig.de/statcity/table.aspx?cat=2&rub=1&obj=0

Leipzig Statistik. Stadt-Daten. Verkehr. (2015)

      http://statistik.leipzig.de/statcity/table.aspx?cat=10&rub=4&obj=0

"ORCA Product List." ORCAcard.com. N.p., 19 Oct. 2016. Web. 9 Apr. 2017.

Population estimates, July 1, 2015, (V2015). (n.d.). Retrieved March 26, 2017, from

      https://www.census.gov/quickfacts/table/PST045215/3918000

T. (n.d.). Let's Bounce! Retrieved April 19, 2017, from http://myhopcard.com/index.html#works

TA Ridership Statistics & Reports. (n.d.). Retrieved March 30, 2017, from

      http://www.transitchicago.com/ridership/#open

The 4 Best Car Sharing Companies in Portland of 2017. (2015, November 11). Retrieved April

      19, 2017, from http://www.reviews.com/car-sharing/portland/

TriMet Ridership Performance. (n.d.). Retrieved March 26, 2017, from

      https://trimet.org/about/pdf/trimetridership.pdf

TriMet Tickets app now helps riders connect to other transportation options. (2016, May 09).

      Retrieved April 19, 2017, from http://news.trimet.org/2016/05/trimet-tickets-app-now

      helps-riders-connect-to-other-transportation-options/

TriMet Tickets mobile app nears two million tickets sold in year one! (2014, December 19).

        Retrieved April 18, 2017, from http://news.trimet.org/2014/09/trimet-tickets-mobile-app

        nears-two-million-tickets-sold-in-year-one/

SFMTA. (2017, March). Strategic Plan Progress Report: Goal 2 Focus. Retrieved April 2, 2017.

Stadt Leipzig. Umwelt und Verkehr. Öffentlicher Personennahverkehr. (2017) Retrieved on

        April 10, 2017 http://www.leipzig.de/umwelt-und-verkehr/verkehrsplanung/oeffentlicher

        personenverkehr/#c99197

USA Data. (n.d.). Retrieved March 26, 2017, from https://datausa.io/profile/geo/columbus-oh/

Ventra Chicago. (n.d.) Retrieved January 27, 2017. https://www.ventrachicago.com/

Viriyincy, Oran. "ORCA 2: The Next Generation." Seattle Transit Blog. N.p., 5 Oct. 2015. Web.

        9 Apr. 2017.

Waxmann, L. (2015, November 23). SF Muni Goes Mobile With First Ticketing App. Retrieved

        April 1, 2017, from https://missionlocal.org/2015/11/sf-muni-goes-mobile-with-first-

        ticketing-app/

<u>Personal Sources, Collaboration, and Consultation</u>

Bollo, Ryan. Senior Project Manager – ITS/Technology Program. City of Columbus.

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8.0 Appendices

Dataset #1: Cap City Data_Research.xls

Sources: U.S. Census website: https://www.census.gov; USA Data website: https://datausa.io/profile/; U.S. Department of Labor website: https://data.bls.gov/; Leipzig website: http://english.leipzig.de

Description: This data set includes the following information on city demographics: population, income per capita, poverty rate, unemployment rate, average commute time, methods of travel by percentage. Much of this data derives from 2015 estimates and 2010 census measurements. This data helped produce Figures: 1, 4, 6, 8, 10, and 12 as well as Table 1.

Dataset #2: Cap City Data_Research.xls

Sources: TriMet Website (Accountability): https://trimet.org/about/pdf/trimetridership.pdf; King County Metro Website: http://metro.kingcounty.gov; Chicago Transit website: http://www.transitchicago.com; SFMTA website: https://www.sfmta.com; Leipzig Transportation website: http://www.leipzig.de

Description: This data set includes annual or weekly ridership and revenue statistics from public transportation in chosen case cities. This was the most available data, spanning from 2000-2016, released in performance reports in across the case cities. This data was used to create Figures: 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13.

Dataset #3: Cap City Data_Research.xls

Sources: Linden Surveys: 170210_SmartColumbus_Linden_CommentsSheet_Redact.pdf

Description: This data reveals the current situation, needs, and preferences of Linden residents regarding the Smart Columbus project. This data was collected at a town hall style event on February 10, 2017 with about 70 participants. These surveys were compressed into numerical figures and were used to create Figure 3.

Dataset #4: TriMet_Phone Interview.doc

Sources: TriMet Representative in Administrative Offices. Phone: 503-962-2992 Website: https://trimet.org/

Description: Notes from a brief phone interview with a representative of the TriMet administrative office on the TriMet app. Phone conversation on February 13, 2017. Questions included (also replicated in Datasets 5 and 6):

    1. Is there a notable increase in ride-sharing/public transportation usage since deploying this program? (common payment system)

    2. What are some noticeable issues you would improve upon?

    3. How are you able to accommodate disadvantaged people? ex. senior citizens, people without a smart phone, cash-based…

    4. What were the obstacles the city faced that led to the creation of the card/app?

    5. Were there any obstacles the city had to get people to use the card/app?

Dataset #5: Diaz_interview.docx

Source: Jackie Diaz, Revenue and Fair Systems for Chicago Transit Authority. Phone: private number. Email: jdiaz@transitchicago.com

Description: This is a collection of notes from a conversation with Jackie Diaz regarding Chicago's common payment system. The phone conversation took place on April 5, 2017.

Dataset #6: Raupbach_interview.doc

Source: Armin Raupbach, LVB Representative. Email: Armin.Raupbach@L.de

Description: This a collection of notes from an interview with Armin on the Leipzig transportation common payment system. The phone conversation took place on March 21, 2017.