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How Transportation Network Companies Could Replace Public Transportation in the United States

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by

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DEDICATION

This page is dedicated in memory of my beloved uncle, Joel “Jerry” Kessler, my grandparents: Miriam Sylvia and William Berkowitz, Gertrude and Sam Kessler. Lifelong friend MariaLita Viafora, and a special friend, Michael R. Rosenberg, all of blessed memory. They consistently encouraged me to pursue degrees of higher education. Even though they are no long with us, and even those with us - and they know whom they are - it is the spirit that counts and lives on perpetually.

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ABSTRACT

The quantity of cell phone applications or mobile apps have seen an upsurge at an exponential rate in under a decade. Many have been created for a variety of industries, including transportation. The advent and subsequent commercialized implementation of near-instant transport by a middleman-type of app is now known as a Transportation Network Company or TNC. Examples of the more renowned TNCs are Uber, Lyft and Sidecar.[1]

In recent years, TNCs have cultivated a tremendous following, to the degree of taxicab desertion. Moreover, the massive success of TNCs led to expansion of its capacities into public transportation.

The TNC's expeditious popularity has garnered the attention of government and transit agencies. Without fail, TNCs can complement, supplement or compete with transit. However, sparsely has there been any deep discussion about a TNC potentially supplanting transit. The aim of this paper is to show how TNCs could replace public transportation in the United States if subsidized at the same level of transit agencies. Austin, Texas was analyzed as the case study city. A comparison of subsidization between Austin's transit agency: Cap Metro, the local TNCs, and on a national aggregate level was conducted. The evidence herein clearly shows that TNCs are highly competitive when in revenue service operating at full capacity, potentially replacing public transportation.

[1] Sidecar was at one point the Number Three TNC. It ceased revenue service operations December 31, 2015.

CHAPTER 1: INTRODUCTION

Engineering innovations for mass transit have transformed the way people get from Point A to Point B and beyond. Since the late 19th century industrial evolvement in the movement of passengers, beginning with the streetcar, has produced what is considered today generally accepted modes of public transportation. Examples of this are commuter rail, fixed-route bus lines, and subways also known as heavy or rapid rail. In the latter part of the same period, additional modes became part of that same list and they are light rail and bus rapid transit (BRT) systems.[2] As a result, the global populace has seen increments in their mode choices.

Part of this transformation can be attributable to technological companies such as Uber, Lyft, Sidecar and their respective counterparts. The nexus was their invention of a smartphone app, or high-tech capable cell phone software, where transport is requested by an individual and instantly arranged with someone who possesses a vehicle. The app – provided at no cost by a third party – makes all the arrangements for conveyance. The rapid popularity of this electronic tool is largely due to the swiftness of service, convenience and efficiency involved when coordinating a ride. The ride is furnished for an agreed upon fee which is involuntarily cashless since payment must be in the form of a debit or credit card.[3] Many consider this to be a 21st century version of a taxi.

This type of commercial operation has been highly criticized by the taxicab industry as an actual transportation provider hiding behind the veil of technology. Taxicabs and myriad for-hire

[2] Light rail is considered by some to be a modern term for what was formally referred to as a trolley.
[3] In venues outside of the United States, some of these tech app firms will allow for passengers to pay with cash. Additionally, gratuities may be paid in cash as well – subject to the company's policies.

livery enterprises became disgruntled since these "taxi-like" apps have encroached on their livelihood. The steep depths of penetration by these techno-transport firms have led to lengthy, and at times, controversial debates on what their exact role is and how they should even be categorized. The high level of provocation within the United States alone compelled a state legislature to intervene and create a legal classification. Under the State of California, Uber, Lyft, Sidecar and their future contemporaries will be known by the lawfully authorized term: Transportation Network Company or TNC, for short.[4]

The motivation for this thesis developed from original research that focused on the causation of the disproportionate, yet, exponential growth in the recognition and acceptance of Uber. Historically, the immediate swift rise of any new product or service, overall, either lasts until a new but lesser cost breakthrough comes to market or the enthusiasm for that item fizzles out. Similarly probed was whether TNCs were nothing more than the latest fad or a shining example of a trend for the future.

Throughout the duration of this research, innumerable articles on TNCs concentrated primarily around Uber. Uber in a short span of time expanded and magnified its presence by leaps and bounds. Factors that led to the extraordinary growth include, but are not limited to, aggressive market entry; allegations of misfeasance and nonfeasance; implementing guerilla-style marketing tactics; atrocious labor relations; contemptuous customer service and its sheer aptitude of persuading many hedge fund managers and venture capitalists to invest into it with no less than nine figures.[5] In light of that, Uber, allegedly, ignored legislative and other promulgated

[4] Sidecar formally terminated its operations on December 31, 2015. It is only being utilized so the reader has a better idea of the context.
[5] Uber proclaims their policy is not to reveal, unbelievably, its finances – past or present - to any potential investor.

requirements. Outright insurrection also played a huge role exacerbating Uber's negative reputation as dramatized by adverse media attention.

At the end of the day, there are direct and indirect effects Uber created affecting public transportation. First, most transit agencies (TAs) must contend with its own chronic first mile/last mile (F/L) syndrome. This entails a passenger to require the use of at least one or more transportation modes from an origin to gain access to another transportation mode, or more than one mode, to reach his or her ultimate destination. To illustrate, a commuter who lives in a rural area either starts their journey by walking, biking or driving to a commuter bus or railroad station that will carry him/her to another bus stop, or other such terminus. Then, upon arrival, continue the journey with either a subway, bus, taxi, or other available mode.[6] Considered a premier program in the United States, at the time of inception, Metropolitan Atlanta Rapid Transit Authority (MARTA) was the first transit agency (TA) to establish an alliance with a TNC – Uber. MARTA passengers, to this day, have another viable alternative of mobility to/from any of their facilities. Although the fares for the TNC and MARTA collaboration are not discounted, this kind of pact results in generating a ton of positive promotion for fostering these types of public-private partnerships (P3). It furthers the argument that TNCs have what to contribute if they're able to work jointly with public transportation in a harmonious fashion.

Second, TAs across the country are also experiencing funding issues. It is an established fact that TAs, by and large, are not profitable enterprises. In other words, TAs must have the financial wherewithal to operate with the capital necessary to preserve current and future revenue service. This translates into subsidization – whether it be Federal, state, local governments or private enterprise – that are increasingly becoming limited. TNCs present a number of

[6] Subject to where the commuter is located, the possibility exists that bikesharing may be a viable option as well.

opportunities and challenges to public transportation. Yet, under certain circumstances, the TNC could furnish itself as a prospective, viable option if properly and strategically integrated into public transportation.

Presently, TNCs supplement TAs by furnishing passenger transportation during conditions or situations such as closed or off-hours, track, tunnel and/or other maintenance, along with special unordinary events. It also plays a crucial role in complementing TAs as a missing piece in the F/L puzzle. Some municipalities have taken the initiative to implement pilot programs with the notion of partial, or even full subsidization of trips taken with a TNC. There is also the potential for jurisdictions to observe and learn from these demonstrations as it creates a tremendous possibility of avoiding the need to create, develop and finance a full-scale transit agency that may emerge as cost prohibitive. Altamonte Springs, Florida has proven itself to be an exemplary model.

Given the above, one area that has not been explored is whether the TNC could conceivably replace TAs. Although several articles published support the theory of supplantment, there is very little in the way of research papers on the subject matter of transit agency replacement by a TNC – in general. This void provides an opportunity to fill this scholarly cavity.

An examination is made outlining various recent cases studies and their consequences. Additionally, an actual case study city is explored, the advantages and disadvantages for four of the main stakeholders as well as the possibility of congestion being an issue and a list of TAs apt for replacement are analyzed.

1.1 Background

In a little over a century, we have come to observe an assortment of inventions that have altered the transportation industry. From vehicles powered by the combustion-engine to high speed rail to the present-day testing of autonomous vehicles. These contrivances have revolutionized the

way people and goods get from Point A to Point B. The same can be said of the engineering innovations for the mass transit or public transportation industry. It has, as well, transformed the way people get from origin to destination and beyond. Beginning with the horsecar, novel designs have led to the progression of what are considered today to be generally accepted modes of public transportation. Such examples are commuter rail, fixed-route bus lines, and subways or heavy rail. In the latter part of the 20th Century, additional modes such as light rail and bus rapid transit (BRT) eventually became part of that same list.[7] As a result, particularly within the most recent half-decade, the global populace has witnessed an enormous metamorphosis in public transportation mode choice.

Part of this transformation is attributable to peer-to-peer sharing mobility as it has become a huge component of the latest trend in recent up-and-coming transportation concepts. The nexus of one particular byproduct of peer-to-peer sharing was the creation of the mobile application, or app, geared specifically for transportation. An app is high-tech software engineered to perform on peripatetic devices such as a smartphone or other similar mechanisms. Apps, in general, have manifested prolific agility and ubiquity. As can be seen in Figure 1.1 the number of mobile app downloads worldwide for 2016 and the estimates for 2017 and 2021 are shown in billions.

Under the context of peer-to-peer sharing, transport is requested by an individual and instantly arranged with a driver who possesses a vehicle. The app, provided at no cost by a third party, makes all the arrangements for conveyance – including the financial aspects. Basically, a customer asks to be introduced to a driver "sharing" or "sourcing" his or her private vehicle – for a fee. This is conveniently ordered by a few taps on a cell phone and, within minutes, not only is the chore of setting up transportation achieved, but so is compensation for the trip. The rapidity of

[7] Light rail is considered by some to be a modern term for what was formally referred to as a trolley.

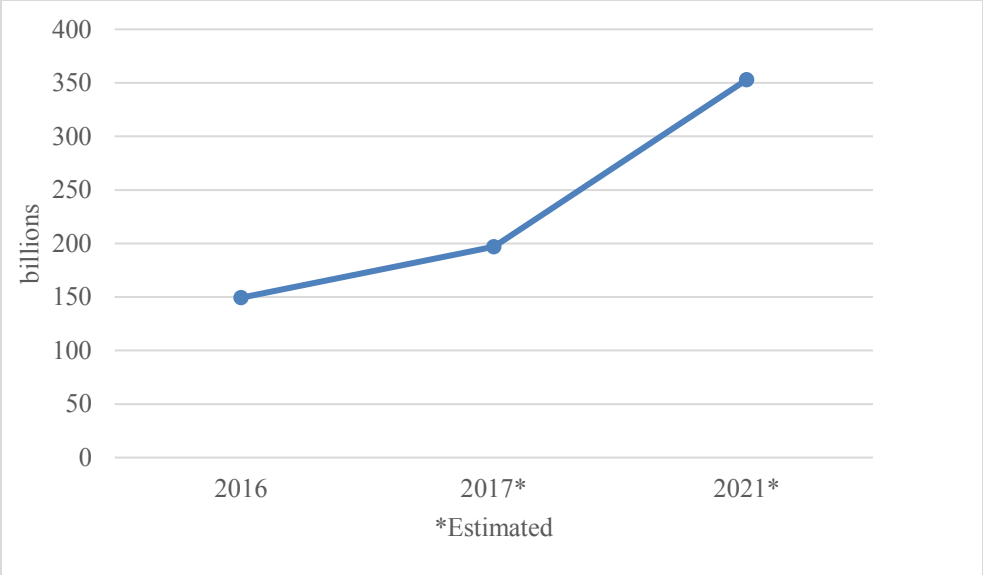

Figure 1.1 Number of Mobile App Downloads Globally (in Billions)

Source: Statista

popularity of this electronic tool is largely due to prompt service, ease and efficiency involved when coordinating a ride. The ride is furnished for an agreed upon fee which is, for the most part, involuntarily cashless since payment must be in the form of a debit or credit card.[8] This type of app was developed by a few techno-companies such as Uber, Lyft, Sidecar and their respective counterparts. Many consider this service to be a 21st Century version of a taxi. Figure 1.2 shows how swiftly apps became prominent – specifically Uber and Lyft.

A great deal of credit is due to Uber. Uber and Lyft's stories of success did not come without a plethora of drama along the way. The commercial operation has been highly criticized by the taxi industry of being, in actuality, a transportation provider hiding behind the veil of technology. Taxicabs and a myriad of for-hire livery enterprises became disgruntled since these taxi-like apps have encroached on their livelihood. As an illustration, traditional taxi and for-hire

[8] In venues, outside of the United States, some of these tech app firms will allow for passengers to pay with cash. Additionally, gratuities may be paid in cash as well – subject to the company's policies.

livery companies in Los Angeles have seen a serious decimation of business because of customer desertion. The steep depths of disruption caused by these quasi-techno transportation firms have led to lengthy controversial debates on what their exact role is and how they should be categorized. Since there was no one word or simplistic phrase to accurately categorize these apps, or their developers, the high level of provocation that this generated within the United States alone compelled a state legislative body to intercede. Under the State of California, Uber, Lift, Sidecar and their contemporaries are known by the officially authorized term: Transportation Network Company or TNC, for short. [9] [10]

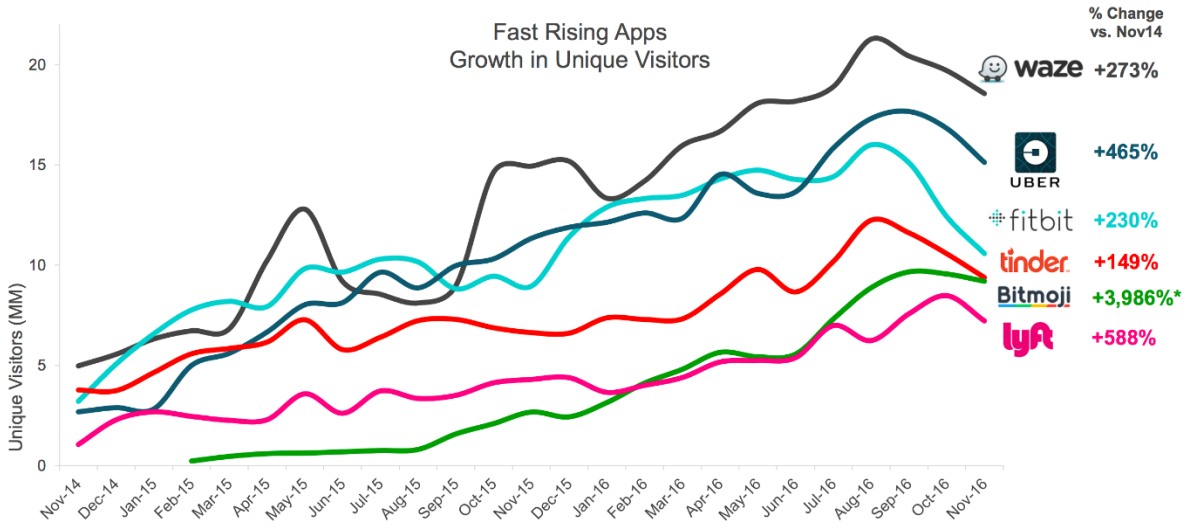

Figure 1.2 Upsurge of the Uber and Lyft App

Source: ComScore Media Matrix, November 2016, U.S.

Simultaneously, also observed within the last quarter century, was how hi-tech developments like the portable wireless phone evolved into a "smartphone". Unlike past models, even though they were also compact, today's phones are small enough to be placed into a shirt or

[9] Sidecar formally terminated its operations on December 31st, 2015. It is only being utilized so the reader has a better idea of the context.
[10] The original term was New Online-Enabled Transportation Service (NOETS). https://www.itf-oecd.org/sites/default/files/docs/1-discussion_paper_darbera_rd15-itf-oecd.pdf

pants pocket. Each smartphone provides the user with a variety of capabilities. Most cell phones are either already pre-programmed with apps, or many more can be selected and purchased from a multitude of vendors. These types of devices "help users…from turn-by-turn driving directions to assistance with public transit" *[77]*. For example, a smartphone owner can download an app such as Google Maps and/or a regional mass transit system. Figure 1.3 illustrates the current and projected market for smartphone usage.

Currently, statistics indicate 77% of all American adults own a smartphone, up from 64% in 2015 *[77, 78]*. Data such as this translates to mean that the United States consumer has come to accept the smartphone, is comfortable with its features, and may very well know how to utilize its amenities. Companies have incubated a multitude of apps, some with transportation in mind, which allow potential customers to get to where they need to quicker and, in many cases, cost-effectively. Uber, Lyft and Sidecar typify the above.

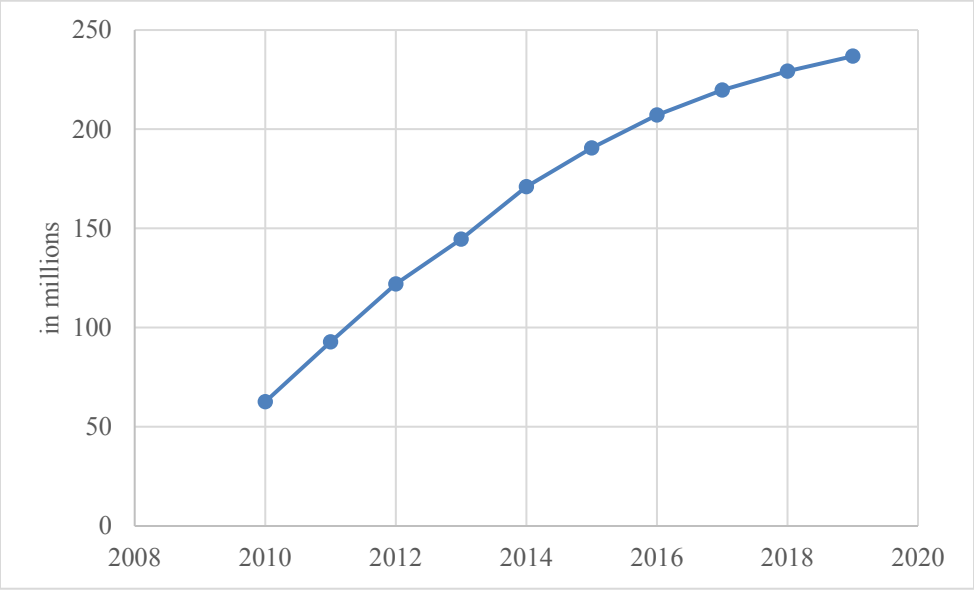

Figure 1.3 Quantity of US Smartphone Users from 2010-2019

Source: MediaVidi

A little unknown company, called Uber, underwent quick growth within a very short amount of time. To review, the innovation behind the concept is fairly simple: a mobile-based app acts as an intermediary arranging transportation service between a driver and a customer, who happens to be in the immediate vicinity of the privately-owned automobile. The driver is not necessarily a direct company employee or even a full-time professional. Rather, s/he is most likely to be a person seeking extra income that happens to be traversing nearby, in the same direction, or heading to, as adjacent as possible, towards the same destination. Regardless, the ride, fare collection and business responsibilities are managed by the third-party technology firm.

Consequent to inception, Uber's competition began to intensify and other comparable companies have spawned off something equal or very close to it. In addition to Uber, there are others who've entered this potentially lucrative field. As of 2011, there were as many as 613 of these types of firms in North America alone *[25]*.[11] At present, there are at least a dozen companies to rival Uber. Some of the more established well-known apps are Lyft, Wingz, Summon, Taxify, Haxi, Didi Kuaidi, InstantCab, Grabtaxi, Ola, Mytaxi, RideAustin, Fasten and Sidecar.[12] However, from these, Uber is the largest in terms of the number of venues it offers service in and market valuation.[13]

Other questions abound ranging from their overall business model to their ability to expansively operate. Regardless, these queries have become issues that everyone – from academics to governmental authorities – are now seriously researching and deliberating. To illustrate, Uber proclaims to be a software firm where drivers are independent contractors in lieu of full-time employees.

[11] The authors do not list all 613 companies. It is assumed their definition may not concur with the definition of a TNC.
[12] Sidecar terminated revenue service final day of 2015.
[13] As of press time, Uber is in 400+ cities and 58+ countries. Valuation, as of February 27, 2017, ~$70B.

Yet, their own drivers are claiming that TNCs should be considered a company that in actuality, controls and directly manages them – regardless of full-or-part-time status. Since TNCs commenced and expanded revenue service operations, it has, been under a microscope of consistent scrutiny. There has been ambiguity as to how these firms should be categorized. A wide variety of publications all depict these firms within a multi-gamut of classifications. The assorted menu of terms to define these kinds of operations are comprehensively extensive: ridesharing, car-sharing, taxi-service, transportation broker, or merely a software developer. What's more, in addition to the latter, peer-to-peer sharing mobility has become the latest in this fad of up-and-coming, promising concepts. It "entails the participation of one or more riders (peer consumers) who, together with a driver (peer provider)…typically [share] a car [or ride], when travelling from start points to destinations. To accomplish this, peer providers together with peer consumers agree on various aspects before or throughout the service performance; e.g., pick-up and drop-off points, waiting time, compensation, etc. A specialized type of peer-to-peer service sharing platform, [also referred to as] a ridesharing platform, facilitates this." *[25]*. In attempting to comprehend why this is so significant, upon investigation and analysis one can see a TNCs deep similarity to taxis, yellow cabs and for-hire livery.

TNCs took peer-to-peer sharing mobility and developed it into a multimillion-dollar commercial enterprise. Since its establishment, at least a dozen TNCs commenced operating in the United States.[14] The main TNCs are Uber, and Lyft.[15] Nevertheless, irrespective of the competition, Uber is the largest in terms of variety of services available, where it can be found and market valuation.[16] To illustrate, Uber is in over 400 cities and valued roughly at $70 billion.

[14] See Appendix A for a comprehensive list of TNCs.
[15] The TNCs are placed in order of industry position. Sidecar was considered a third rival but has since ceased revenue service December 31, 2015.
[16] At press time, Uber published it was in 400+ cities and 58+ countries.

Over the past few years, TNCs have not only affected the traditional cab, livery and taxi industry, but the proliferation of TNCs have had a wide array of impacts and effects on other facets of society, particularly: public transportation. Additionally, TNCs have affected the various modalities of public transportation. Equally important is the impact upon the conventional transportation authority or transit agency (TA).

Presently, TNCs supplement a TA by furnishing transportation to passengers during conditions or situations such as closed or off-hours, track and tunnel repairs, along with special unordinary events. It also plays a crucial role in complementing the TA as a missing piece of the F/L puzzle. As a result, some municipalities have taken the initiative to implement pilot programs partially or fully subsidizing TNC trips. Alternatively, in some jurisdictions, TNCs are directly competing with the local or regional TA. With that said, one area of possibility that exists that has not been entirely explored is whether the TNC could replace a local or regional TA.

TNCs present opportunities and challenges to public transportation as a whole. Yet, under certain circumstances, the TNC clearly is a prospective, viable option when compared to a conventional TA. Although a couple of published articles support the aforementioned theory of replacement, there is very little in the way of research papers on said subject matter. This void provides an open window of opportunity for research.

TNCs are now on everyone's radar – regulators, the business community, media, academia and those that need to get to their intended place of interest. Acclamation specifically goes to Uber not just because of its massive commercial success, but also for the expansion of its capacities into public transportation. In trying to grasp why this is so vital, it would be prudent to investigate and critically analyze the interrelationships between the TNC and public transportation.

Relentlessly, just about every transit agency (TA) struggles with its own chronic first mile/last mile (F/L) syndrome. Deemed to be the premier program in the United States, Metropolitan Atlanta Rapid Transit Authority (MARTA) was a pioneer in establishing an alliance with a TNC. MARTA passengers, to this day, have a doable alternative of mobility to/from a MARTA station.

Although the fares for a linked trip involving the TNC and MARTA collaboration are not discounted, this kind of pact results in generating a ton of positive promotion for a TA and TNCs ability to work jointly in a harmonious fashion for the public betterment. Equally vital is how a partnership, such as this, enhances the resolution of F/L.

Equally imperative is how many people have to expend a considerable percentage of their income towards their transportation. Noteworthy are how a person's transportation costs have been on double-digit levels. The significance can be seen even under conditions where a $100,000 salary – post-taxed - will observe a tremendous financial bite.[17] The good news is current trends illustrate a downward inclination as shown in Figure 1.4. It indicates that, since 2003, transportation costs have decreased by 7%. Cost/price is a compelling factor in any purchase decision – including mode choice. For some the maintenance and financial responsibility of vehicle ownership, fares and overall services of public transportation, taxicab and for-hire livery can be expensive.

1.2 Problem Statement

These days the public strenuously places demand on various levels of government and elected officials, to expand and maintain infrastructure and furnish more service with budgets that are, at times limited in financial latitude. The operating expenses involved in vehicle revenue

[17] In urban areas such as New York City, a person will be taxed on their income by the city, state and Federal governments. This does not include special taxes that may be imposed. Each jurisdiction has different vehicle taxes.

service are becoming increasingly costly. As time goes forward, such expenditures are not anticipated to decrease. Without any newly created and/or inventive dedicated funding mechanisms, TAs are constrained to make the hard decisions that ultimately affect the transit constituents at large.

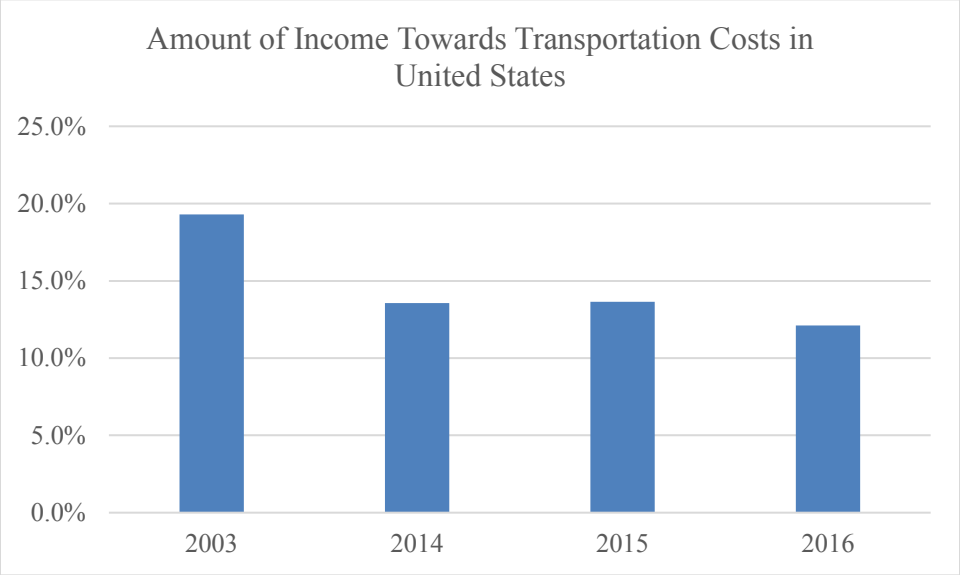

Figure 1.4 Transportation Costs in the United States as a Percentage of Income

Sources: Surface Transportation Policy Project; US Bureau of Labor Statistics

Rather than plead for an increase in support and scrimp by TAs, and the municipalities that control them, need to initiate exploring with the idea of thinking out of the box. In other words, the time has arrived for properties to admit that they have a certain amount of monies necessary to operate. In the midst of the era of emerging technologies, without a doubt TNCs definitely can play a vital role as a partner with and for public transportation. The question being placed forth is how can a TA maintain or expand levels of service in tandem while contained by their budget?

1.3 Thesis Hypothesis and Objectives

It is crucial for TAs and other government entities to capitalize as much as possible on nominal funds. Ultimately, there is only so much subsidization that can be had. The hypothesis is

how TNCs could supplant transit agencies, in the United States, if subsidized on the same level as public transportation

The objectives of this thesis are:

1. To show using the financials of a large city TA how this could occur.
2. An analysis of case studies and their consequences.
3. A discussion of the advantages and disadvantages should a TNC replace a TA and
4. Tender several recommendations, suggestions for future study, concluding with remarks and observations.

1.4 Scope

1.4.1 The Definition of a TNC

Crucial is the need to identify how a TNC can be categorically titled or defined. In other words, because there have been a considerable and significant number of debates as to whether a Transportation Network Company is a transportation provider or a mere technological invention, an assured criteria needs development.

There are five essential characteristics that need be implemented as a benchmark for any entity to be distinctly identified as a Transportation Network Company or TNC:

1. App – naturally, a smartphone application must already be downloaded and an active account readily available for use
2. Rider – a potential customer that chooses to be taken from Point A to Point B.
3. Driver – there must be a motorist with a motor vehicle available upon a moment's notice or reasonable amount of time, that is willing to take a passenger to his/her desired destination.
4. No Fleet – the driver must procure a vehicle at his or her expense – not the TNC.

5. No direct/indirect ownership in a transportation business – Taxi companies, that are now dealing with the competitive reality have begun to create apps for themselves. Customers dealing directly with a taxi firm offering an app option would still not meet the criteria or definition of a TNC. i.e.; it is obviously evident that the taxicabs are already furnishing direct transportation services.

Indispensable is the first since that is what makes a TNC most distinctive. Livery, taxicab and other for-hire enterprises can always offer transportation service directly to any member of the public. Regarding the fourth and fifth variables, once an app provider has ownership of a vehicle with the intent of providing transportation to the public, it can no longer be a TNC. Rather, it is unequivocally competing with for-hire enterprises and would need to comply with any and all jurisdictional regulations as it pertains to the cab/for-hire livery industry.

1.4.2 Supplement

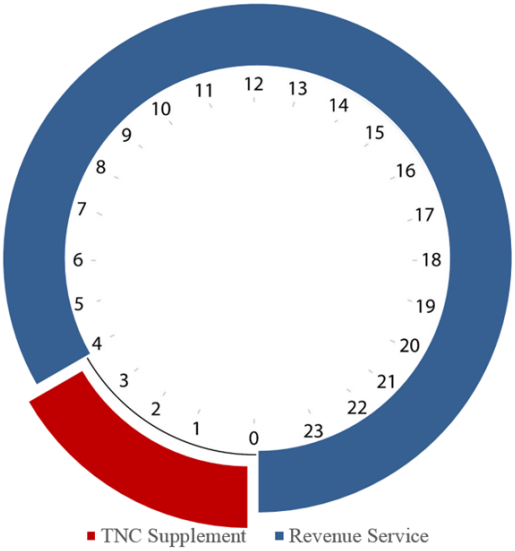

Figure 1.5 Optimal Time for TNC Supplantment

The consensus amongst journalists is TNCs are invaluable to transit. Questions abound how and what function can it provide. There are several prospects. One of them is for a TNC to supplement transit agency.

Fundamentally, it is imperative to have a basic understanding of the word supplement. To supplement, means "something added to supply a deficiency" *[19]*. Figure 1.5 demonstrates how a TNC could supplement transit. Within the context of this thesis, supplement would be TNCs furnishing service when public transportation is not operating revenue service or is shut down. That is, not all transit agencies furnish 24/7 revenue service. The Bay Area Rapid Transit or BART, located in the San Francisco Metropolitan Area, is an example of one such agency.

Since BART is a transit agency that does not provide service for part of the night, this is where a TNC can successfully fill the revenue service void. BART's operating hours vary by the day and ceases overnight. Depending on the day, the gap can be anywhere from four-to-eight hours.

Many of San Francisco's young people attend clubs and other opportunities of social interaction around the Bay Area. These places and other points of interest are open into the very early hours of the morning where there are limited options of public transportation. This is where a TNC can becomes a hero by supplying what was sorely in demand: reliable and convenient transportation for those who would find procuring taxicabs late at night to be expensive and/or undependable. Uber became an immediate protagonist with the after-hour crowds and took its instant popularity as an impetus to expand.

Uber, whose main office happens to be located in the Bay Area, began its roots by serving the above mentioned region. It offered service to whoever sought transportation during those off-hours. It, Lyft and others, continue to do so to this day. As a TNC, it was essentially supplementing BART by not realizing it or, at least, without a formalized agreement with the property.

This level of effectiveness allows for the further advancement of transportation service continuity enabling people to strategize potential travel plans and mitigate any possibility of schedule captivity to transit.

The above presents a temporal aspect of how a TNC can supplement transit. Another attribute is from a spatial aspect. Under this facet, the transit agency inserts a TNC into areas where they have never had transit service. Although a more detailed discussion can be found in Chapter 2, suffice it to say that the Tidewater Regional Transit Authority implanted shared-ride taxis into selected geographical zones where public transportation was never offered beforehand.

1.4.3 Complement

Many authors are, for the most part, in agreement that the TNC can be instrumental to transit - it is just a matter of how. Another likelihood is where a transit agency is complemented by a TNC.

When things go together or for the purpose of making something complete that is how complementation is achieved. Notwithstanding, a persistent and common conundrum within transit is the First Mile/Last Mile Dilemma (F/L). Already stated earlier this is where a commuter may need more than one mode from origin and to reach his or her final destination as part of a linked trip or overall journey.

A property may collaborate with a TNC to transport passengers from remote or beyond local geographic limitations to areas where there is token or economically unfeasible scheduled fixed-route revenue service. For example, Pinellas Suncoast Transit Authority (PSTA) operates a program called DirectConnect. This agency entered into an agreement with a TNC, Uber, whereby a passenger can be transferred to a bus stop and board a PSTA bus to his or her final destination. Currently, there are plans for Lyft to join PSTA in the very near future. Mentioned earlier, MARTA

was the first United States transit agency to create this type of service arrangement. It should be noted that MARTA and Uber do not offer any discounted fares. Contrariwise, PSTA subsidizes theirs.

Figure 1.6 best illustrates how a TNC complements a transit agency. The TNC carries customers from a venue not normally served by transit and taken to a bus, subway or multi-mode station so s/he can complete the linked trip.

Figure 1.6 TNC Complementing Transit

1.4.4 Other Feasible Partnerships

There are several other conditions where transit, at the very least, could integrate a TNC into their operations. There are times that a TA will extend or expand service for certain special occasions, such as New Year's Eve celebrations, sporting events, conventions and/or when there is an anticipation of large crowds. The below examples are not to be construed to be an exhaustive list, but are prospects of how a TNC could connect with a transit agency.

1. Special events. San Diego Metropolitan Transit System (MTS) partnered with a TNC when two major exhibitions were to occur successively. MTS endeavored to have Uber assist with a projected overflow of passengers during the anticipated timeframe of the baseball game and convention. Under this agreement a "one-time discount" of five dollars was available for customers of UberPOOL *[75]*.
2. Labor disputes. A Southeastern Pennsylvania Transportation Authority (SEPTA) union shepherded a strike prior to Election Day 2016. There was no official agreement made between SEPTA and any specific TNC. Nevertheless, TNCs did quite well under the circumstances as their ridership amplified from the incident, albeit at the expense of the commuter. Had SEPTA met with and negotiated with the TNCs a more affordable and equitable fare could have been instituted. Transit agencies in the United States may wish to peruse the lessons learned from SEPTA in the event that a strike is looming, in order for precautionary measures to be logistically strategized.
3. Service interruptions. At times, there are preplanned and impromptu moments where transit has to temporarily suspend service. For example, MTA Long Island Railroad (LIRR), at times, faces incidents both within and beyond their control. As a result, they normally dispatch buses to transport passengers so that they would not be stranded. Regardless, of whether buses are privately chartered or from a transit agency, there is always the question of the amount of waiting time and peripheral costs involved before s/he boards the bus to complete their journey. TNCs have earned a reputation for proffering instantaneous service.[18] Also, unlike the chartered bus, the TNC app has built-in GPS capability. Thus, the passenger knows exactly what is transpiring, in real-time, which makes their travel plan decision slightly easier.

[18] This depends on where the TNC is positioned relative to the location of the station in question.

4. Other. There are some other situations when transit may consider coordinating with TNCs. Examples include impermanent budget limitations, unanticipated power-source outages, and temporary removal of equipment from vehicle revenue service.

1.4.5 Competition

In the past year or so, there have been published accounts about how TNCs have devastated the taxi industry. TNCs have overwhelmingly enticed loyal taxi customers with not only airport transportation but local usage as well.

As recent as April 2017, a piece appeared publicizing a new service by a TNC called Lyft Shuttle. To be further discussed in chapter under Literature Review, it is described as a "public transit-style service" *[30]*. In addition, to it being a demo, Lyft Shuttle "will run [along] specific routes during rush-hour periods" *[30]*.This service is slated to be tested in San Francisco and Chicago. Uber conducted a similar service called Smart Routes, in 2015, within the above same cities. During the same time period it entered the Seattle market as Uber Hop *[53]*. In the end UberHop did not as well as projected.

In the summer of 2016, New Yorkers were introducing to the Uber Commuter Card. This time-limited promotion was marketed for two months and allowed UberPOOL passengers the chance to purchase TNC rides, or commute, at a discounted rate. Whether Uber or Lyft, or other TNCs do not explicitly state it will go head-to-head with transit, the adage of actions speaking louder than words could not be farther from the truth. This publicity stunt "suggests [TNCs] may be inching closer to becoming competition for public transit" *[88]*. The Uber Commuter Card was quite efficacious as it was completely sold out *[7]*.

When taking the above into consideration, inserting the high density of the New York City Metropolitan Area, the already existing operations of TNCs in NYC into the mix it does allude to

a potential of TNCs competing with transit. Yet, keeping the latter in mind, assuming there is a critical mass for TNC viability to compete with transit and if it is cost-effective for both parties? Why not replace transit with TNCs? Taken together there is the axiom: if you cannot beat them, join them - is clearly apt.

One major issue for some transit agencies was the perception of ridesharing as potential competition for both business and ”resources”. That is, attracting riders to them from transit. Approximately 29% of the organizations that replied deem market acceptance would not be easy if ridesharing were to substitute “full transit service” *[66]*.

CHAPTER 2: LITERATURE REVIEW

For purposes of this research, a vast assortment of publications were reviewed. Included amongst the 350-plus pieces examined were research papers, theses, webpages, blogs, op-eds and a myriad of articles. Similar in range were the authors' views regarding replacement. Without question, many believe TNCs complement transit including the American Public Transportation Association, along with a report by the Transportation Research Board *[38, 40, 44, 52, 66, 74, 88]*.

Some writers are under the impression that TNCs can supplement transit *[30, 47, 50]*. Various authors view TNCs as competition to transit *[28, 40, 46, 52, 53, 71, 76, 85]*. There are those that believe TNCs want to replace public transit *[32, 37, 39, 43, 52, 58, 63, 80, 83, 88]*.

Yet, there are authors who believe that TNCs may be a panacea to the first mile/last mile problem *[40, 84, 88]*. One opinion is how TNCs may substitute rather than complement or replace public transportation *[86]*.

Bear in mind, at the time this thesis was conceived, the subject matter of TNCs was barely in formulation. However, one unearthed research document – the Maxi Taxi Study – sustains a single degree of separation that sets it apart from this thesis. And that is the smartphone app.

The Maxi-Taxi (MT) demo was one of 17 grant-funded projects under the purview of the Federal and State of Virginia DOTs. Moreover, out of all 17 – the Maxi Taxi demo was the only one of its kind. The goal of the MT demo was set out to prove cost-efficiency of replacing public transportation with a shared-ride taxi. This demo began in 1980 with the anticipation of it being no longer than a one-year pilot.

The Tidewater Regional Transit (TRT) was the transit agency (TA) awarded grant funding to implement the MT demo. Although its main goal was to achieve reductions in operational costs, other goals were to inject service into low-dense areas and to supplant some of their inefficient fixed-route bus service. TRT entered into contracts with local taxi companies. For the most part, the service comprised "one-to-three vehicle[s]…operat[ing] as a combination demand-responsive and scheduled-route service within a specified service area" *[59]*.

Initially, the MT demo did not have a smooth transition as TRT had issues of opposition similar to the current sparring between TNCs and the taxicab/for hire livery industry, The taxi cab companies felt that the MT demo could imperil cab driver employment as a function of their customers gravitating towards MT, further leading to decreases in business. TRT maintained that there would be no chance of that occurring since the service would be fulfilled by local taxi firms.

Another issue was taxi companies operating within the State of Virginia would not be "regulated by the transportation district commissions" *[59]*. Like the aforementioned, an enormous controversy has been the lack of any oversight or legislation policing TNCs. Whereas, in opposition, the taxicab and for-hire livery industries are highly regulated.

Originally, TRT designated 11 of their conventional bus routes to be placed under the MT demo. The TA selected six from the 11 for replacement by taxis.[19] One of these routes was kept as fixed-route service while the remaining five were door-to-door. Varied as well amongst these routes were levels of service, hours of operation and fares. Interestingly, the other five were all terminated by or before the end of the demo. Only those routes slated for replacement were still in revenue service operation at time the demo concluded. Other salient points are:

[19] Some of the routes that were served by conventional transit buses were replaced by van-sized vehicles operated by the taxi companies.

1. Service changes: One route had its service area expanded and merged with another route with excellent results leading to the addition of jitney service. The other routes had adjustments to account for poor ridership.
2. Overall ridership: Only two routes attained an increase in ridership. The remaining four routes had Unlinked Passenger Trip (UPT) decreases.
3. Net Cost per Passenger showed that from commencement of the demo to its termination only one route showed an increase.

Ultimately, TRT maintained many of the instituted services which can be inferred that the MT was a "promising" viable alternative concept that "demonstrated that a transit operator [could] provide certain types of service at [a] lower cost …[using] shared-ride taxi services *[59]*.

Later on, will be a more detailed discussion on the City of Austin, Texas which was chosen as the case study venue. In an article, the Austin, Texas transit authority called Cap Metro, planned, inter alia, to include replacing at least 30 of its 80 bus routes due to plummeting ridership. Cap Metro hired consultants who advised the transit agency on how their ridership could see a sharp increase if they conducted a system wide overhaul. Noted is the direct correlation between ridership and federal subsidization. If there is a decrease in ridership, federal grants and other funding decreases with it and vice versa. Although Cap Metro will not execute a total replacement with TNCs, it may conduct a pilot program in "seven mobility innovation zones…[to] perhaps [include] ride-hailing services *[87]*.

Related, and considered the transit industry outlier, is New York City. The annual subway or heavy rail ridership is over 3.5 billion UPTs *[4]*.[20] Yet, what if TNCs could replace public

[20] The data was extracted from the 2014 Annual Agency Profile. It includes the total annual UPTs for HR and MB.

transportation in New York City? If TNCs could do so, logically, it could be deduced that they can manage public transportation of any ridership levels that currently exist in the United States.

Williams and Hawkins published articles and Schaller's research document, examine whether TNCs actions give the public a perception of standard competitive market entry or intentional encroachment upon the New York City transit industry.

Uber claims to have carried 50,000 passengers in a single week of October 2015 under their UberPOOL service option in New York City. Further is how Uber proclaims they are not seeking to compete with New York City's transit system. Hawkins asserts that due to the voluminous amount of passengers "it's not [about] competition - but about taking more cars off the road through matched rides". UberPOOL passengers receive a 25% fare reduction. Doing so, in effect, would mean Uber is competing with transit. In July 2016, Uber offered a fare payment and transit-like service called Uber Commuter Card. This empowered passengers with unlimited rides, albeit with some restrictions. This particular promotion was a complete sell-out, yet has not been duplicated since *[88]*. The latter should be indicative enough to attract the attention of policy decision makers when conjoining the number of Uber rides conducted in October 2015 with the aforementioned promotion.

Uber promulgated that it is not seeking to get involved in private transit *[52]*. Yet, Uber Hop is similar to UberPOOL where more than one rider traveling along the same route is matched with that particular driver. And making it quite similar to transit is where the UberPOOL customer must walk to a rendezvous point at an appointed time. Uber tested Uber Hop in Seattle, where it was described the service as "an imitation public bus service" *[52]*. But the long-term image of replacement would not be too far behind. He quotes a professor from Columbia University who believes that UberPOOL "competes with public transit, but Uber pool and transit services are not

direct competitors for a wide range of riders and situations" *[52]*. In another of his articles, Hawkins states how Uber's long-term vision is for a concept called "the perpetual trip" *[52]*. The idea is for vehicles to consistently be filled with customers. He concludes with the subsidization of rides is costing Uber "when a rider selects [the] Uber POOL [option], but the driver fails to find another fare, Uber covers the difference between the discounted or regular fare. [Uber] is reportedly burning through money faster than it can earn" *[52]*. Uber terminated UberHop service on Friday, August 19, 2016. Another TNC, Lyft, avails similar services called Shuttle. It is currently being experimented in Chicago and San Francisco *[51]*.

Schaller's research is based upon "[TNCs] effects on traffic congestion and…their potential to undermine public transit and taxi services that are essential components of urban transportation networks" *[71]*. His findings include "TNCs transported 15 million passengers per month in Fall 2016; TNC ridership tripled between June 2015 and the Fall of 2016; TNCs generated net increases of 31 million trips and 52 million passengers since 2013 *[71]*. "In 2015, however, as Uber and Lyft grew rapidly, taxi/for-hire ridership increased by 17 million passengers. Subway and bike ridership each increased by 11 million trips. Bus ridership declined for the second year in a row"; "Most TNC customers are coming from transit…Migration from public transit translates to increased mileage even if the trips are shared" *[71]*. Schaller alludes or minimally believes replacement could occur if passengers alter their mode choice from transit. And because of an "aggressively customer-focused private sector competitor with deep wells of capital for expansion and marketing. If managers of the transit system and street network do not respond quickly and effectively, TNCs will continue to attract rapidly increasing numbers of customers to their services, with increasing impacts on traffic congestion, transit ridership and potentially traffic safety and the environment" *[71]*. Schaller, a nationally recognized taxi industry consultant

provides crucial support with his indirect inference of how TNCs could replace public transportation even in large and very large cities: “Thus, in highly transit-oriented areas like the San Francisco neighborhoods… TNC trips are about six times more likely to displace transit, walking and biking trips than personal auto trips. In Denver, which has a higher non-auto mode share, TNC trips are about equally likely to displace personal auto trips as transit/walking/biking trips” *[71]*.

As this paper was coming to an end, Hall, et. al., introduced quantitative evidence proving TNCs complement public transportation *[49]*. Nonetheless, while their research ensures transit ridership increases within a two-five year span, post-TNC entry, they are unsure of whether TNCs are a blessing or curse. Despite the fact that the scholars demonstrate that TNCs contribute to public transportation ridership growth the researchers express concern, similar to Schaller, about recent dips in the number of passengers may be from the inherence of TNCs. That is, people will switch from transit even if TNCs are more expensive and offer a higher level of service such as swiftness and reliability.

To summarize, many authors believe transit can benefit by collaborating with TNCs it is only a matter of how. Although the majority of the narratives believe TNCs can complement properties, there are some who that take into account other roles like supplementation. Very few discuss supplantment as a possibility except a nearly 40 year-old study, called the Maxi Taxi demo. It gives an indication of the effects of replacing transit with a taxi particularly at a time when smartphone apps where not invented. Recent slumps in the number of unlinked trips may be affected by TNCs. The latter is a concern to researchers and a caution to transit agencies.

CHAPTER 3: CASE STUDIES

Upon reviewing a myriad of publications for this paper, inferred from all of the authors were how they are in agreement that transit can benefit greatly by enlisting TNCs. A couple of cases were already referenced in Chapter 1. Supplementation and complementation, are examples of a TNC/TA partnership. If properly organized, a property could mitigate or possibly eliminate its first mile/last mile condition.

There have been at least ten instances, latterly, where a TA or municipality entered into some type of an agreement with a TNC. In most cases, they were generally promulgated as pilot programs. Similar to a temporary trial period, if the pilot was deemed successful, it would then be a matter of what next steps of feasibility would be. That is either there'd be permanence or a modification to the program such as a minor adjustment to fares, service and/or variation of revenue vehicles coupled with a time extension.

The bulk of the alliances involve first mile/last mile (F/L) partnerships. First mile/last mile, as previously discussed, is where people may require more than one mode to reach their destination. Whether it is due to living in areas of low density with barely any to non-existent public transportation options, or working too remotely from the closest transit facility, this type of accord with TNCs can empower TAs to attempt dissolving the longstanding F/L dilemma. More important is how this could develop into a new method of attracting customers and increasing ridership. Largely, the pilot programs were deemed a success.

In Table 3.1, an overview of recent, current and planned-for TA/TNC relationships are shown. For the most part, Table 3.1 is self-explanatory and only the salient cases will be discussed.

Table 3.1 Case Studies

Agency	TNC	Relationship	Program Name	Year
LACMTA	Any TNC	GRH	Guaranteed Ride Home	2015
PSTA	Uber	F/L	Direct Connect	2017
San Diego MTS	UberPOOL	F/L & Special Events	*Not Applicable*	2016
Centennial, CO	Lyft	F/L	Go Centennial	2016 - 2017
SEPTA	Uber	F/L; busiest stations w/ltd parking	Rails to Rideshare	2016
Altamonte Springs, FL	Uber	F/L and general trips w/in city	*Not Applicable*	2016
Maitland	Uber	F/L and general trips w/in city	Municipal Mobility Working Group	2016- 2017
MBTA	Uber/Lyft	Paratransit	The On-Demand Paratransit Pilot	*Ongoing*
MARTA	Uber	F/L and general trips w/in city	Last Mile Campaign	2015
LAVTA	Uber & Lyft	F/L & low density/no T	Go Dublin	2016
Arlington County, VA	Uber or Lyft	Low ridership	(proposed study based on Transit Dev. Plan	Proposed 2016
Minneapolis Metro Transit	Any TNC	GRH	Guaranteed Ride Home	*Ongoing*
Summit, NJ	Uber	F/L	City of Summit Commuter Parking Ridesharing Pilot Program	2016
SORTA	Uber	F/L	*Not Applicable*	*Ongoing*
DART	Uber	Special Event & General	*Not Applicable*	2015

3.1 Centennial, Colorado

Uniquely, the City of Centennial, Colorado earned the distinction of becoming the first municipality in the United States to fully subsidize TNC rides. Go Centennial Pilot, as was titled, united with Lyft.

Eligibility for the 100% subsidization included specific terms and conditions as listed below:

1. Geographical Restriction. Riders received free rides if they were within the explicit boundaries demarcated by the City of Centennial and
2. Origin/Destination. Can only go to and from the local light rail station.

Although the program was only preplanned for six months, it was deemed a success. Presently, there are discussions for another pilot modified to be expanded regionally.

3.2 Pinellas Suncoast Transit Authority

The Pinellas Suncoast Transit Authority (PSTA) is another property proclaiming to have had a positive partnership with a TNC. PSTA established a one-year pilot program to assist with their F/L challenge. At the time, they announced the original pilot program, it already had been providing "a subsidized taxi service" known as the East Lake Shuttle *[62]*. The East Lake Shuttle program and Uber varies in that the TNC would be instantaneously available upon request as opposed to the Eastlake Shuttle which required advanced reservations. Like the Go Centennial Pilot, it was restricted by geographical limitations.

PSTA predicted that it would be successful from a financial perspective. The East Lake Shuttle cost PSTA approximately $16 per person, with riders paying $2.25 – hence, the total cost was $18.25 per ride. A countywide pilot plans to have riders pay one dollar for the TNC and PSTA would subsidize five dollars. This amounts to a savings of $1.25 for the passenger and $11 per rider by the property.

In October 2016, PSTA announced that as a result of the program's favorable outcome, it was going to implement another pilot program but expand it countywide and invite Lyft to come on board. A countywide pilot program was scheduled to commence mid-December 2016. The geographically expanded program inaugurated in January 2017, for six months, and is formally called Direct Connect.

3.3 Guaranteed Ride Home

Whether you are stranded or must work later than usual to meet a crucial deadline, Los Angeles County Metropolitan Transportation Authority (LACMTA) and Minneapolis Metro

Transit assure it will get a person home. Called the Guaranteed Ride Home (GRH) program, these agencies have entered into agreements with TNCs in the event a situation should arise. Each transit agency has a set list of circumstances that qualify for the passenger to receive full reimbursement.

3.4 Special Events

From time to time, transit agencies must tend to unordinary activities as they can result in higher than normal passenger convergence. Examples are Dallas Area Rapid Transit (DART), for Saint Patrick's Day events and Uber. The TNC gave riders $20 off their very first Uber trip.

San Diego Metropolitan Transit System (MTS) had its most recent Comic Con concurrently with a major league baseball game, and when LACMTA celebrated the extension of one of its lines, Uber was the preferred TNC. Uber furnished a $5 discount for riders. Notable are all these promotions were no longer than three days.

3.5 Replacement

Within the realm of this paper is the discussion of supplanting transit by a TNC via subsidy. For instance, the County of Arlington, Virginia which was in deliberation of replacing some of its fixed-route bus service with TNCs, and Livermore Amador Valley Transit Authority (LAVTA) who wants to substitute some bus service to enhance transporting people to and from the local commuter rail station.

3.6 Purchased Transportation

The National Transit Database (NTD) requires transit agencies to report the mode and type of service or TOS. Modes are reported to the NTD with a two-letter code. For example, Capital District Transportation Authority (CDTA), the transit agency located in Albany, New York, provides regular bus and commuter bus services. At the time that CDTA files their reports the

codes used, respectively, are MB and CB. Agencies that report regular bus service mode use MB for motorbus, and CB for commuter bus.

There are two types of TOS, for NTD reporting purposes. TAs either or in some cases both, directly operate or purchase transportation. A two-letter code is applied to TOS as well: DO and PT, respectively. The differentiation how the TA operates. TAs can directly hire the drivers and mechanics, and procure and maintain the vehicles. Purchased transportation is where a property farms out or purchases transportation service via a subcontractor. Under this category, the subcontractor would generally be responsible for hiring drivers and mechanics, and vehicle maintenance. The subcontracting firm may also be accountable for purchasing the vehicles subject, of course, to the contract terms and conditions agreed to by the TA employing them.

Table 3.2 shows transit operating expenses by mode and type of service. Already mentioned afore are the types of service (TOS): purchased transportation (PT) and directly operated (DO). The highlighted portions are provided to simplify the difference between the modes and TOS. Observe how under PT the modes have, primarily, trifle labor costs. This is not insignificant since labor costs for a TA can be as much as 61.1% of its budget.[21] Conflicting are the operating expenses for modes the TAs directly operate. If a contract were issued to a TNC, regardless of whether the TNC is temporarily or permanently replacing transit, the TA could very well realize substantially reduced operating expenses.

[21] This is 2014 data taken from the 2016 APTA Fact Book Appendix A: Table 70. The percentage shown is the result of blending Salaries and Wages with Fringe Benefits.

Table 3.2 Transit Operating Expenses by Mode

Mode	Mode	TOS	Total Operating Expenses	TOTAL WAGES (not including *Fringe Benefits)*	Operator Wages as a % of Total Wages	Operators Fringe Benefits	% of Total Operator Labor Costs/ Total Operating Expenses
Aerial Tramway	TR	PT	2.3	0.0	0.00%	0.0	0.00%
Bus Rapid Transit	RB	PT	8.2	0.4	0.00%	0.0	0.00%
Demand Response - Taxi	DT	PT	165.3	9.8	0.00%	0.0	0.00%
Ferryboat	FB	PT	65.1	1.4	0.00%	0.0	0.00%
Heavy Rail	HR	PT	57.4	0.0	0.00%	0.0	0.00%
Hybrid Rail	YR	PT	84.0	7.2	0.00%	0.0	0.00%
Light Rail	LR	PT	107.9	10.7	0.00%	0.0	0.00%
Monorail/Automated Guideway	MG	PT	24.4	2.4	0.00%	0.0	0.00%
Publico	PB	PT	40.4	0.1	0.00%	0.0	0.00%
Street Car Rail	SR	PT	38.7	1.4	0.00%	0.0	0.00%
Vanpool	VP	DO	87.8	18.6	0.00%	0.0	0.00%
Vanpool	VP	PT	84.9	5.3	0.00%	0.0	0.00%
Bus	MB	PT	2,513.6	94.3	0.46%	0.3	0.03%
Commuter Rail	CR	PT	1,222.0	58.0	0.53%	0.2	0.04%
Demand Response	DR	PT	2,636.8	115.6	0.58%	0.4	0.04%
Commuter Bus	CB	PT	243.9	13.3	2.35%	0.2	0.19%
Monorail/Automated Guideway	MG	DO	50.2	17.9	5.16%	0.3	2.52%
Heavy Rail	HR	DO	8,591.0	3,548.6	15.81%	492.7	12.27%
Light Rail	LR	DO	1,638.3	614.1	23.73%	103.3	15.20%
Commuter Rail	CR	DO	4,437.7	1,666.9	28.95%	400.0	19.89%
Alaska Railroad	AR	DO	39.0	16.3	35.35%	1.7	19.23%
Inclined Plane	IP	DO	3.2	1.3	43.61%	0.4	28.83%
Street Car Rail	SR	DO	101.5	43.6	44.56%	15.6	34.55%
Cable Car	CC	DO	52.1	26.0	50.96%	11.5	47.49%
Trolleybus	TB	DO	249.0	110.9	53.23%	41.4	40.34%
Commuter Bus	CB	DO	764.9	293.5	56.15%	107.7	35.63%
Bus Rapid Transit	RB	DO	112.2	41.5	56.24%	19.3	37.99%
Bus	MB	DO	17,161.8	7,111.0	57.32%	3,085.4	41.73%
Demand Response	DR	DO	966.9	374.0	59.04%	137.6	37.07%
Ferryboat	FB	DO	503.4	200.5	62.26%	49.2	34.57%

Source: NTD 2014, Table 13

CHAPTER 4: METHODOLOGY

To conduct the quantitative analysis, the question posed is what methodologies are to be employed as part of the supporting evidence for the hypothesis: TNCs could replace public transportation in the United States if they are subsidized at the same level of TAs.

4.1 Data Sources

4.1.1 Transit Agencies

Transit agency data was procured from the National Transit Database (NTD). NTD is overseen by the Federal Transit Administration, one of several divisions under the auspices of the United States Department of Transportation (USDOT).

US Federal law, precisely Title 49 of the United States Code §5335, requires a reporter or transit agency to 'report' or file certain vital revenue operational and financial statistics on a monthly basis. Specific agency material was extracted from NTD 2014 Transit Agency Profiles. These profiles furnish monetary measurements, and other performance metrics used to calculate the figures detailed further in the Results and Discussion section. NTD is generally two years behind. As an illustration in the year 2016, it will provide researchers with 2014 data. Thus, the Florida Transit Information System (FTIS) was employed, secondarily, to accompany and support NTD info where incomplete. FTIS is an online database that offers quicker access to the latest TA statistics. To maintain consistency, all data is from the year 2015, except where indicated.

Besides the Profiles dataset, other facts and figures were derived from the 2015 Public Transportation Fact Book Appendix A: Historical Tables. These tables are industry-wide and

provide aggregated numbers based upon type of mode, and its corresponding expenditures such as operational and capital costs.

The American Public Transportation Association (APTA) is a professional organization that speaks for the public transportation industry. APTA represents the full gamut of modes including, but not limited to, people movers, ferries and funiculars. APTA produces their own datasets from information gleaned by its members. The annually figures are aggregated industry-wide by mode and a variety of operational statistics. APTA also obtains data from NTD.

4.1.2 TNCs

Data was extricated directly, where possible, from the TNCs respective websites. i.e. www.uber.com, www.lyft.com, etc. Due to the proprietary nature, the only open data available are the details of how they approximate their fares. The latter was confirmed either by live telephone conversations with representatives of TNCs or delving every single TNC website. Google Maps furnished routes, route lengths, travel times as well as transit options.

4.2 Metrics

The metrics utilized for determining productivity efficiencies, calculating the aggregated financial performance of TAs, and subsequent subsidization is organized for reference in Table 4.1. In the How Calculated column, the Tables refer to those found in the 2015 APTA Fact Book Appendix A – Historical Tables.[22] For those items that couldn't be found in any of the APTA Tables or any other of their publications, either were located in FTIS and/or supplementary publications. Furthermore, the calculations regardless of wherever they were found are fully explained.

[22] https://www.apta.com/resources/statistics/Documents/FactBook/2015-APTA-Fact-Book-Appendix-A.pdf

Table 4.1 Metrics

Metric	**Unit of Measurement**	**How Calculated**
Average Trip Length	miles	Table 5
Vehicle Revenue Miles	millions	Table 11
Passenger Miles	millions	Table 3
Vehicle Revenue Hours	millions	Table 15
Average Occupancy	per Passenger	Passenger Miles (millions)/Vehicle Revenue Miles (millions)
Number of Unlinked Trips	millions	Table 1
Average Fare (USD)	per unlinked trip	Fare Revenue (Millions of USD)/Ridership (Millions)
Assumed Average for Vehicle Revenue Capacity or Quantity of Seats per Vehicle	per Passenger	Number of Active Vehicles in Fleet x Seating Capacity/ Number of Active Vehicles in Fleet
Total Expenses (USD) includes Capital and Operating Costs	millions	Tables 62 and 68
Fare Revenue (USD)	millions	Table 92
Subsidization (USD)	millions	TA Total Expenses - TA Fare Revenue
Average Subsidy (USD)	per Passenger	Subsidization (USD)/Ridership
Average Vehicle Revenue Speed	miles per hour (MPH)	Vehicle Revenue Miles (millions)/ Vehicle Revenue Hours (millions)
Assumed Average for Vehicle Revenue Capacity or The Quantity of Seats per Vehicle (Total = Seating + Standees)	Passengers	Number of Active Vehicles in Fleet x (Seating Capacity + Standing Capacity)/Number of Active Vehicles in Fleet
Efficiency (assumed capacity)	Percentage	Average Occupancy/Assumed Average Revenue Vehicle Capacity

Pre-established is how TNCs do not make their data readily available to the public. Accordingly, some of the data needed is not easily or promptly obtainable other than what is promulgated on their respective websites. Therefore, certain assumptions were made and are systematized in Table 4.2.

Table 4.2 TNC Assumptions in Methodology

TNC Metrics	**Unit of Measurement**	**TNC Assumptions**
TNC: Average Trip Length	miles	Assumed trip length is the same as TA mode average trip length; Pathway is mirrors route
TNC: Average Vehicle Speed	miles per hour (MPH)	Equal or higher than MB
TNC: Fare	per Passenger	Regular TNC fare
TNC: Average Trip Duration	minutes	Time is approximate and was retrieved from Google Maps

Further assumed are vehicle revenue miles and average trip length remain the same. The metric's figures stay the same since an apple-to-apple or as close as possible comparison is being presented. Average vehicle revenue speed of the TNC is equal or higher than road-based vehicles. This is mainly due to dedicated bus lanes versus uncommitted lanes for taxis and regularly operated passenger cars. Also, cars may move faster since they do not have to constantly stop to conduct boardings and alighting which can result in increased bus dwell time and revenue service bus travel time.

4.3 Venue

For venue selection, the City of Austin, Texas was chosen. Forbes Magazine named Austin the fastest growing city in the United States.[23] As of 2016, it had a population growth rate of 3.15% and is the capital of the state of Texas *[15]*. From this it can be inferred that the trend is for anticipated development. This became obvious to Austin's business leaders and elected representatives as they continue to plan, strategize and prepare accordingly in anticipation for its future's inevitable expansion. The TA for Austin is Capital Metropolitan Transportation Authority or Cap Metro. It is designated as operating within the 37th largest Urbanized Area (UZA). Atypical is the quantity of 18 TNCs, Austinites can select from.[24]

In the United States properties are of various sizes: small, medium, large and very large. Without question, TNCs are already operational in many small, medium and larger sized metropolitan areas. Supposing that TNCs are legally permitted to operate everywhere it could, at the very least, engage parallel to any sized reporter. And what makes this characteristically attractive is how TNCs currently manage to transport thousands of riders. There are 18 TNCs

[23] Forbes named fastest growing United States city at least twice – 2012 and 2016.
[24] Recently, it was ascertained that ScoopMe, the 19th TNC, ended operations November 30, 2016. There are, currently, 18 TNCs in Austin

already operating in Austin. Only Lyft Line offers a commuter type of fare. Assumed are these low fares are privately self-subsidized with investor funds. Even if it is highly speculated that TNCs operate under this type of strategic tactic to increase ridership, should a private public partnership be combined with government assistance, that is subsidization, this could lead to a serious contemplation for supplantment.

The origin/destination pair selected was based upon iconic status and proximity. The AMTRAK Station is well-established. The Barton Creek Square shopping mall is also deeply-rooted in the Austin metropolitan area. The route is as close to the TA's Average Trip Length as can be attained.

4.4 Other

Taking all the above into consideration, this paper's scope is purposely limited to the United States for a miscellany of reasons listed below:

1. Language Barriers. Even with tools such as Google Translate there is no guarantee that a perfect translation shall occur. Above all, tools such as the latter provide literal interpretation. Those can be problematic for people who do not speak that language as they will not notice the dissimilarity. Also, some languages utilize that type of verbiage for idiomatic functions. Procuring information from foreign transit and government agencies can been challenging especially if the responsible personnel do not speak English fluently.[25]
2. Legal restrictions. Some foreign properties and/or agencies may not be permitted to release data because of policy or their country's laws.[26]

[25] At least s/he claimed to want to help but could not do so because of a lack of English comprehension or some other raison d'etre.
[26] An example of a policy is where the data can only be utilized by citizens within the country of agency origin.

3. Ease of Data Procurement. The Federal government mandates TAs to submit statistical reports making the task of obtaining and examining data straightforward. Especially if, for the most part, it is within a single data source. For reasons stated earlier, this may not be the case for many other countries.

CHAPTER 5: ANALYSIS, RESULTS AND DISCUSSION

Until this point, there has been a comprehensive qualitative analysis of how the TNC could replace public transportation if subsidized at the same level of TAs. Detailed below is a quantitative study of figures to support this hypothesis.

As previously mentioned in the Methodology section, public transportation agency data was employed from the National Transit Database 2014 Transit Agency Profiles and Florida Transit Information System (FTIS). To maintain consistency, unless otherwise specified, NTD is 2014 and FTIS data is for 2015. The TNC information was directly obtained from their respective websites and with personal follow-up telephone calls where necessary.

The City of Austin, Texas was chosen as the case study venue for a few reasons. First, constituents can choose from as many as 19 TNCs. Second, it is one of the fastest growing cities in the United States.[27] Finally, it operates a multi-modal transit system within a large city.

5.1 Austin, Texas

As a working example, a simplistic route:

1. Origin: AMTRAK Railroad Station
2. Destination: Barton Creek Square Shopping Mall
3. Length: The route is approximately 4.5 miles.[28]

[27] Forbes has named Austin "America's fastest growing city" two times. https://www.forbes.com/pictures/56d9af8fe4b0c144a7f6b761/americas-fastest-growing-/#4e581bf93bbe

[28] Trip length approximation was taken from Google Maps utilizing their preferred path for a vehicle with no special options selected on July 12, 2017. Google Maps provides Cap Metro info, but did not furnish detailed distance information. Travel via car is 4.5 miles.

4. Time: Car; approximately 7-13 minutes; Transit: 41-50 minutes by transit [29]

5. Local transit agency: Capital Metropolitan Transportation Authority or Cap Metro.

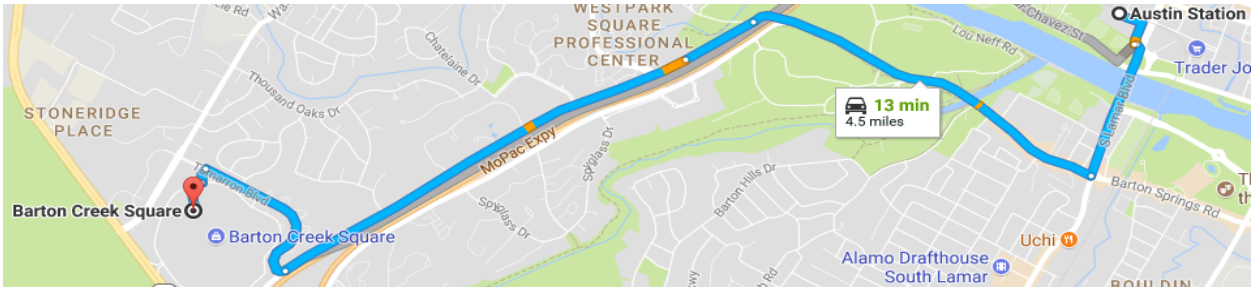

Figure 5.1 Route Map via Car

Source: Google Maps

Figure 5.1 and Figure 5.2 show the route differences between the selected origin and destination. Figure 5.1, clearly, shows how traveling by car (or assumingly TNC) is the most direct and quickest mode when measured up to the transit route as can be seen in Figure 5.2. However, the TA and TNC, as a disclaimer, should inform its customers route circuity could occur.

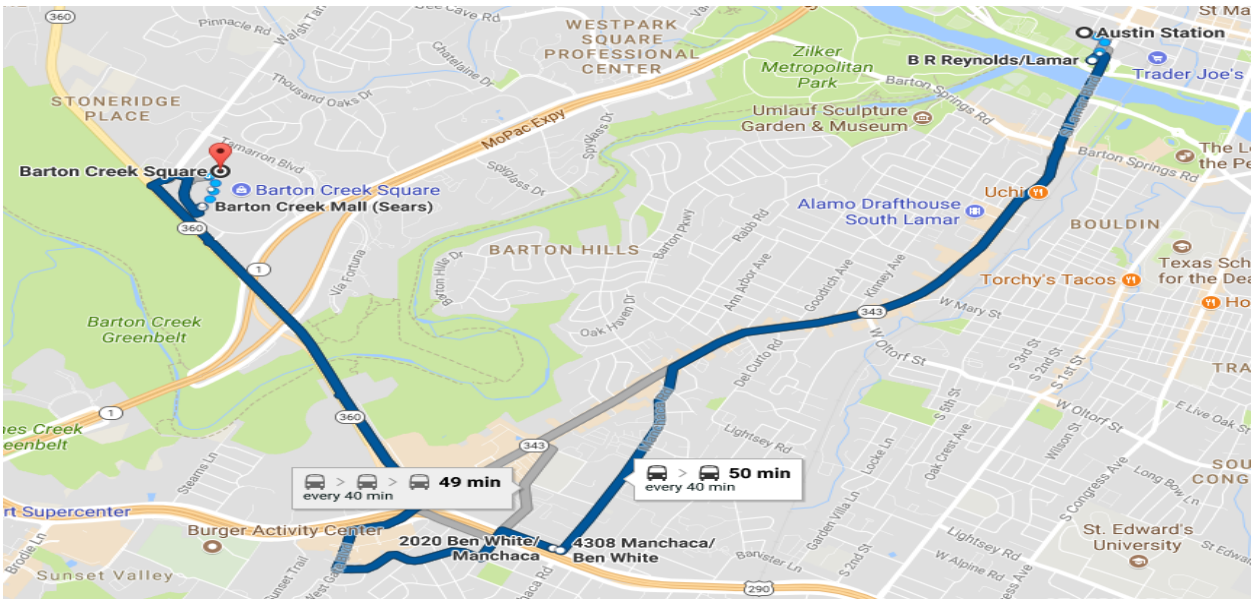

Figure 5.2 Route Map via Transit

Source: Google Maps

[29] Time estimates provided by Google Maps on July 12, 2017. Trip time estimates are time-of-day based.

As mentioned in the introduction, one of the significant factors of inducement shall be cost structure. In other words, how much will the transit agency expend to furnish a steady flow of readily available revenue service? Part of that cost structure involves subsidization. However, the financial support, in these case, would to go the TNCs.[30] The other factor is the temporal element. That is, what value is placed on an individual's time so s/he can quickly arrive at their final destination?

Below is a step-by-step breakdown on how much it costs to subsidize a TNC if it were on equilibrium with Cap Metro. In the final analysis, two main determinants for TAs and TNCs are ridership and speed. TNC charges are based upon distance and time. Whereas a TAs fare policy is, generally, either a uniform or flat-rate fare regardless of time or if distance-based.[31]

In Table 5.1, the basic fare calculation is per ride traveling in Austin via a TNC. TNC fares, in Austin, are contrasted amongst its peers and compared to Cap Metro. Although the transit fare is $1.25 per person per ride, TNCs are highly competitive amongst themselves.[32] Additionally, the five TNCs (i.e., Uber, Lyft, Fasten, Ride Austin and T-Ride) were selected based on competitive fare range.[33] Shown are how subsidization could be if TNCs were fully occupied. Included are the menu of service levels, a potential customer can choose from comprising vehicles at full capacity that range from four to six. Table 5.2 is an extension of Table 5.1 due to space limitations. As a convenience, the TA fare is posted as a reference.

Moreover, Table 5.1 shows the basic fare structure regardless of how many persons travel along the AMTRAK Station to Barton Creek Square Shopping Mall route using TNCs as their

[30] The assumption here is the possibility is, especially with 19 concurrent TNCs operating in Austin, more than one TNC will vie for and function accordingly,
[31] A number of TAs when they do charge based on distance it is often a flat fare within a zone. A zone is a demarcated area
[32] Fare data was extracted from the TNCs respective websites on August 6, 2017.
[33] The subsidy is based upon base fare calculation. i.e.; before actual time and mileage is applied which can change the final fare and necessitated subsidy, if any.

mode choice. Clearly, it can be seen how T-Ride (regular sedan service) is cheaper compared to its more prominent rivals: Uber and Lyft. The latter two TNCs, though may have established brand recognition, by contrasting their fares, as seen in Table 5.1, Lyft would be cheaper.

Table 5.1 Comparison of Main TNC Basic Fares

	Uber	Uber XL	Lyft	Lyft Plus	Fasten	Cap Metro
Per Mile	$1.06	$2.06	$1.00	$2.00	$1.00	
Per Minute	$0.20	$0.30	$0.20	$0.30	$0.20	
Booking Fee	$1.95	$2.15	$1.95	$2.15	$2.00	
Base Fare	$1.00	$2.00	$1.00	$2.00	$1.00	
TOTAL FARE	$4.21	$6.51	$4.15	$6.45	$4.20	$1.25
Minimum Fare	$5.95	$8.65	$4.00	$6.50	$6.00	$1.25

Table 5.2 Comparison of Other TNC Basic Fares

	Ride Austin	RA Premium	T-Ride	T-Ride SUV	T-Ride Luxury	Cap Metro
Per Mile	$0.99	$2.75	$1.00	$1.75	$2.25	
Per Minute	$0.20	$0.40	$0.25	$0.27	$0.30	
Booking Fee	$2.00	$2.00	$1.75	$1.75	$1.75	
Base Fare	$2.50	$4.00	$1.00	$1.75	$2.00	
TOTAL FARE	$5.69	$9.15	$4.00	$5.52	$6.30	$1.25
Minimum Fare	$4.00	$10.00	$5.50	$7.00	$9.00	$1.25

The Total Fare per Passenger based on Full Capacity, seen in Table 5.3, is provided for this O/D pair.[34] Although Table 5.3 provides five TNCs, original estimates involved six TNCs offering 17 different LoS. The five TNCs selected also indicated the lowest subsidy amongst the competition. Assumed is the transit fare at $1.25 per person, and the mileage equal to the TA's average trip length. Uber, even with their basic service is, for the most part, higher than the other three TNCs. Remember that there are also different levels of capacity. T-Ride, an Austin-based

[34] According to Google Maps, the fares range is $1.25 to $3.75. This is subject to the route selected at the time of the passenger's departure. Cap Metro maintains a no transfer policy. The fare ranges from a one-seat ride to up to three buses for this O/D pair.

TNC, offers a SUV vehicle as part of their list of optional services available, if requested. A SUV has a maximum capacity of up to six passengers. The remaining levels of service indicated all have a general capacity of up to four passengers. Interestingly, is how competitive T-Ride SUV is with Lyft's basic service. Lyft Line, a low-cost service for groups of four, again assuming full capacity, has a slightly lower subsidy but may not be readily procurable.[35]

Table 5.3 Comparison of TNC Fares for One Person

	Uber	**Lyft**	**Fasten**	**T-Ride**	**T-Ride SUV***
Per Mile rate	$4.77	$4.50	$4.50	$4.50	$7.88
Per Minute rate	$2.54	$2.54	$2.54	$3.17	$3.42
Booking Fee	$1.95	$1.95	$1.95	$1.75	$1.75
Base Fare	$1.00	$1.00	$1.00	$1.00	$1.75
TOTAL FARE	$10.26	$9.99	$10.04	$10.42	$14.80
Total TNC Fare per Passenger Full Capacity	$2.56	$2.50	$2.51	$2.61	$2.47
Transit Full Fare (CAPMETRO) Subsidy = TNC Fare - Transit Full Fare	$1.25 $1.31	$1.25 $1.25	$1.25 $1.26	$1.25 $1.36	$1.25 $1.22
Minimum Fare	$5.95	$4.00	$6.00	$5.50	$7.00

* = 6 person vehicle; all others are 4 persons

Upon analyzing the three-cent difference in subsidization, under the assumption between the basic Lyft service and T-Ride SUV (up to six passengers) comes to a lesser difference of under one million dollars.[36] Equally noteworthy are how the minimum fares are substantially competitive.

The formula for calculating TNC's cost per mile for this trip is:

$$\textit{Average TNC's Cost per Mile for this Trip} = \frac{\textit{Average Total TNC Fare for this Origin/Destination}}{\textit{Total Trip Length}}$$

[35] Lyft Line is operable in selected markets.

[36] The annual number of unlinked trips was based upon the NTD 2015 Transit Agency Profile which denoted ridership of 32,261,330 bus passengers. The exact figure is $969,991. It was rounded for purposes of simplification.

Keep in mind, the TNC's cost per mile will vary, as does their total fares, only the trip length is constant. Total TNC Fares differ also subject to the TNC and level of service preferred. Basic TNC LoS has a Total Fare ranging from $9.99 to $10.42, with Lyft placing lowest and T-Ride ranking highest.[37]

For this trip, assumed is an average Total TNC Fare of $10.17, and the total trip length is 4.5 miles.[38] The Average TNC cost per mile, for this trip, is $2.47. Comparatively, Cap Metro's costs for this trip is slightly under 400% more. However, the bigger picture is the level of subsidization between the modes. The TNC subsidization was calculated by the following formula:

Average TNC Subsidy (for this trip) × Total Cap Metro Ridership (2015) = $41,295,000

The Average Regular TNC Subsidy, for this O/D, amounted to $1.28 per passenger. This figure was first derived by adding the subsidies for the TNCs (Uber, Lyft, Fasten, T-Ride and T-Ride SUV/5) in Table 5.3. Then, multiplying Cap Metro's annual number of unlinked trips. This is a substantially lower amount when contrasted to the $124,400,000 it would cost to subsidize Cap Metro – about a 300% difference.

It must also be recognized that the $19.04 per hour TNC drivers earn is based upon straight time.[39] The latter does not take into consideration factors such as:

1. Partner Share. TNCs officially manage their drivers as independent contractors.[40] Regardless of the vernacular, each TNC acts as if it were in a partnership by deducting a percentage from the total revenue of each ride. Using the above fare as an example, if a TNC fare is $9.99, the

[37] Technically, Lyft Line is the lowest, and T-Ride SUV is the highest. However, Lyft Line is not a ubiquitous basic service and T-Ride SUV has a higher capacity.
[38] This does not include the T-Ride SUV which is a 1+6 capacity vehicle. If included the average fare would be $11.10. If Lyft Line is included the average fare becomes $10.58.
[39] A study was conducted with data collected from the month of October 2014. It is aggregated and it combines UberX and UberBLACK. https://techcrunch.com/2015/01/22/uber-study/.
[40] Uber formally refers to its drivers as Driver-Partners. Currently, there is a pending court ruling to determine the legal status of the TNC driver.

TNC retains 20% or $2.00, leaving the driver with $7.99. The $7.99 amount is the driver's net, but not the driver total net since that must include the expenditures for fuel, maintenance, insurance and any other cost in operating the vehicle for the TNC.

2. Mileage. Drivers earn a per mileage rate. The trip length can be a determinant in whether the driver profits or not.
3. Other. Besides the Partner Share, there are other fixed and variable costs the driver is responsible for: taxes, registration, fuel, and maintenance, insurance.

Table 5.4 Calculating the Level of Aggregate Subsidization for This Route

TNCs cost per mile for this trip	$2.47
TA Operating Expenses per Vehicle Revenue Mile (Cap Metro)	$9.60
Operating Cost per Passenger (TNC) [41]	$4.45
Bus Operating Expenses - Fare Revenues = Amount of TA Subsidization	$124,400,000
Total Bus Cap Metro Ridership (2015)	32,261,330
Cap Metro Full Fare [42]	$1.25
Amount of TNC subsidization per passenger	$1.28
Subsidy per Bus Passenger	$3.86

In Table 5.5, we seek to compute for total aggregate values. In order to accomplish the latter we also needed to determine the Average Trip Length which is 4.49 miles. This was derived by dividing the Passenger Miles by Ridership figures.

Table 5.5 Factors in Determining the Cap Metro Average Trip Length

Total Cap Metro Ridership as of 2015:	32,261,330
Total Cap Metro Passenger Miles as of 2015:	144,788,219
Average Trip Length in Miles:	4.49

[41] The formula used: Total Cap Metro Motor Bus Operating Costs including Capital Expenses/NTD Cap Metro Ridership Figures. (NTD Transit Profiles: 2015 Full Reporters, 2016).
[42] This particular route, Google Maps, furnishes as many as three different routes ranging from a one-seat ride to as many as three separate buses. Cap Metro has a no transfer policy. Thus, passengers can pay as much as three individual fares or a maximum of $3.75.

Average speeds and distances for Cap Metro are shown in Table 5.6. The Average Vehicle Revenue Speed by dividing the Average Vehicle Revenue Miles (AVRM) by the Average Vehicle Revenue Hours (AVRH). Doing so leads to the Average Vehicle Revenue Speed of 12.04 MPH. Taking the Average Trip Length and dividing it by the Average Vehicle Revenue Speed gives the Average Trip Duration (ATD). Upon multiplying ATD by number of minutes per hour gives the Average Trip Time in minutes. These figures are vital when juxtaposing the TNC and transit fares. It will also be better understood in the supplementary tables provided throughout this chapter.

For TNCs metrics such as Average Vehicle Revenue Speed, assumed was its likeness to Demand Response – Taxi (DT). Cap Metro, a multi-modal TA, files operating statistical data which can be found on NTD. Respectively, for 2015, DT average vehicle revenue speed was 21.24 miles per hour. As a result, this trip's duration is 12.68 minutes.

Table 5.6 Cap Metro Bus Average Speeds and Distances

Average Trip Length (in miles):	4.49
AVRM	14,001,707
AVRH	1,162,528
Average Vehicle Revenue Speed	12.04
Average trip duration (in hours)	0.37
Number of minutes/per hour	60
Average trip time (in minutes)	22.4

In Table 5.7, ascertained are the efficiencies or capacity level of vehicle trips necessary in order to meet the demand. The assumptions are as follows, and can be seen below, TNC (basic service) LoS has a maximum capacity of 1+4. Bear in mind, the utilization of 1+ = the driver. The driver or operator is never part of the equation since there must always be a human operator.[43]

[43] This will change when the AV or Autonomous Vehicle becomes perfected to the degree of becoming a true "driverless" car. At that interval, the capacity will increase by one extra available seat.

Table 5.7 Various Efficiencies or Capacity Levels of Vehicle Trips (Sedan)

Total Cap Metro Bus Ridership in 2015		32,261,330
TNC – 1+4		
Vehicle Trips @ Full Capacity	4 Passengers	8,065,333
Vehicle Trips @ 75%	3 Passengers	10,753,777
Vehicle Trips @ 50%	2 Passengers	16,130,665
Vehicle Trips @ 25%	1 Passenger	32,261,330

Considering the Cap Metro Ridership of 32,261,330 at 100% full efficiency, they would need to have 8,065,333 Vehicle Trips. As a reminder, 100% capacity, for basic service, is for four people, 75% is for 3, 50% for 2 and 25% is for one person.

In Table 5.8, the capacity is increased. But the number of trips due to the LoS such as T-Ride SUV which offers vehicles with a maximum capacity of six individuals are reduced.

Fundamentally, the higher the vehicle capacity, the lower the number of vehicles trips necessary to keep up with demand. Yet, any additional vehicle trips will increase ridership figures and, simultaneously, reduce the demand for four-seat sedans.

Table 5.8 Efficiencies or Capacity Levels of Vehicle Trips (6 Passengers)

Total Cap Metro Bus Ridership in 2015		32,261,330
TNC 1+6		
Vehicle Trips @ Full Capacity	6 Passengers	5,376,888
Vehicle Trips @ 75%	4.5 Passengers	7,169,184
Vehicle Trips @ 50%	3 Passengers	10,753,777
Vehicle Trips @ 25%	1.5 Passenger	21,507,553

Table 5.9 provides more detail about the averages necessary to obtain an aggregated subsidization. The per mile rate was determined by taking the standard per mile rate and the Average Trip Length. The per minute rate was calculated by taking the standard per minute rate and the average trip time

in minutes. Respectively, the remainder are the uniform Booking Fee and Base Fare for each individual TNC. Noticeably, Lyft comes in at the lowest Total Fare.

In Table 5.10, it has been determined that at a 50% Efficiency rate or by subsidizing the transportation of two passengers in a basic TNC service sedan, it would be economically beneficial to employ Lyft. The TA could go as far as employing T-Ride SUV, a six passenger vehicle, as another option. The calculation for Revenue is the Full Fare multiplied by the Total Number of Unlinked Trips.

To restate, the higher the percentage of efficiency the lower the subsidy. In the case of Cap Metro's bus division after applying and calculating the various system's performance metrics, the data indicates that subsidizing a TNC may be more cost effective than operating buses as Cap Metro received $124,400,000 in subsidization.[44]

However, the subsidization for bus operations per passenger, as observed in Table 5.4 is $3.86 with the amount of total subsidization at $124,400,000. In Table 5.10, it can be realized that subsidizing TNCs even at a 50% system efficiency equates to transporting as little as two passengers with Lyft or up to six with T-Ride SUV service. Doing so would still beget a savings ranging from $3.65 to over $5.5 million – of course, subject to the TNC and its respective LoS. In addition, municipalities (i.e., Federal, state, county, city and other local jurisdictions) will save taxpayer money as opposed to the expense of commencing a new or existing TA.

Surpluses could be used to offset anything from maintaining and stabilization fares to financial incentives such as bonuses to drivers. Should the monetary overages do reach levels above projections those funds could allow for the occasional free ride. Of course, this is all subject to the laws that regulate the particular property and/or TA board approval.

[44] This is a rounded figure. The exact amount is $134,404,306 and is specifically for motorbus operations. Total multi-mode expenditures amounted to $194,645,347. It was extracted from the NTD 2015 Annual Agency Profile.

Table 5.9 Total Cost of TNC Fare Integrating Cap Metro Ridership Metrics

TNC Fare Framework	**Uber**	**Lyft**	**Fasten**	**T-Ride**	**T-Ride SUV**
Per Mile rate	$4.77	$4.50	$4.50	$4.50	$7.88
Per Minute rate	$2.54	$2.54	$2.54	$3.17	$3.42
Booking Fee	$1.95	$1.95	$2.00	$1.75	$1.75
Base Fare	$1.00	$1.00	$1.00	$1.00	$1.75
TOTAL FARE	$10.26	$9.99	$10.04	$10.42	$14.80
Vehicle Size	**1+4**	**1+4**	**1+4**	**1+6**	**1+6**
TNC	Uber	Lyft	Fasten	T-Ride	T-Ride SUV
100% Capacity = 4 Pass	$82,718,050	$80,540,410	$80,943,677	$84,040,765	$79,570,420
75% Capacity = 3 Pass	$110,290,733	$107,387,214	$107,924,903	$112,054,353,	$106,093,893
50% Capacity = 2 Pass	$165,436,100	$161,080,821	$161,887,354	$168,081,529	$159,140,839
25% Capacity = 1 Pass	$330,872,200	$322,161,641	$323,774,708	$336,163,059	$318,281,679

Table 5.10 Cost of Subsidizing TNC Fares (in Millions)

Subsidy by Cap Metro	**Uber**	**Lyft**	**Fasten**	**T-Ride**	**T-Ride SUV**
100% Capacity = 4 Pass	$42.39	$40.21	$40.62	$43.71	$39.24
75% Capacity = 3 Pass	$69.96	$67.06	$67.60	$71.73	$65.77
50% Capacity = 2 Pass	$125.11	$120.75	$121.56	$127.75	$118.81
25% Capacity = 1 Pass	$290.55	$281.83	$283.45	$295.84	$277.96

5.2 Subsidization

5.2.1 Bus

To recap, the TNC could offer a lucrative financial option for public transportation bureaus based upon the amount of subsidization. Now armed with calculations, created in the earlier sections, the ensuing discussion can now focus on subsidization. This subsection shall focus squarely on the subsidization of the motorbus mode.

Bus fares, contingent upon the transit agency's policy, can either be flat and/or distance-based. Some properties charge a nominal fee for transfers and may not have an interagency agreement whatsoever. The subsidization for the bus mode was already established in Table. 5.4

Presumed is that a TA will negotiate with a TNC, or conceivably more than one, for a fare that is fair to all stakeholders involved. For now, let's assume the TNC collects its standard fare. In essence, TNCs operate regular revenue service and all passengers pay their existing rates. The up-to-date TNC rate, for this O/D pair, amounts to $9.99.[45] If the bus fare per passenger is $1.25 and the aggregated subsidy is $3.86 the total is $5.11 per passenger. Observably, this is 51.1% less than the regular TNC rate for the same route. If the TNC were to be subsidized, that amount would come to $8.73 for a single occupant. Yet, if two passengers it would be $3.74 per passenger for a total of $7.48 per trip, three would be $2.08 per passenger or $6.24 per trip, and if four $1.24 per passenger or $4.96 per trip.

Efficiency means, under this context, what is the return on investing into equipment involving capital dollars. In other words, are the buses adequately sized for what is being acquired on behalf of the capacity of customers transported from place to place? Would it be much more economical for the property to purchase transportation as opposed to directly operating? The operational style of Cap Metro is where all of their modes are purchased transportation.

Figure 5.3 shows the different amounts of subsidization applicable to full TNC fares with corresponding TNC averages of capacity. Again, the level of efficiency is advantageous when contrasting buses to TNCs. Aggregately, at a 19.5% LoE, a bus would need to carry ~10.5 people steadily in order to be considered efficient. A single person in a TNC already provides the public with a higher LoE at 25%. Two persons in a TNC would be the equivalent of 26.5 or so a 50%

[45] The TNC in this case is Lyft.

LoE, and so on. At 75% LoE, three people in a TNC would be amount to approximately 40 commuters by bus and the best consequence would be a fully loaded TNC which would require a bus to attain crowded vehicles – every time. Unmistakably, the TNC offers a higher LoE and is quite competitive with buses which could be of great financial savings to a TA.

5.2.2 Demand Response - Taxi

Suffice it to say, Demand Response - Taxi (DT) was mentioned, mainly, because it is another mode offered by Cap Metro and is very analogous to TNCs, operationally. Central is how competitive TNCs are when compared to DT. DT fares are flat rates, conditional upon the rules and regulations of the property in question. The subsidization for the DT mode can be found in Table 5.12. Presumed, as well, is that a transit agency will settle with a TNC, or conceivably more than one, for a fare that is fair to all stakeholders involved.

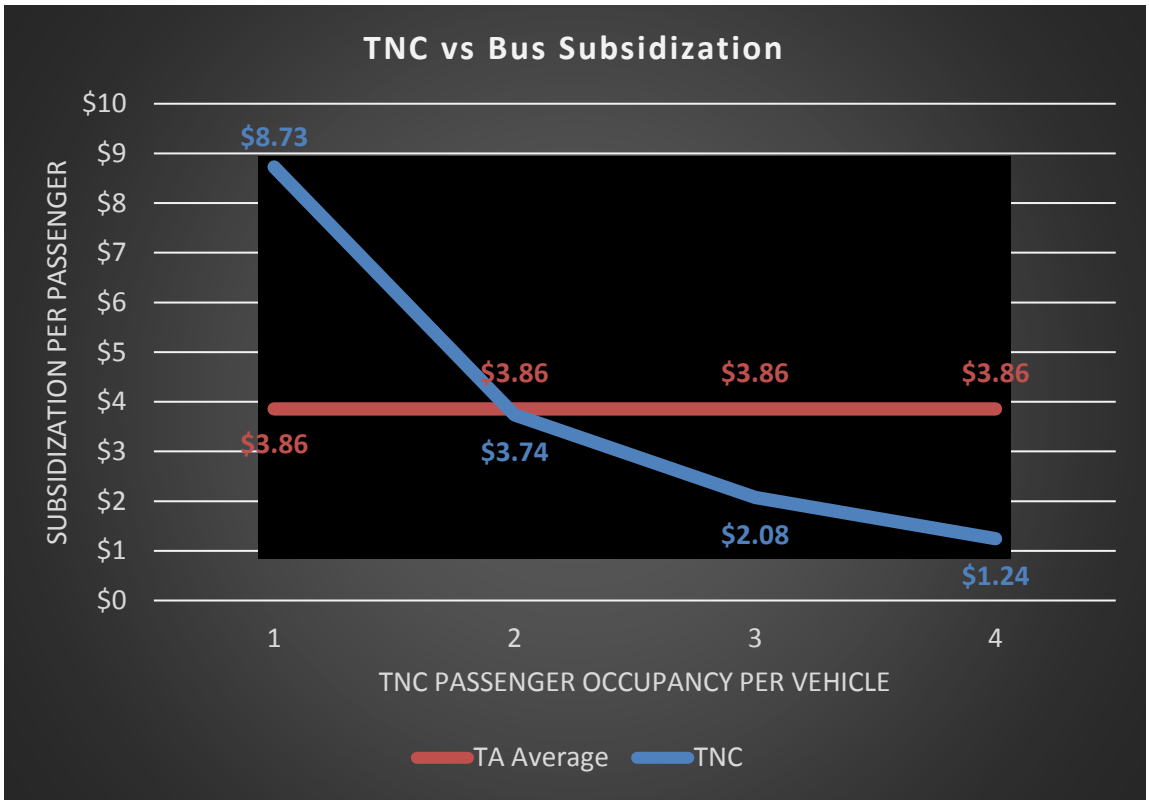

Figure 5.3 TNC vs. Transit Subsidization – Bus

Table 5.11 Level of Efficiency – Demand Response - Taxi

Average Occupancy	1.2
Assumed Average Vehicle Revenue Capacity	4
Efficiency	29.9%

Table 5.12 Average Subsidy per Passenger

Aggregated Total Expenses (thousands)	$867.87
Aggregated Fare Revenue (thousands)	$83.97
Subsidization for Demand Response Taxi (thousands)	$783.89
Annual Unlinked Trips (thousands)	28.68
Average Subsidy per Passenger	$27.33

The same approach in the Bus Mode segment can be applied to DT. To reaffirm, all passengers pay the TNCs existing rates. The latest TNC rate, for this excursion, amounts to $12.73.[46] The present-day Cap Metro fare is $1.75 and the aggregated subsidy is $27.33, the total is $29.08 per passenger in DT mode. Observably, this is 200% more than the regular TNC rate for the same route. But if the TNC were to be subsidized, that amount would come to $11.48 for a single occupant. On the other hand, two passengers would be subsidized at $5.12 per passenger or a total of $10.24 this trip, three would be $2.99 per passenger or $8.97 this trip, and if four, it would be $1.93 per passenger or $7.72 per trip.

Figure 5.4 shows the different amounts of subsidization applicable to the full TNC fare with corresponding average TNC passenger occupancy compared to DT. Table 5.11 establishes LoE for DT. At a 29.9% LoE, a DT would require ~2 individuals sturdily to be marginally efficient. Earlier discussed was how DTs and TNCs are, operationally, almost equivalent. A single person in a DT already provides the public with a LoE fairly close to the above. Two persons in a DT would be the equivalent of 50% LoE or two passengers, at 75% LoE, three people, and a fully

[46] The TNCs in this case is Lyft.

loaded DT which would require a TNC to have four people.[47] Juxtaposed, the TNC naturally provides an equal LoE and is exceptionally competitive with DT from a financial viewpoint.

5.2.3 Overall

On the whole, it would appear that TNCs could supplant either the bus or DT. Table 5.12 gives an overall view at the NYCT general expenses and subsidy for both modes when combined. From the data, the TNC might replace both modes for this agency.

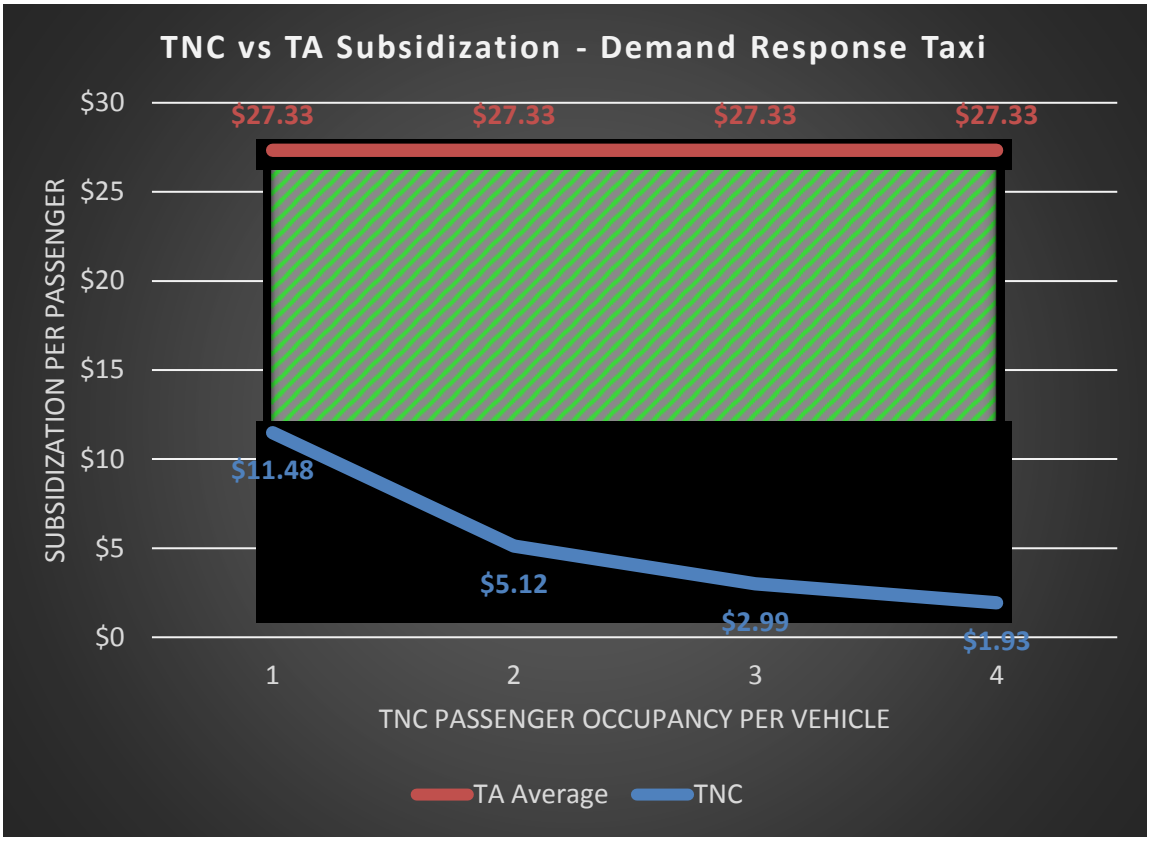

Figure 5.4 Subsidization of TNCs vs DT Mode

Utilizing the comparative analysis earlier, based upon subsidization alone, at $3.88 plus Cap Metro flat rate fare of $1.25, the total fare would be $5.13. This is at least 50% less than the current TNC fare. It would take about 3.1 people to travel simultaneously for the exact same

[47] The assumption is the DT mode operates is a four-seat vehicle sedan as the TNCs basic service.

subsidy. If three people were to consistently fill the TNC, the subsidy amounts to $1.29 per passenger, and a fully occupied vehicle would cost nothing since the TNC would earn a profit of $0.97 per passenger.

Table 5.13 Combined Subsidization of TA Bus and DT

Cap Metro	Bus	Demand Response - Taxi	Combined
Operating Expenses (OE)	$143,670,777	$867,866	$144,538,643
Fare Revenues	$19,255,701	$83,973	$19,339,674
Total Operating Loss	($124,415,076)	($783,893)	($125,198,969)
Annual Unlinked Trips	32,261,330	28,678	32,290,008
Subsidization	($3.86)	($27.33)	($3.88)
OE per Vehicle Rev Hour	$115.61	$123.22	$238.83

Source: NTD 2015 Transit Agency Profile

5.3 Application of Transit Agency Replacement

This thesis has previously detailed financial evidence of how a TNC, hypothetically, could replace public transportation if it were subsidized on the same level as a transit agency. The aim of this section is to discuss which transit agencies would be replaceable.

To determine transit agency supplantment candidacy, there are extra-financial and other non-financial variables that need to be deliberated. However, for the purpose of staying within the scope of this paper, the calculation is limited to the following variables:

1. Load Factor. This variable is key. A load factor, or rate of occupancy, is a ratio of passenger miles to vehicle revenue miles. In other words, how many people are carried on a bus or other revenue service vehicle. This metric is critical when making a compelling argument to sustain continued financial support for transit service.
2. Vehicles Operating in Maximum Service (VOMS). This is the number of revenue vehicles the transit agency has in revenue service.

3. Farebox Recovery Ratio. This is the proportion of fare revenue to operating expenses.
4. Average Headway. This is the amount of time between vehicles in revenue service operating along a scheduled defined route.
5. Average Trip Length. This is determined by dividing the number of Passenger Miles by the number of Passenger Trips.
6. Average Fare. This is calculated by dividing Fare Revenues by Annual Unlinked Trips (UPT).
7. Average Speed. This is calculated by dividing Revenue Miles by Revenue Hours.
8. Type of Service. There are two types of service: Directly Operated (DO) or Purchased Transportation (PT). The difference between the two is operational. A TA that hires, trains and compensate their bus operators and mechanics directly is considered DO. Whereas PT, the TA is contracting all the responsibilities, hitherto, to a third party.
9. Total Operating Expense. The total amount of expenditures to operate that mode under the type of service. Additional variables included in the analysis is the Urbanized Area (UZA) that the TA serves. The TA may function within a market that encompasses more than one UZA. In keeping consistency, this paper will follow the same guidelines as the NTD, which places a transit agency into the larger UZA. There are three UZA indices which are:
    - Under 200,000,
    - Between 200,000 to 1,000,000 and
    - Above 1,000,000.

TAs are also divvied into Reporter Types. A Reporter is a transit agency or other type of organization that is required to file statistical data, monthly and annually, on behalf of that property to the NTD. Facts can include, yet are not limited to, financial, safety, ridership and fleet figures. The mandate is incumbent upon those properties receiving federal funds under certain sections of

the United States Code. Some TAs may not be listed due to the waiver option, which can be applied for by those TAs having a VOMS of 30 or fewer. The data illustrated three reporter types: Small Systems Reporter; Full Reporter - Operating, and Full Reporter - Operating/Building. The last reporter type means that it is already in revenue service operation and building a new line or mode. It is beyond the scope of this paper to enter into a detailed discussion of each reporter type.

The analysis also includes TAs categorized into 14 organization types. Many of the TAs are under the auspices of a city or an independent authority. It is beyond the scope of this paper to enter into a detailed discussion of each organization type. A complete list of organization types can be obtained from the 2015 NTD Policy Manual.

In 2015, according to FTIS, which acquires data from NTD, a total of 675 TAs were operating bus service, commonly referred to within the United States transit industry as motorbus (MB), with it being either their core mode or one of several.[48] NTD, in the same year, computed the aggregated average load factor for the bus mode to be 10.10 *[6]*. In other words, nationally, a typical bus transports about 10 people. A total of 379 agencies have a load factor of under 10.[49] A full and complete list of transit agencies ripe for supplantment can be found in Appendix E.

Nevertheless, there are assumptions that need be kept in mind:

1. The majority of TNC fleets will consist of sedans carrying a maximum of four passengers. Not every market offers the option to select a special accommodation such as an automobile or car with a larger occupancy. For example, UberWAV, UberBLACK,, UberPOOL, nor Lyft Line, respectively, are not everywhere.

[48] Motorbus or MB is one of three types of bus modes. The other two are Bus Rapid Transit and Commuter Bus. Not every agency offers the latter two.
[49] The author cleaned the data. There were many agencies having missing data for the requisite variables. As a result, they were deleted.

2. Whole agency VOMS Size may not equal VOMS for the enumerated properties. Mentioned earlier is how a transit agency may be multi-modal. Thus, a TA's VOMS includes vehicles from modes other than MB. That is, included will be heavy rail cars, commuter rail cars, etc.
3. The data extracted for this study is accurate. Transit agency CEOs are required to sign an attestation prior to filing their report. Further assumed is that by his/her signature on the required forms, it is understood that s/he agreed that the submitted materiel was reviewed and is true and accurate.

Worcester Regional Transit Authority COA (WRTACOA) has a load factor of 0.02 - the lowest load factor of this group. This translates to the public barely utilizing public transportation. It is also an example of a TA operating within a medium-sized UZA of 200,000 to 1,000,000 people.

Consider, that this TA's existing average fare is heavily discounted, provides headways of about a half-hour and a decent average speed. However, there is only one VOMS and a farebox recovery ratio slightly below three percent. According to their most recent Regional Transit Plan, disseminated in June 2015, it had no immediate plans to collaborate with a TNC. In view of WRTACOA's total operating expense of under $19,000, an average trip length of 3 miles, and is already purchasing transportation, it could be in this property's best interest to conduct a trial program with a TNC.

An examination of another suitable candidate for replacement is Fort Bend County Public Transportation (FBC). FBC operates in a large UZA of over 1 million persons and has a load factor slightly below one. Yet, even with an average fare of about one dollar and a farebox recovery ratio of under two percent, it has five VOMS, an average headway of almost two hours, and a total

operating expense of over $140,000 per revenue service vehicle. Even if FBC's average trip length is nine miles, the amount spent on a TNC could still be equitable to FBC.

The Massachusetts Bay Transportation Authority (MBTA), is a multi-modal transit agency, serves one of the largest UZAs in the United States and has a whole agency VOMS size of 1000 and over. Its load factor is slightly above five. Moreover, it has two types of service DO and PT. Under DO, the load factor is 14.40, which is above the national average, and therefore not listed in the Appendix. Under PT, however, MBTA has a relatively low load factor, a nominal average fare, 17 VOMS operating on an average headway of under one hour with an average trip length of two-and-a-quarter miles, and an operating expense close to $300,000 per revenue service vehicle.

MBTA currently has a pilot program with a TNC: Uber. [50] Riders can employ the UberPOOL service where the passenger pays one dollar per trip and MBTA subsidizes the balance up to $15.00. Anything above that is the passenger's responsibility. If this pilot is deemed successful, it would be an excellent yardstick for peer agencies to emulate.

[50] Only through its paratransit service, MBTA has a pilot with Uber and Lyft.

CHAPTER 6: IMPLICATIONS

There are four main stakeholders that need to be highlighted:

1. Riders
2. Transit Agencies
3. Drivers and
4. The Transportation Network Companies.

Each of the above plays a fundamental role in how and what conditions replacement could occur. This section will discuss the salient aspects of not just how each of these affected parties will benefit from replacement but, as a matter of unbiasedness and equity, what the risks are as well. The discussion will be divided into four parts:

1. Advantages/Disadvantages from the Rider's perspective
2. Advantages/Disadvantages from the Transit Agency's stance.
3. Advantages/Disadvantages from the Driver's position and
4. Advantages/Disadvantages from the TNCs viewpoint.

Mankind all across the globe have eye-witnessed various milestones in history. As mentioned earlier, technology has revolutionized the everyday way of life for civilization. The evidence can clearly be observed with vigorous clarity within the railroad industry, as an example. Characteristically, we have seen how technology altered the course of rail transportation allowing for trains to reach their intended destinations with ever-increasing rates of speed. Nonetheless, such transformation is not limited to or applicable to the railroad or transportation industry, per se.

Technology has evolved with increasing vigor, for the most part, within the past decade. This transfiguration applies, as well, to every active industry available in modern times.

Table 6.1 Advantages and Disadvantages to Riders and TAs Utilizing TNCs

Riders		**Transit Agencies**	
Advantages	Disadvantages	Advantages	Disadvantages
Time savings	Disparity	Increased Ridership	Legal
Convenience	O/D Restrictions	Increased Revenue	Safety
Cashless/Paperless Transactions	Health	Increased Transportation Parity	Company Support
Communication	Fare Sharing	Increased Revenue Service	Corporate Relations
Safety	Monopoly	Employee Reduction	Fare Agreement
Reviews and Ratings	Ubiquity	Decreased Operating Costs	Diminished Dedicated Funding Sources
Insurance Coverage	Unionization	New/Expanded/ Terminated Routes	Ratings
Legislation	Dependency	No Capital Costs	TNC Captivity
Accessibility	Congestion	F/L Elimination	Ridership Losses
One-seat rides	Other	Congestion	Drivership
Fares			Technology
			Congestion
			Potential Competition

For each new successfully completed phase of technological research and development market-demand produces at least an equal number of pristine inventions. As a result, the market is, and can be inundated with a horde of brand-new products and services.

We see how new merchandise and services created are advertised. Most potential customers can recite the repetitious rhetoric heard countless times. For example, the public is told

why you should purchase this new service. Obviously, when in the midst of selling anything, the seller seldom discloses the disadvantages, if any, for fear of the pending transaction prematurely terminating. Naturally, a new product or service will always retain a certain level of pluses and minuses. Thus, Uber, Lyft, Sidecar and their rivals are not immune. They too have their good points and bad points.

6.1 Advantages from the Rider's Viewpoint

This address will focus on the Rider's viewpoint. It shall categorically enumerate the advantages and disadvantages emphasized in generalities. The question being placed forth is: What are the advantages from the Rider's viewpoint by if public transportation would be replaced with a TNC.

6.1.1 Time Savings

The time factor may be the main advantage. Instead of having to physically flag down a taxi (especially during foul weather conditions) where it could plausibly take more than an hour for a vehicle to be available, a TNC can be at your service within minutes. This is much quicker than your traditional taxi, commuter bus or rail system. It is, moreover, the difference between arriving to your destination on time with the possible added bonus of completing an additional task or two with any allotted extra time should the passenger come to its destination ahead of scheduled arrival. Table 6.2, was the result of a survey given to inhabitants of San Francisco. It measures the percentage of how many people claimed to encounter wait times of ten minutes of less when requesting a TNC or taxicab *[68]*.

6.1.2 Convenience

A central theme under TNCs marketing is their promotion of dynamic capability to furnish almost instantaneous service. To illustrate, upon the passenger placing their request for a ride,

there is nearly an immediate reply by the app giving detailed information, such as which driver is most adjacent to the passenger, their name, and other identifying information, as well as an estimated fare.

Table 6.2 Comparing Wait Times

Time of Need	Ridesourcing	Taxi (Landline)	Taxi (Street Hailing)
Mon-Fri: 4AM-6PM	93%	35%	39%
Mon-Fri: 6PM-4AM	92%	16%	33%
Saturday & Sunday	88%	16%	25%

Source: Rayle, et al, 2014

An equally decisive factor is the wherewithal of having these resources at your fingertips. To illustrate further, you live in New York City and wake up with 102+ degree temperature compounded by other medical conditions of unknown etiology. You determine that it would be best to see a doctor. Aggravating matters is the meteorologist correctly predicted blustery weather conditions. To boot, the medical receptionist explains that the doctor has a very limited window of opportunity to see patients on an emergency basis that day. Historically, in certain metropolitan areas a taxi could be reserved. Yes, in other locations taxi hailing would require an individual - regardless of how horrific you felt or how squallish the weather was - to get dressed and carry weather protection, all whilst standing outside until a taxi became available. With Uber, Lyft, and their competition, this can simply be arranged while lying as comfortably as possible in bed.

Furthermore, there is always seat availability. When compared and contrasted to your conventional modes of public transportation, seat procurement is never assured.

When taking both the above and time savings into consideration, emphasis must be placed upon venue; reason being, urban and rural settings are clearly different. Respectfully, the population levels are dissimilar too. Therefore, supply/demand for service will not be the same. It

will be much quicker to summon Uber or Lyft for service in the city than it would be in the suburbs. Bear in mind in some cases, these company types may, at this time, still not be allowed, choose not to or not well-equipped to offer service to/from some rural or urban areas.

6.1.3 Cashless/Paperless Transactions

All the aforementioned firms require a valid credit, debit or other electronic form of payment ahead of a request. This method offsets the need for additional cash to be carried by the passenger. A receipt is electronically delivered to the passenger's email of preference, mitigating strewn and missing proof of payment. It also saves trees which, in turn, positively affects the environment.

Inevitably, the mass transit industry will need to adapt to these and other similar types of fare collection methodology. Several agencies have experimented with electronic style fare payments. Barriers such as union acceptance, funding and strategic planning for future technological needs, such as the inevitably supplantment of obsolete equipment, shall require further research, investigation and negotiation in order to be conquered and met.

6.1.4 Communication

Passengers can communicate directly with the driver. Riders can follow, via the app's GPS, the Driver every movement until boarding occurs. Doing so enhances coordination, if necessary. Ordinarily, this would be unheard of amid the time-honored taxi, commuter bus or commuter rail systems.

6.1.5 Safety

Passengers employing Lyft have equanimity of knowing that their driver's vehicles must pass an inspection. Riders will receive a picture of their selected TNC Driver. Uniformly, TNC Drivers are required to undergo a background investigation.

As an additional benefit:

1. Riders decrease their risk of causing drunk-driver related accidents when hiring a TNC since this grants an unofficial license of designated driver status.
2. And all TNC vehicles must be meet certain standards. e.g.; it must be a newer model and cannot go beyond a pre-established year or amount of time.

6.1.6 Reviews and Ratings

Drivers are issued a report card in the form of ratings. Subject to the rating, the TNC has the power to sever all future ties or rides with the driver and/or the passenger.

Similarly, a passenger can submit a "rating" to a transit authority and a taxi company by filing a letter of praise or a formal complaint. The difference is at a TNC and a taxi/for-hire livery company, a driver can be terminated. At a transit authority, drivers are usually union members and cannot be easily separated.

6.1.7 Insurance Coverage

TNCs furnish policies ensuring customers from origin to destination. If they or others desire to enter new markets, such as transit revenue service, they may have to meet or exceed the policies that transit and taxi organizations hold.

6.1.8 Legislation

Suffice it to say, legislators are taking notice as well as serious action in investigating how to best regulate these companies. Uber's "bad-boy image" has crossed diverging intercontinental borders to earn the distinct reputation of becoming an international menace, in many instances.

6.1.9 Accessibility

Transportation parity is key. Riders cannot be precluded if their intended terminus is one that is perceived to be located in an unwelcoming or reputably known high-crime area. Street-

hailed taxis, at times, would deny conveyance upon learning the address from the passenger. Mass transit can refuse transportation for lack of payment.

Clearly, what needs to be focused upon are the benefits for people that can get to prospective new employers, educational and medical institutions, shopping malls, and friends and family that are located in many remote outlying places that were not too easily reachable in the past. The physical characteristics of buses, vans, and sedans and any other public transportation mode not restricted by dedicated right-of-ways makes it increasingly easy to have ingress/egress access to places due to its innate flexibility.

6.1.10 One-seat Rides

For some commuters public transportation involves two or more unlinked trips. An unlinked trip is a single boarding upon a public transit mode. A one-seat ride is where the passenger does not have to transfer after his or her initial unlinked trip. Moreover, the passenger literally sits in the same seat from origin to destination. In addition to time savings and convenience the rider could potentially find comfort and the ability to achieve the completion of small goals of work upon arrival at his/her destination.

6.1.11 Fares

Indistinguishable is the fare structure when comparing conventional mass transit and taxis. The same could be said when examining, in contrast, public transportation fares to the TNC. Be that as it may, what could be previously considered a disadvantage would definitely become an advantage at the time of replacement.

It is generally known that TNCs have commensurate price frameworks. Such as peak and off-peak prices, only they are referred to with characteristically phrased nomenclature. For example, peak prices, or high-in-demand-based fares are termed by Lyft and Uber; respectively,

"prime time" or "surge pricing". Under prime time, Lyft imposes a limit on the multiple added to its normal fare. Uber's surge pricing charges involve various multiples.

Alleviating the financial burden would be a chief beneficial effect from replacement. There has been a history involving unwarrantable charges from TNCs as well as transit agency's questionable justifications for a fare hike. Here the fares, whether distance-based or flat rate, could make it much more affordable.

6.2 Disadvantages from the Rider's Viewpoint

6.2.1 Disparity

Everyday people earning, what has been defined as, poverty level income are most likely unable to buy mobile devices, never mind, sustain the expense of a defined telecommunication service plan. This is an imperative disadvantage for low-income earners and, in some cases, for those within the minority community. Today's society demands justice in the form of equal footing and comparable accessibility for everyone. It must be stressed that accessibility based on financial affordability is the point being accentuated, when earlier it was a matter of traveling to a known unsafe area.

Demographics such as the senior citizen/disabled/handicapped population may not be assured of the proper TNC vehicle due to its driver procurement limitations and the unique and individual mobility issues of each individual passenger. In other words, TNC drivers are generally not in a monetary position to acquire the necessary highly specialized transport vehicles. Therefore, unless the TNC does the actual purchasing and supplying a sufficient quantity if these vehicles types with drivers this group may still be in the same position it was beforehand.

6.2.2 Origin/Destination Restrictions

Although a TNC can take someone to an airport, it cannot offer service *from* some airports. However, that is changing. TNCs are slowly, but surely being given permits to operate from airports.

Some urban and rural communities have not yet consented to e-hailing. Legislation needs to be or is already in progress requiring the immediate and swift attention of elected officials to remedy this and other TNC-related issues.

6.2.3 Fare Sharing

Transit policy has always been where each rider pays their own fare, individually. On the contrary, TNCs policy has been to sanction fare sharing.to groups of two or more riding simultaneously. For example, if two or more people are riding Uber together, the fares can either be divided amongst themselves with their own separate, individual accounts or the rider who made the original arrangements can be responsible for payment *[21]*. Furthermore, if more than one person - or a group - select a TNC and want to share the cost Uber insists that each rider have their own account. Not everyone has that capacity.

6.2.4 Monopoly

The transit agency should not beholden to one TNC. If the transit agency selects a single TNC as opposed to more than one then there may be an issue with fares, actual conveyance as well as customer service.

1. Fares. Fares must be negotiated with and under the direct control of the managing transit agency.
2. Insolvent Routes. This too must be under the immediate supervision of the transit agency. Otherwise, if the management of fixed-route operations were to be replaced by TNCs, the TNC

may seek to delineate the unprofitable routes leaving many that are already captive to public transportation stranded without an alternative option.

3. Customer Service. In the event of lost and found items, a protocol needs to be created so the owner is properly reunited with his or her property. Additionally, even though the passenger is able to submit a driver rating, the TNC is aware of the rider's experience. Current TNC procedures are if a rider's ratings it should go below a pre-established threshold that particular driver will be deactivated. The transit agency must establish a set of rules, too, which includes how to contact said property and TNC administration in the event of an issue.

6.2.5 Ubiquity

Already mentioned was how the TNC may be geographically restricted and can only offer services from/to certain localities. The other issue may be that the TNC may not have enough drivers or already investigated some other areas and determined it would not be financially feasible. In order for ubiquity to happen, once again, if dependent on legalization, legislation needs to be created and quickly passed to become law.

6.2.6 Unionization

The disadvantage is if the drivers decide to amalgamate into an organized association. The rider would be at a loss if there is a strike. There are other events that could negatively affect a passenger should a union take action outside of a strike.

6.2.7 Dependency

If the passenger finds the TNC to meet and exceed his/her needs. S/he may find themselves relying on the TNC too much. If such a situation should occur it could reach a degree that should TNCs no longer be available, for whatever reason, the rider may be forced to select another mode that is financially not a viable option, a time-consuming alternative or no option at all.

6.2.8 Congestion

1. Environmental. TNC customers, and others who live and work along their pathways, may not appreciate the problems that traffic jams cause. Examples are: people whom are very active in championing environmental related causes, such as the reduction in greenhouse gases (GHG) in the air and noise pollution. Individuals breathing in fumes from the vehicles could develop or exacerbate any existing health issues especially for those that have autoimmune dysfunction, pulmonary and/or other respiratory difficulties.
2. Trip time length. Subject to the route and time of the day, normal commuting time patterns can become even lengthier especially if there is an unknown incident such as an accident – direct or indirect. Special events can add to this as well. Additionally, there are days preceding certain holidays that are treated as peak traveling periods usually resulting in gridlock.
3. Higher fares. Present-day TNC tariffs are time-and-distance based. Longer trip times translates into inflated fees.

6.2.9 Other

There are other considerations that need to be addressed and are listed below:

1. Even if Drivers possess the latest TNC software package s/he may not still be acquainted on how to get around. As a result, it may take longer than anticipated for him/her to first arrive, necessitating the passenger to play backseat driver as warranted.
2. To reprise, unless the Rider knows that the TNC has been legally recognized within the transit agency's jurisdiction of service, s/he is taking a risk of the unknown. For example, a Rider who survives an accident with the prognosis of possible loss of life or limb. The Rider may have an inability to file litigation against the e-hailing firm. The root cause is the legal status of the

Driver. If the Driver is legally considered a TNC employee as opposed to an independent contractor the Rider can easily and directly sue the TNC.

6.3 Advantages from the Transit Agency's Viewpoint

This discussion will focus on how it would be advantageous to the transit property should it decide to go forward replacing its revenue service operations with a TNC. Categorically, it enumerates the advantages and disadvantages emphasized in generalities and not in any particular order. The question being placed forth is: What are the advantages from the transit agency viewpoint are there for it by replacement with a TNC.

6.3.1 Increased Ridership

The TNC has destroyed the taxi industry in both San Francisco and Los Angeles. This has mainly been attributed to the popularity of the TNC. (Cabanatuan, M., 2014; Morris, D.Z., 2016). Los Angeles still has a very primitive public transportation system when compared to a city such as San Francisco where population figures are 1200% less and has more mode choices and service to select from.[51] To illustrate, Table 6.3 shows a contrasted outlook of San Francisco and Los Angeles giving population figures and the various mode choice availability. i.e.; San Francisco has Automated Guideway Transit, Cable Car, Commuter Rail, Heavy Rail, Light Rail, Streetcar and Trolleybus. Los Angeles, on the other hand, has BRT, Commuter Rail, Heavy Rail, and Light Rail.[52] Regardless of either of these respective public transportation systems, the fact that TNCs have devastated or "disrupted" a whole, albeit long established, industry translates to riders evidently being dissatisfied with conventional taxi and livery service. It also means that those same

[51] United States Census Bureau, American Fact Finder, 2015 Population Estimate (as of July 1, 2015), Los Angeles County has a population of 10,170,292 people and San Francisco County has a population of 864,816. https://factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml#

[52] Los Angeles has 2 Light Rail systems. One is operated by the Los Angeles County Metropolitan Transportation Authority and the other is managed by the Port of Los Angeles. (APTA Fact Book, Appendix A, 2016).

passengers are highly satisfied with TNCs. Conspicuously, the figures strongly indicate that conventional taxi service has pretty much been abandoned due to rider defection to the TNC The assumptive idea is that it was due to, but not limited to, variables such waiting time and cost and a higher quality level of customer service *[33, 65]*.

Since popularity breeds familiarity this is one of the more positive effects for the transit agency should it engage in replacement with a TNC. This will make it a little easier for the property when marketing the TNC since many will already have previously installed the app unless the agency develops their own or formerly doubt filled customers modify their decision to download the app.

Additionally, inside the urban landscape there are those that cannot afford to own and maintain a motor vehicle. As already mentioned in the Introduction, is how Cost Structure will impact the rider's decree whether to utilize a TNC or public transportation. The geographic territory of Los Angeles is far and wide, some of it, because of urban sprawl. Naturally, there are going to be those that live far away from their daily or frequent destination. Yet, because their public transportation system is not as extensive as it could or should be there are those that have been captive to either what the agency provides or other limited options such as ordering a taxi.[53]

The transit agencies benefit from all of this as a result of the TNCs charging fares based on time and distance.[54] If a TNC were to propose flat rate fares to their customers it is assumed their ridership figures would soar even higher.[55] Using San Francisco as an illustration if it were to

[53] The commuter can, if s/he has access to a bike or is able to walk. Additionally, Los Angeles County Metropolitan Transportation Authority (LACMTA), at this time, has a laundry list of capital projects in the works.
[54] Uber and Lyft's total fare consists of: A base fare; booking fee; and a charge per minute and per mile. The passenger is also furnished with a minimum fare requirement in the event the total fare is not met.
[55] Uber initiated a pilot program in New York City called The Uber Commute Card ("Card"). The Card was sold for a flat rate, with unlimited UberPOOL (their carpooling service) usage confined to a specific geographical zone for either a two-week, four-week, or eight week period of time. All these Cards were sold out. https://www.giltcity.com/newyork/ubernycjuly16

replace one of the modes, as indicated in Cap Metro 3, with a TNC ridership would increase based on the following assumptions:

1. Because there are so many that abandoned the taxi it is safe to assume that many are familiar with TNC ride use. How to use the app is important because there are still many that may not have taken a rider with a TNC.
2. Equally, if not more important is, because so many people have already used a TNC, instead of paying the fare based on distance and time, the passenger would just pay a flat rate fare. This alone could be the determinant for the rider if indecisive about mode choice.

Finally, current trends indicate a steady decreasing numbers of trips made by people choosing the taxi as their mode choice.[56] Should this continue, if the decision is made based purely upon economic reasons, many taxi medallion owners will be compelled to terminate and, perchance, sell off their vehicles. If that were to transpire what would happen if there were no taxis available? This would compel the taxi populace to resort to public transportation. Assuming no other reasonably affordable mode choices is available.

Table 6.3 Population and Available Modes– San Francisco vs. LA

San Francisco County	**Los Angeles County**
Population: 864,816	Population:10, 170,292
Automated Guideway Transit Cable Car Commuter Rail Heavy Rail Light Rail Streetcar Trolleybus Bus	BRT Commuter Rail Heavy Rail Light Rail Bus

Source: United States Census Bureau, American Fact Finder, 2015

[56] Taxi trip statistics in Los Angeles are on par, as a trend, with data from New York, San Francisco and Las Vegas. (Morris, D.Z., 2016).

6.3.2 Increased Revenue

For the most part, the TNC will transport newly found and existing transit agency passengers. For the most part, both new customers and loyal commuters may give the TNC a try. For those trying it for the first time, will find themselves temporarily ditching their original mode choice. In other words, the commuter will leave their car, bike or other mode behind as an experiment to determine whether it is a positive and worthwhile experience. Some examples for the decision for a trial run are beyond the initial day of commencing revenue service. There can be an upsurge of demand from certain weather conditions, unexpected incidents and/or pre-planned special events. What matters is all of these passengers will be conveyed by a TNC, in lieu of a traditional transit vehicle. Ostensibly, this translates to more revenue – not necessarily more of a surplus.

Like anything else, the transit agency should anticipate initial figures will swell. Realistically, it needs to expect some to abandon the TNC conception. Even with the latter, the transit agency should hopefully see a net positive gain in customers.

6.3.3 Increased Transportation Parity

With the onset of transit agencies creating and developing relationships with their selected TNC (or conceivably more than one), for many properties this can become a momentous transportation policy decision. Historically, certain demographics had great difficulty gaining access to or had no public transportation options. Because of the TNC, increased transportation parity will provide the access they have always sought. This is particularly vital to such demographics such as low-income families, minorities, youth, seniors, the disabled and others as listed in the sub-sections below.

6.3.3.1 Low-income Families

Many cannot gain access due to distance, lack of frequent headways. Moreover, not every transit agency provides 24\7 revenue service. Here, depending on the service agreement the TNC may be able to go as far to furnish door-to-door services.

6.3.3.2 Minorities

The transit agency must enforce, as part of the contractual negotiations, that the TNC of choice not discriminate and serve all communities. Even if there are geographical zones that may be perceived and understood to be considered to be “high-crime”.

6.3.3.3 Youth

There are many people within this population that are not old enough to either drive or procure a driver’s license. Never mind that they may not be able to afford a car. As a result, there is increased opportunity for less dependence on friends and parents for rides.

6.3.3.4 Seniors

Although this group has seen a dramatic change since transit agencies commenced paratransit there are still some limitations. For example, in New York City its transit agency MTA New York City Transit provides paratransit service for city residents called Access-A-Ride. If the passenger qualifies for and lives within New York City limits and needs transportation to a doctor in Nassau County, which is eastern to, Access-A-Ride will not furnish service over the border. This leaves the senior with a setback of affordable transportation.

6.3.3.5 Disabled

Similar in scope as outlined above in Section 6, the disabled may have a quandary if the property does not command the TNC to have wheelchair-accessible vehicle availability to those who utilize power wheelchairs for personal mobility. TNC must acquire these kinds of vehicles.

6.3.3.6 Language Barriers

There are jurisdictions that require taxi and for-hire livery drivers to know the English language. Agencies need to know that TNC drivers are able to function and communicate in the English language. Yet, there are those newly minted United States citizens that still employ their native language. Although it is always a plus to be bilingual or more, it will be helpful if the TNC can create an option for those who would find it appreciative to have a driver that speaks their language.

6.3.3.7 Tourists

The agency and TNC will need to partner into a marketing campaign that spotlight the need to assist vacationers or those who have never stepped foot into the municipality and educate the potential visitor on how a TNC will aid when planning a local transportation itinerary. For example, MARTA, the Atlanta transit agency, has a website specifically dedicated to both locals and tourists on how getting around a TNC with MARTA will be of great aid.

6.3.4 Increased Revenue Service

With the proliferation of TNC vehicles, there are a few advantages.[57] Trains are constructed along a dedicated Right-of-Way or ROW. That being said, locomotives cannot swerve nor does it have the capability to instantaneously turn since it is confined to the direction of the rail. Although buses do have swerve and turn capabilities, at any time, there are still many streets that do not have the capacity to incorporate buses due to its size. Cars, on the other hand, are not captive to dedicated right-of-way infrastructure and are extremely flexible. Principally, a car should be able to go anywhere door-to-door. Moreover, with the higher number of TNC vehicle availability there

[57] The assumption here is that if today's standard 40' transit bus seats approximately 32 passengers and a car holds 1+ 4 passengers, then the bus to car ratio is 1:8. The "1+" refers specifically to the driver who is easily assumed to be a fixed variable. The higher the vehicle capacity, the ratio decreases. e.g.; a van holding, conservatively, 15 passengers the ratio would be amended to 1:2.67.

would be less waiting time as opposed to the long headways of buses and trains. Dwell time should also be greatly reduced under the assumption that passengers are ready and prepared to jump in and out of the TNC.

6.3.5 Employee Reduction

Similar to Purchased Transportation, the costs of training, human resources, salaries, fringe benefits, pensions, taxes and any other legal obligation involving managerial responsibility of the driver is now in the hands of the TNC. Therefore, there will not be a need to have Directly Operated employees in revenue service under this arrangement.[58]

6.3.6 Decreased Operating Costs

Simultaneously, with the reduction in employees comes a decrease in the operating costs of revenue service. It can be assumed that some, but not all, administrative costs will diminish as well. There may still be a need to have a certain number of transit agency employees in an administrative/managerial or other oversight role.

6.3.7 New/Expanded/Terminated Routes

Because of the physical characteristics of a car or van, the operating flexibility of a TNC, playing a role in transit, will open new doors by providing ingress to areas that may have never seen public transportation availability. The agility factor allows the car to pretty much go just about anywhere there is a road.

Another point to be taken under advisement is the newly generated convenience of one-seat rides. Instead of what may have been a minimum of two or more unlinked trips is now a single

[58] Purchased Transportation (PT) and Directly Operated (DO) are terms, utilized and defined by the National Transit Database administered by the Federal Transit Administration of the United States Department of Transportation. Transit agencies are required to report and file on a frequent basis certain statistical operation data. Primarily the difference between PT and DO is when the transit agency farms out transportation service to another transport service supplier. Further details of each respective definition can be found at https://www.transit.dot.gov/ntd/national-transit-database-ntd-glossary

complete linked trip. To illustrate, instead of walking to take a bus to the commuter rail, then riding a subway placing you at your destination, the TNC could do all of this in one conveyance.

Lastly, since the TNC would replace a number of fixed-routes, the opportunity may exist to eliminate some routes and combine them subject to, of course, sufficient and data analysis over a reasonable time period. Doing so would create another avenue of furnishing the convenience of a one-seat ride.

6.3.8 No Capital Costs

This is a major advantage since the bulk of the capital investment in revenue operations equipment would fall in the lap of the TNC driver. Of course, the TNC is responsible for providing the service. However, under the TNC business model, if someone desires to work as a driver for a TNC it places the onus on the driver to procure and maintain the vehicle.[59]

Theoretically, the transit agency could determine the viability of constructing a maintenance facility for TNC vehicles subject to the terms and conditions of the contractual agreement with the TNC as well as political interplay.

6.3.9 F/L Elimination

If the TNC was already under an agreement to assist a property with its First Mile/Last Mile Dilemma (F/L), it could, via replacement, take the passenger(s) from origin to destination in one complete ride. Hypothetically, this could eliminate F/L. This can be seen in both Chapter 2, Case Studies, as well as within Chapter 3, Literature Review. TAs are already employing TNCs to aid in the TA objective of diminishing F/L in many parts of the country. There are reports of its success in feeder service involving commuter rail.[60]

[59] This is one of the reasons Uber has been given its eight-figure pre-IPO valuation. As of December 2014, Uber has at best a minimum of 160,000+ drivers nationally (Badger, How Many Uber Drivers, 2015).
[60] A study claims that commuter rail ridership has seen an increase as a result of TNCs.

6.3.10 Congestion

Many may opt to shell out the toll instead of waiting for an unknown amount of time in queue to crossover free bridges. If a TA is a subsidiary of a larger system of transportation such as the NYMTA, it will benefit them greatly. Under NYMTA, the toll revenue surplus from its sister facilities go to financially support transit agencies within its purview.

6.4 Disadvantages from the Transit Agency's Viewpoint

Before entering into an agreement with the selected TNC, the policy makers should ponder some of the caveats should it decide to go forward with replacement. Similar to the earlier section, the disadvantages will be emphasized in generalities and not in any particular order. The question being placed forth is to be answered is what the disadvantages from the transit agency viewpoint by replacing its revenue service with a TNC.

6.4.1 Legal

In many jurisdictions, the TNC is either considered illegal or is not exactly welcome. That being said if and when the transit agency and the TNC enter into an agreement, if the TNC is still considered illegal or should the transit agency experience resistance of any legal sort the transit agency will have to appeal to the legislature having competent jurisdiction to either expedite any existing bills, create a bill to legalize TNCs to become the law, or bestow a special temporary permit to the TNC until it is considered legal to operate within that municipality or jurisdiction. Currently, there are several states that are in the mess of formulating bills to make TNCs legal.

6.4.2 Safety

One of the many controversies involving the TNC is one of safety. The taxi and livery industry, who are the biggest competitors to any TNC, have promulgated their dismay of TNCs safety policy. Many taxi and limousine commissions have strict requirements whereby a taxi driver

seeking licensure must undergo a fingerprint-based background check as a prerequisite. As a bare minimum, the taxi and for-hire livery want TNC drivers to undergo an investigation equivalent to their own.

TNCs, like Uber and Lyft, have fiercely opposed the fingerprint checks because "… [It] slows the pace of hiring and increases pickup times… [and] because they're so cumbersome" *[41]*. Obviously, it is in the transit agency's best interests from both a public relations standpoint, and a legal standpoint as well, to make sure that the TNCs drivers are fully vetted.

6.4.3 Company Support

It's important to obligate the TNC to assure the provision of a 24/7 liaison or some other basis of direct communication if and when the need arises. Unlike Lyft, Uber has not had a dedicated phone line for customer service – only for emergencies. As recent as May 2016, Uber commenced a pilot program in the San Francisco Bay Area allowing drivers to contact them by phone but restricted its business hours and use of their app *[34]*. The pilot was conducted in 22 cities since October 2016 *[10]*.[61]

6.4.4 Corporate Relations

The TNC will have a dual duty of keeping the transit agency and its passengers satisfied. TNCs, historically, have not had good relations with its drivers, riders and other stakeholders. Therefore, it may be in TNC's best interest to have a dedicated liaison to monitor realistic benchmarks, and furnish reports on a periodic basis, to gauge everyone's satisfaction.

The TA can always stipulate a clause in their contract that punitive damages be payable to the property in the event specific customer satisfaction metrics are not reached or furnish a monetary award as a bonus if the opposite is proven to be accomplished.

[61] This website does not have a date of publication. The assumption of when it was published is based upon the dates of the comments as well as the copyright year as shown at the bottom of the webpage.

6.4.5 Fare Agreement

This may be the most pivotal part of the arrangement that will need to be very well negotiated. Currently, there are a number of transit agencies and/or local governments where they have agreed to subsidize or discount the TNC fare but not without some terms and conditions. e.g., the passenger must utilize the TNC to go to and/or from a public transportation location. This will be discussed in further detail within the Case Studies section of this paper.

For many, the price or total fare (i.e., TNC fare and transit fare) will be the decisive factor when selecting his/her mode choice. For example, MARTA, has an agreement with Uber. So far, there is no combined discounted fare between the two firms. Thus, a passenger would have to pay a fare to Uber in addition to MARTA. The best case scenario would be for a complete single fare that is similar to a commuter or discounted unlimited ride pass.

6.4.6 Diminished Dedicated Funding Sources

If the transit agency completely replaces the revenue service modes with a TNC, the possibility exists that dedicated financial sources, such as taxes and any other variety of assorted fees, could de facto defund the organization. This could be subject, but not limited, to the potency of political muscle displayed and by whom, the agency's actual savings, and ridership as well as what is being paid to the TNC.

6.4.7 Ratings

TNC drivers and riders are given ratings to each other upon the conclusion of the ride. Moreover, TNCs, like Uber and Lyft are known to be extremely proprietary with their data. Therefore, it would be imperative that the transit agency gain access to said data. This would give the agency a glance at how well the TNC is functioning under its system. In other words, by knowing whether such matters as OTP and rider satisfaction will indicate program success.

6.4.8 TNC Captivity

If the transit agency during a trial period determines for whatever reason it is not doable, there could be the off-chance of a minimal time period requirement by the TNC. The agency should have a Mitigation or Early Termination clause in its contract.

6.4.9 Ridership Losses

In the Maxi-Taxi Study, Tidewater Regional Transit Authority had several of their fixed-routes replaced with taxis. Ridership declined along some of their routes to the point that TRTA decided to disband them. However, it should be duly noted that the difference between the TRTA and today's modernized transit agency is the not just the app, but the lack of sophistication in communication options. i.e.; the smartphone or any kind of cellphone did not exist in 1985.[62] Furthermore, the transit agency, along with the TNC, would need to craft an extensive marketing campaign educating passengers about available service options.

6.4.10 Drivership

Of all of the factors previously listed this one is probably the most crucial of them all. Basic to any Introduction to Business 101 course is in order to meet the demand you must have the supply for that reason, in order to make the TNC a viable operation it must have enough drivers. If the necessary quantities of drivers are unavailable, the TNC cannot satisfactorily function. Subject to the terms and conditions of the contract the transit agency may want to consider having a contingency plan in place that would include retaining a definite number of vehicles and employees on standby. This would empower the TA to preserve a continuity of revenue service operations if, in the event, TNC drivers conduct work stoppages and/or unauthorized strikes.

[62] This was the year the study was published. The study was conducted pre-1985.

6.4.11 Technology

Although already discussed under Advantages from a Transit Agency's Viewpoint, technology is a double-edged sword. To reiterate, it can be both an advantage and disadvantage. On one side, it can be of great utility in waning many of the transit agencies costs. Conversely, because technology is rapidly changing on a very frequent basis, depending on the innovation at the time of introduction it could be detrimental to the transit agencies operations – even with a TNC. A good example is the automated vehicle or AV. It is no longer a matter of if, but rather one of when. The AV will need a period of time for adjustment or market acceptance. The assumption is there even if the AV is perfected, over time, there will always be those skeptical of its performance. Presuming that the AV operates favorably there is the outside chance that TNCs will want to implement them. If fully functional and affordable the transit agency should be concerned as people may forego public transportation for the option of another cheaper mode that utilizes AV's or an outright purchase for private use only.

6.4.12 Congestion

TAs can find themselves with a public relations nightmare in explaining their reliability factor. Along with longer trip times these situations can also lead to longer passenger wait times.

6.4.13 Potential Competition

Even though TNCs are already operating and transporting passengers it is not too overly surprising, that some suspect a TNC may be testing the waters for possible market entry into transit. For example, in July 2016, Uber publicly offered its "Uber Commute Card" *[31]*. Yet, Uber asserts that it "aims to complement, not replace…" public transportation *[88]*. To reaffirm, there have been a myriad of allegations lobbied against TNCs involving controversial activities. This has earned itself a status of ill-refute. Uber, for instance, has been accused of being "unethical and

ruthless" *[54]*. Taking all that into consideration, a transit agency would want to closely monitor a TNC ensure that it does not encroach upon its operations. A non-compete clause should be in the TNC operating agreement

Table 6.4, below, provides a brief overview of the general advantages and disadvantages for the TNCs Drivers and the TNCs in their relationship with a transit agency.

Table 6.4 Advantages and Disadvantages to Drivers and TNC

Drivers		**TNC**	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Increased Income	Recruitment Drives	Increased Valuation	Legal
Flexibility	Safety	Increased Ridership	Safety
Multiple Employers	Customer Relations	Increased Revenue	Fare Agreement
Multiple Opportunities	Tax Liability	Broader Experience	Reduced Number of Investors
Selectivity	Reliable Reviews	New Opportunities	Data Sharing
Incentives	Virgin Territory	Brand Awareness	Contractual Confinement
Networking	Time	No Capital Investments	Unionization
Ratings	Technology	No Infrastructure Maintenance	Competition
Support	Congestion	No Employees	Technology
Technology	Other	No O&A Costs	Venue
Training		New Territories	Congestion
Unionization		Congestion	Other
Congestion		Other	

6.5 Advantages from the Driver's Viewpoint

6.5.1 Increased Income

The ability exists for those in need of earning a supplementary salary without jeopardizing any other employment drivers may already have. Currently, a TNC at times offer certain

"guarantees" *[11]*. Subject to the firm's terms and conditions[63] and the driver's base of operation, there will be an assured minimum amount given to the driver, hourly or weekly, provided s/he meets the criteria as set forth by the respective firm. Moreover, "[s]urge pricing is uncapped. Make up to 50x the base fare during peak demand times." *[12]*.

6.5.2 Flexibility

Drivers have an option to work full or part-time and whenever the desire to work suits their needs. Similar to the above, Drivers can work without imperiling any other existing employment s/he may already have.

6.5.3 Multiple Employers

Drivers can work for any TNC or more than one "platform for the same [TNC]", simultaneously *[12]*. Allowing drivers to earn valuable experience and more income.

6.5.4 Multiple Opportunities

Sidecar, a TNC, ceased its operations the last day of 2015. Beforehand, they expanded their repertoire by offering delivery service. This added feature allowed a Sidecar Driver the option to select from two distinctive divisions or transport for both.

TNCs, like Uber, offer other types and kinds of services. Drivers may be permitted to schlep goods and other items beyond people.

6.5.5 Selectivity

At times, fares are based on demand/supply; it can also determine the boundaries or limitation of distance, i.e. how far the driver will go *[76]*. Drivers may determine that a particular ride request is not profitable enough and can choose when and how long to work *[12]*.

[63] In a live telephone interview with an Uber Driver/Partner representative, there are four requirements in order to receive the "guarantee". 1) Limited to select Drivers via email. 2) The Driver must be within precise geographical parameters. 3) No more than two trips for the same customer shall count towards the trip total, and 4) the invitation requires a specific number of trips to be completed within a certain amount of time.

6.5.6 Incentives

TNCs do have, on occasion, promotions that benefit their Drivers. Examples are: sign-on bonuses and monthly referrals. There are websites that supply intelligence on these matters specifically *[12]*.

6.5.7 Networking

Mainly, this would be contingent on the passenger's personality. A driver may strike up a conversation which leads to either increased business from building loyalty and trust to being introduced to new people facilitating other unknown opportunities and "learning about different cultures" *[12]*.

6.5.8 Ratings

Drivers can rate their passengers and vice-versa. If the customer receives poor ratings, the driver will never have to encounter that particular rider in the future.

6.5.9 Support

There are a few important areas of support which are discussed in the following subcategories.

6.5.9.1 Customer Relations

Customer, within this subsection context, covers both drivers and riders. TNC riders cannot request specific drivers which allows sharing the wealth of good payers amid the drivers.

Drivers have access to TNC representatives subject to the individual entity's policy. e.g., a Lyft representative is available 24 hours/7 days-a-week by means of a dedicated toll-free phone number, and/or email. Replies, normally, take no more than 48 hours *[8]*. Uber, unfortunately, is quite the opposite. On the other hand, it has begun a pilot offering telephone access but it is restricted to business hours only. Drivers need to know there is advocacy from the TNC.

6.5.9.2 Insurance

TNCs offer a policy covering collisions. For instance, Lyft would compensate a driver's deductible with amounts higher than what Uber will proffer. Lyft, unlike Uber, gives round-the-clock accessibility to an insurance agent since time is of the essence.

6.5.9.3 Other

In addition to the aforesaid, TNCs would be responsible for certain summonses, and cover any costs involving customer-produced property damage or "loss of business" hours *[8]*. Likewise, TNC drivers provide forums, such as a blog, and other social media pages where colleagues and others interested in pursuing a sideline career with TNCs can talk shop and consult amongst one another.

6.5.10 Technology

At this juncture, it is a matter of who offers a better product and how frequent each company updates their software. Accordingly, the one who produces an improved platform first will reap the benefits. Drivers always seek, to operate with maximum efficiency, synchronously, keeping their customers satisfied and steadfast.

6.5.11 Training

Generally speaking, no formal company training is required. This allows for an easy and immediate entry into the market. Nonetheless, depending on the venue of operation, local regulations may require a formal training session as part of the mandatory licensing requirements. e.g.; New York City *[13]*. If any training were to be offered, especially if it is at no cost, drivers, it would benefit them greatly. For instance, courses such as handling difficult customers, increase customer satisfaction, vehicle maintenance, financial management, logistics management, linguistics and many other how-to types of classes.

6.5.12 Unionization

This can be an advantage if drivers integrate and formally create a unionized organization. For the TNC this would be a force to deal with as there are over 160,000+ drivers nationwide.[64] Because many feel exploited, there has been encouragement and backing from one of the more established unions. If this were to occur the drivers would receive a number of benefits, perks and an increase in income

6.5.13 Congestion

1. Greater Opportunity. There is potential for other drivers to accept rides that would have been performed by drivers had they not be subject to increased traffic.
2. Income Growth. Less can mean more. More trips, means more earnings. In addition, a newly minted app, Mystro, was engineered to aid drivers in ride selectivity. In other words, drivers can pick and choose which trips to refuse.
3. Time-Based Fares. TNCs fares are based on time and distance. The longer the TNC sits in congestion the higher the fare and the increase in income.

6.6 Disadvantages from the Driver's Viewpoint

6.6.1 Recruitment Drives

If TNCs prohibit their drivers to work for competitors or even the transit agency it serves, then it is not only problematic for the driver – but for the TNC as well. The bottom line to the drivers is being able to make a living. TNCs need to be more sensitive to driver needs

Sidecar sought to enroll as many drivers as possible *[76]*. This policy is still executed by Uber and Lyft. By doing so, this diminishes the value of the current, more experienced drivers as well as creating an increased quantity of intra-competition.

[64] The number would be obviously larger if, globally, all international drivers joined.

6.6.2 Safety

This is to be discussed in further detail within the Controversial section of this paper. Nevertheless, due to its criticality, it is appropriate to reiterate. Being a Driver there is the risk of being robbed, beaten, or worse, as a result of the lack of passenger unfamiliarity. Even if the passenger has the highest of accolades, this does not guarantee Driver protection, as it can be a false customer profile purposely created with willful intent to commit a criminal act. For example, unbeknownst to Uber or its Drivers, drug dealers hired their service *[57]*.

6.6.3 Customer Relations

Uber, unfortunately, is antithesis to Lyft in this classification. Access to Uber is limited to Internet communication and replies are anticipated to take almost a week.

6.6.4 Tax Liability

Briefly mentioned hitherto, currently, litigation has been ongoing in the courts for a legal decision on whether Drivers are considered, legitimately and finally, employees or independent contractors. The final ruling shall affect whose responsibility it is to pay income tax. As an employee, some of the liability shall be borne by Uber, Lyft et.al. If the verdict is against the Drivers, the companies will still lose since many Drivers may decide to quit. For a lot of Drivers, the extra income in comparison to the tax to be paid on it may not be in their best interests. Employee status offers additional legal safeguards such as the employer could be named as a direct defendant in a civil litigation proceeding as opposed to being behind the shield of an indirect service provider.

6.6.5 Reliable Reviews

Uber drivers have what to fear since there is a very high reliance on customer satisfaction. i.e., the lack of submitting a rave review. As an example, a passenger knowingly received a very

high quality level of service, but out of spite or for other malicious reasons, may tender a low rating, Consequently, Uber, ex parte, hastily dissolves its relationship with the Driver.

On the other hand, any company's position is the desire to maintain the public opinion of credibility. Partially, to keep customers happy and nurture loyalty with the goal of long-term repeat business. Another stance is reputation. TNCs do not need to attract negative notoriety.

6.6.6 Time

Depending on whose outlook, Uber, Lyft and current and future rivals, may still be considered in their infancy or post-infancy stages of growth and public-acceptance. Even though these firms have cultivated an acute mass of exponential growth, there are still governments that are not receptive to this type of service, yet. Still they are at a disadvantage as it will take time until they are accepted – legally and socially. Persuasion through professional lobbyists and civilian advocates can either expedite matters or it can take years before proper jurisdiction accepts the responsibility of generating and enforcing regulations as it relates to this type of commerce.

6.6.7 Technology

GPS technological innovation and its subsequent advancements have enhanced traveling. No longer is it necessary to carry maps of various sizes and localities to find out how to reach a destination. Today, reasonable pricing affords the consumer with a choice of sizes and styles of a GPS. However, venue can have a significant affect how the GPS functions. This can be a considerable advantage for one firm to have over another. For example, in Las Vegas, Lyft has better GPS technology over Uber. Drivers can zero in on the exact location of the customer where Uber cannot. Uber only has a general location feature which becomes a liability for all involved. The Driver cannot find the passenger and s/he cannot locate the waiting vehicle. This could greatly inconvenience a rider forcing him/her to a walk to an out-of-the-way rendezvous point.

6.6.8 Congestion

1. Opportunity Costs. Each moment a vehicle sits in a traffic clogs it leads to a diminished number of rides completed. Riders may need to hurry to their destination compelling them to select another driver or a different app altogether.
2. Decreased Income. Drivers produce more income if they can conduct shorter trips. Congestion may hinder those prospects.

6.6.9 Other

Tactics plays a somewhat partial relevant, interconnected role. To their disadvantage, the tactics implemented by Uber, Lyft and Sidecar were what brought on all the deep-seated chagrin. Case in point, when Sidecar was in revenue service, unlike Uber and Lyft, they purposely sought to negotiate, cooperate and comply with the regulatory authorities. In fact, they were the first to procure operating permits for service to/from San Francisco International Airport. Suffice it to say, Lyft was far from being angelic; however they were not as culpable as Uber.

Like Hansel and Gretel, wherever Uber traversed one can always find a breadcrumb trail of trouble in its wake. Such as, when Uber opted to begin serving a new territory; they always landed themselves in some dispute. The turmoil became a disadvantage to drivers since as TNCs actions affected them though received the negative publicity and those same tactics would be used to exploit driver pay.

6.7 Advantages from the TNCs Viewpoint

This discussion will focus on how it would be advantageous to the TNC should it decide to go forward with replacing the revenue service operations of a transit agency. Unconditionally, it itemizes the various advantages emphasized in generalities and not under any specific ranking. The question placed forth is: What are the advantages for the TNC if it were to replace transit?

6.7.1 Increased Valuation

Estimated assessments for Uber, not yet on the stock market, envisage a valuation of approximately $68 billion *[35]*. Lyft, a distant second to Uber and its chief rival, has been appraised at $2.5 billion *[70]*.[65]

Uber and Lyft have already launched or are either in the midst of various pilot programs involving joint ventures with transit agencies and municipalities. These pilot programs, principally, involve a TNC taking someone to/from a public transportation location. Assuming that these programs are proven to be successful and contracts are awarded on a long-term basis with the addition of the program to expand to other revenue services such as paratransit and fixed-routes, it is conceivable that the valuations of these TNCs rise. Consider that these TNCs have not even announced, thus far, plans for an IPO date anytime soon.

6.7.2 Increased Ridership

Many similarities to this were mentioned in the Advantages from a Transit Agency's Viewpoint section. Based on recent figures there is the suggestion of a trend in the up growth in TNC ridership. The taxi industry, for one, in San Francisco and Los Angeles as well as two other major US cities indicate a sharp decrease in taxi rides. A main cause has been primarily due to riders absconding to utilize the TNC since it offers lower fares *[8]*.

People need to be taken from origin to destination whether it be in an urban and rural locale. In this case, the presumption is ridership quantities will rise as a result of the TNC spreading its services into transit revenue operations. It can be safely assumed that when aggregating the number of unlinked trips with TNCs regular and loyal customers the statistics should easily prove higher numbers of riders.

[65] Didi Chuxing is by far one of the largest as far as number of daily riders, but its valuation as of June 16, 2016 was $28B. http://www.nytimes.com/2016/06/17/business/international/china-didi-chuxing.html?_r=0

6.7.3 Increased Revenue

For the most part, the TNC will transport newly found customers in the form of the transit agency's passengers. For the most part, both the new customers and loyal commuters may give the TNC a try and for many, a first, will temporarily ditch their original mode choice. In other words, the commuter will leave their car or bike behind as an experiment to determine whether it is a positive and worthwhile experience. Some examples go beyond the initial day of commencing revenue service. There can be an upsurge of demand from certain weather conditions, unexpected incidents and/or pre-planned special events. What matters is all of these passengers will utilize transit, employing a TNC in the process. Ostensibly, this translates to more revenue – not necessarily more of a surplus.

Like anything else, the transit agency should anticipate initial figures will swell. Realistically, it needs to expect some to abandon the TNC connection. Even with the latter, the transit agency should hopefully see a net positive gain in customers.

6.7.4 Broader Experience

Generally speaking, the TNC is primarily known for its providing instantaneous passenger transportation service. What separates the TNC from mass transit is the "mass". In other words, high volumes of passengers traveling simultaneously at any given moment.

Previously listed were the various services available by Uber, a TNC. For illustrative purposes, Uber as a TNC has shown itself to be quite prolific but barely ventured into full transit mode neither has any other TNC.[66] With this type of market entry, TNC's will gain valuable experience and will make it easier to say why TNCs should be selected as the preferred mode.

[66] Some may argue that microtransit is lateral to TNCs. However, the author not only disagrees but has given a detailed definition of what is a TNC.

6.7.5 New Opportunities

The consequences from replacement will garner a whole new level of experience for the TNC. There may be some creative inventor or employee within the TNC that develops a new app or other invention that could widen the scope of a TNC. For example, Uber announced it plans to reverse its previous policy to relax its stranglehold on sharing internal data. It has created a website called Movement. It describes it as "anonymized data" furnished at no charge *[9]*. This is data that has been compiled over some time and from various cities it serves. Its purpose is to assist city planners in their pursuit for long-range transportation forecasting and other such similar plans.

6.7.6 Brand Awareness

Like the cell phone, it has taken years for it to develop and progress into what it is today. Equally, is the level of market acceptance for the product.[67] As long as the TNC furnishes dependable and reliable service, the name of the operating TNC will earn itself a good, positive reputation. This type of prominence will, in the long term, give it status with other transit agencies pondering about whom to select while pondering a replacement decision

6.7.7 No Capital Investments

Anyone seeking to become a TNC driver must procure a vehicle at their own expense. Moreover, TNCs, at this time, do not have to construct a maintenance facility or lease any space for administration of transportation management.[68] All of the latter is at the expense of the transit agency.

It is well known that Uber has invested heavily into AV technology *[93]*. If TNCs do purchase and introduce AVs into revenue service, their status as a TNC could change legally.

[67] This has been previously examined in the Introduction section.
[68] TNCs either lease, rent or own administrative offices but not for the purpose of hands-on, personal management of drivers.

6.7.8 No Infrastructure Maintenance

Similar to the above, the expenditure is not the responsibility of the TNC. The burden of building and maintaining roads, traffic engineering, and other related substructure falls upon the government wherever the TNC is or plans to operate.

6.7.9 No Employees

Similar to Purchased Transportation, the costs of training, human resources, salaries, fringe benefits, pensions, all taxes and any other legal obligation involving managerial responsibility of the driver is now in the hands of the TNC. Currently, Uber and Lyft, lawfully, have their drivers classified as independent contractors.

Yet, there are several ongoing class-action lawsuits drivers have with the TNCs. As such, subject to the epilogue those cases of as well as other recent legal rulings will determine whether 160,000+ drivers will be instantly added to the TNCs existing payroll of salaried personnel.

6.7.10 No Operating and Administrative Costs

There is no direct overhead involved in the physical movement of people. The driver bears the responsibility of the vehicle whilst the transit agency is accountable for administrative oversight. Training is conducted via video and where required by regulators.[69]

6.7.11 New Territories

The TNC is prohibited or still unlawful in some areas. It also may not seek to supply service due to their original determination that the venue, in question, is financially impracticable. If the transit agency has legal authority to serve said locations, under replacement, the ban could be lifted with the presumption that under the notion that the public transportation organization is a for-the-

[69] In New York City, the regulatory agency policing TNC operations is the New York City Taxi and Limousine Commission ("NYCTLC"). TNC drivers are required to be procure a license issued by NYCTLC. The process includes, *inter alia,* training in UberWAV, the wheelchair accessible vehicle service. http://driveubernyc.com/tlc/

public-benefit agency could have possibilities to override those sanctions. This is provided that that such an override does not conflict with any other laws that would normally outlaw TNCs.

6.7.12 Congestion

Currently, part of the TNC fare structure comprises a time-based fee (there is a distance-based charge that is added separately). The longer the TNC is in a traffic jam, evidently, the rider will be held responsible for a much higher than anticipated total fare. Moreover, any time there is a price upsurge, TNCs benefit since they collect a percentage from every completed ride.

6.7.13 Other

6.7.13.1 Attenuating Traffic Regulations

If there are any regulations to support transit agency revenue service operations, the TNC would benefit if such laws encompass them too. For example, there are many cities that have bus-only lanes or a BRT ROW. Under this concept, the TNC would have legal rights to operate and maneuver their vehicles in these corridors. Under normal circumstances, their cars as well as other commuter drivers would normally be prohibited.

6.7.13.2 Technology

To restate, technology can be both an advantage on top of being a disadvantage. Under the concept of dynamic evolution what is considered cutting edge today can become obsolete tomorrow. Moreover, it must be accepted that everything – product or service – has a useful, albeit limited, shelf life. To better illustrate, let's look at the everyday motor vehicle. Today's technology there is being combined with it to produce an automated vehicle or AV. The biggest advantage is the permanent elimination of the drivers – even if under the independent contractor status. Theoretically, the TNC would pocket 100% vs. the 70-90% it currently keeps as its income share. Hypothetically speaking, of course, because this could conceivably become a severe disadvantage

dependent upon the TNC outright purchasing AV's which translates to direct ownership and maintaining them.

6.8 Disadvantages From The TNC Viewpoint

Before entering into an agreement the TNC must warrant that they are prepared to meet the challenges involved if selected to replace fixed-routes and/or other revenue service operations. Once again, the disadvantages will be emphasized in generalities and not in any particular order. Moreover, some of the items encountered underneath may seem to appear repetitious. Chiefly, it is attributable to it bearing similarities to the disadvantages of a transit agency. The examination being placed forth is what the disadvantages from the TNC vantage point are.

6.8.1 Legal

While previously discussed under Transit Agency Disadvantages, it needs to be reemphasized. In many jurisdictions, the TNC is verboten. Notwithstanding, the TNC needs to resolve all legal issues before commencing revenue service operations. At the present time, a number of pieces of legislature are at the center of being crafted and awaiting to be passed into law making TNCs legal and under a regulatory framework of inspection.

6.8.2 Safety

To recap, a major point of contention where the TNC is concerned is safety. The taxi and livery industry have propagated their apprehension for the TNCs lack of thorough background checks being on par with theirs. The TNC complains that an in-depth investigation consumes a lot of time, energy and money, and questions the employment of "out-of-date databases" which impedes their need to employ as many drivers as possible to meet demand *[1, 56]*

The TA may, as part of their agreement with the appointed TNC (or perhaps more than one), require a full and detailed driver inquiry which would necessitate the TNC to compose a

strategic recruiting plan going against their long standing policy as evidenced recently in Austin. Such actions may compel transit agencies and regulators to making TNCs spend additional funds and time to recruit drivers. There may well also be possible litigation against drivers, not grandfathered, if the transit agency orders the TNC to drop them as a result of a driver receiving a negative background check. It is in the TNC and transit agency's best interests from both a public relations and legal standpoint to make sure that the TNCs drivers are fully vetted.

6.8.3 Fare Agreement

This, too, has previously been discussed within Transit Agency Disadvantages. As a panacea, the rider will be able to procure a commuter pass sold at a substantially discounted fare.

The transit agency will, in high probability, disallow for any type of surge pricing or charging passengers by implementing multiples upon what would be a normal fare. This practice is usually demand-based. Only the transit agency would be allowed to construct fare policies. This would be a conceivable disadvantage since surge pricing leads to enormous profits also allowing drivers to earn higher amounts of income.

Currently, a number of TNCs are receiving funding that is underwritten by transit agencies and/or local governments where they have agreed to compensate the difference in the TNC fare.[70] The financial inducement for the rider is under the condition that s/he employing the TNC must either travel to or from a public transportation location within its purview or within a specified geographical perimeter. Additionally, TNCs may have to disclose their financial and other data. Likewise, this has been a long standing policy of the TNC to obscure their data proclaiming it is proprietary. The information would contribute to TA for planning purposes.

[70] Presumptuously, TNCs such as Uber have to some extent underwriting fares, where applicable, under the guise of providing phenomenal service coupled with an affordable or low fare. Current, albeit limited, financial disclosures indicate they are not, thus far, churning profits. *[94]*.

6.8.4 Reduced Number of Investors

If the TNC for reasons of cause, even if beyond fault of their own fault are immediately terminated or informed that it will no longer accept any future bids an investment group may either cash out or any impending investor may decide against providing necessary financial capital.

6.8.5 Data Sharing

TNCs, for instance Uber and Lyft, are well known for being tremendously protective of their data. TNCs will need be strategically and logistically prepared to share their data regardless of past practice.

Transit agencies will require all sorts of figures including, but not necessarily limited to, ridership figures, O/D pairs, dwell time, MDBF (if applicable), and of course, the internal ratings of and by the drivers and riders.

As pointed out hitherto, in transit agency disadvantages, TNC drivers and riders grade each other, respectfully, on the basis of the quality of service rendered and passenger behaviorisms. This action is taken upon the passenger alighting the vehicle.

It would be imperative that the transit agency gain access to such data. This would give the property a glance at how well the TNC is functioning within its system. In addition to which it would allow it to monitor which drivers and in some cases riders in the event the agency is duty-bound to ban a driver and/or a rider. Doing so allows analyzers to determine whether riders are satisfied or not, and the successfulness of the program's direct access.

6.8.6 Contractual Confinement

Similar to TNC Captivity, Section 6.4.8, if the TNC during a trail period determines for financial reasons, as an example, it is no longer doable, there could be the off-chance of a minimal time period requirement by the transit agency. TNCs need mitigation or early termination clauses.

6.8.7 Unionization

Uber, since inception, has developed a deep acrimonious relationship – to an extent - with its Driver/Partners. As of December 2014, there were 162,037 "active drivers", or Driver/Partners, who accomplished at least four rides. According to Uber's data, Driver/Partners earn more than those who work for cab companies on a full-time basis *[26]*. But what they neglected to mention was whether the earnings were gross or net. Regardless, there have been a myriad of protests all over the nation. For example, in New York, Tampa and Dallas there have been organized protests over Uber's lowering fares, leading to a reduction in a driver's income.

The Dallas protesters have, for the most part, a legitimate gripe. Uber Driver/Partners for UberBlack in Dallas, rallied when they learned of a new policy to force them to accept UberX Riders whom pay a much lower fee.[71] Under these conditions, UberBlack Driver/Partners will not only culminate in working for less, but because they were also compelled to shell out mid-five figures, on average, for fancier vehicles, in some cases more, the income may not be able to sufficiently cover their expenditures *[89]*.

It has been more than a year since the above figures have been updated, even if 12,000 Driver/Partners resigned and there are 150,000 +/- remaining, the possibility exists that should they act in tandem, or in other words unify nationally, Uber would have no choice but to pander to their demands. The six-figure number alone shows a level of clout that exhibits sheer superior strength, and shows no deceleration. By January 2015, the number of enlistees pursuing to become Driver/Partners increased 200% for every six-month period for the previous two years *[27]*. If the Driver/Partners collaborate with experienced negotiators this could radically change, or disrupt, both the business model and the future practices of Uber as well other TNCs. Should the drivers

[71] UberBlack are rides in luxury-style vehicles commanding a higher fare where as UberX is the basic service.

ratify to unionize, they would have three options: join the ATU or the Amalgamated Transit Union, develop their own union, or perchance join the Teamsters.

This prediction may be coming to fruition quicker than anticipated. In December 2015, the City of Seattle passed legislation permitting Uber and Lyft drivers to unionize. Teamsters Local 117, which is based in the Seattle Area, assisted in shaping and crafting the new law *[82]*.

6.8.8 Competition

At press time, there are 77 TNCs, globally. Here in the United States, there are 37 TNCs in operation (see Appendix A).[72] Only time will tell who are either remaining or insolvent.

Uber by far is the largest TNC and a major player within this domain. Notwithstanding, Lyft comes in at a distant second.[73] Irrespective, of either one of these behemoths there is nothing stopping others from duplicating their business model, modifying it and growing into one of the top three, or even surpassing Lyft – maybe even Uber.

At the present time, there is a newly developed TNC that recently commenced operations mid-2016 in New York City called Juno. They are potentially a serious competitor to Uber, Lyft and any other TNC seeking market entry into the City of New York. Juno has proven itself thus far, and unlike Uber and Lyft, by thinking out of the box with placing driver concerns and welfare above all else. As part of Juno's recruitment campaign, it offers driver's a 90% fare split and the opportunity for actual aggregated ownership up to 50% of Juno shares – pre-IPO *[60]*. However, and unfortunately, in April 2017, Juno was acquired by Gett for $200 million. As a result of the merger and acquisition, a great number of the perks that originally made it attractive for drivers to evacuate TNCs, like Uber, found themselves in many cases with worthless bonuses.

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[72] Appendix A gives a detailed list of every TNC globally including those operating within the United States. The list originally had 79 and 39 respectively. By January 8, 2017, two already discontinued their revenue service operations. i.e.; SideCar & Shuddle.

[73] This is the author's ranking based upon valuations.

Moreover, with its recent departure from Austin, Texas over the disagreement of a fingerprint-based background investigation, Uber and Lyft, created a void that has been replaced by at least a half dozen new TNCs seeking the opportunity for market entry into this city.

What's more is Uber's reputation precedes itself according to Juno's founder: "Everybody we talked to…hated Uber with a passion." *[60]*. This is both damaging and essential as it is a loud and clear message for Uber and other TNCs to take notice. Either take care of your drivers and passengers or lose business. In other words, a TNC should not take its business for granted.

Furthermore, there may be the possibility that a transit agency selects more than one TNC to handle its voluminous ridership. If that is the case, the TNC should do all it can to have an amicable working relationship. Otherwise, it could lose its contract or worse end up terminating its operations.

6.8.9 Technology

Although already discussed under Advantages from a Transit Agency's Viewpoint, technology is a double-edged sword. Basically, it can be both an advantage and disadvantage.

Yet, conversely, because technology is rapidly changing on a very frequent basis, or what I like to call dynamic evolution, depending on the innovation at the time of introduction it could be detrimental to the transit agencies operations – even with a TNC. An example is the current taxi industry in Los Angeles. As aforementioned, the industry was decimated by the TNC. Whatever the reason is today's world requires both individuals and commercial enterprises to keep on top of the latest trends of products and services coming to market. Technology has a shelf life and thus can instantly make a product or service obsolete.

Advantages and disadvantages between each company's service, or in other words, to offer an evaluation between Uber, Lyft, and its rivals has been essentially demonstrated above through

the numerous contrasts from both the Rider's and Driver's perspectives. Amusingly, when pitted against the taxi or mass transit industry, it serves to annotate, that there are advantages and disadvantages there as well. Briefly, when it comes to advantages are more is better. Mode choice is increased; more competition leads to decreased prices. The disadvantage is too many Drivers may lead to a decrease in mode choice. Mass transit can reduce and/or eliminate routes, and reduce service, taxi drivers may see a drop in revenue and could quit to find other employment opportunities, and some taxi companies may go out of business *[69]*.

Moreover, it is essentially a precondition to clarify how human nature is a key, compelling component that must not be overlooked. Basically, as humans we are naturally diversified. We are not all the same age, nor the same height or of a single gender. The consequence is our diverse and assorted opinions. From a customer's initial riding experience versus multifold occurrences will generate a full spectrum of varied assessments. Correspondingly, this holds true for the Driver. His or her ordeals with passengers shall differ even with recurrence. Without assumption, multitudinous rides are never the same. Therefore, it is safe to deduce how someone, Rider or Driver, will evaluate what is an advantage or disadvantage.

From a comparable aspect, they all present the same "product" or service; a means to order transportation service via an app from any mobile device. If there is one fundamental, albeit indispensable, attribute where all these companies differ it would have to be Venue.

6.8.10 Venue

In real estate, realtors always tell prospective buyers that when indecisive about where a retailer should establish itself, the decider comes down to "location, location, location". There has never been a truer aphorism. The dictum applies to Uber, Lyft and its coequals. All three located their initial base of operations in San Francisco, California. Silicon Valley, an area close to San

Francisco, is known for its multitude of incubators or places where high tech start-ups conduct and develop their research. The underlying objective is to eventually lure investors with the intention of selling their ideas or have same purchased after actual execution of revenue operations for as much as can possibly be had. San Francisco was not just a good beta-testing facility for the companies because of its critical mass of population density, but it also had the distinction of being the first major American city to encounter this service.

Within this context of advantages and disadvantages, venue serves a unique role for the following reasons:

6.8.10.1 Virgin Territory

After acquiring the sweet taste of success, Uber, notably, started expanding into other untested urban and rural areas. At the time of this composition, many of these municipalities have either already passed or initiated the process of creating legislation to make these firms legally recognized commercial enterprises. The former is an advantage allowing for Uber, Lyft and other TNCs. to overcome what was once considered burdensome obstacles of bureaucracy. Now they're on their way to becoming an accepted, fully-integrated profit-making entity.

6.8.10.2 Time

Depending on whose outlook, Uber, Lyft and current and future rivals, may still be considered in their infancy or post-infancy stages of growth and public-acceptance. Even though these firms have cultivated an acute mass of exponential growth, there are still governments that are not receptive to this type of service, yet. Still they are at a disadvantage as it will take time until they are accepted – legally and socially. Persuasion through professional lobbyists and civilian advocates can either expedite matters or it can take years before proper jurisdiction accepts the responsibility of generating and enforcing regulations as it relates to this type of commerce.

6.8.10.3 Topography

Unlike certain mass transit modes with its limiting infrastructure and facilities of dedicated right-of-ways and fixed routes, Uber and Lyft do not have these restrictions. Because of this, Uber. Lyft and others may be the solution to the chronic First mile/Last mile problem. Presently, MARTA, the Atlanta transit authority has been in negotiation with Uber for a trial basis to this situation.

6.8.11 Congestion

Similar to Drivers, TNCs losses stem individually as a result of any decrease in rides that may go to their competition or another mode completely. i.e.; Lyft, friend offering a ride, etc.

6.8.12 Other

As stated in Section 6.6.9, depending on the tactics executed by TNCs it may become a disadvantage to their drivers. Yet, those same tactics can convert into disadvantages for TNCs of monumental proportions since it would compel them in the end to pay high legal fees and possibly fines. But in the long term – it can lead to the loss of business.

CHAPTER 7: INTEGRATED VARIABLES

7.1 Introduction

Up till now, this paper's focus has been on the financial aspects of how a TNC could replace public transportation. Assuming that this occurs, interrelated are a few external factors that need to be pondered. The ongoing process of developing policy will have to include three components, as listed below, which will directly affect service outcomes and indirectly carry a certain amount of consequence. This would allow decision-makers to mitigate any unanticipated negative effects.

The variables are:

1. Congestion
2. Curbside Logistics and
3. Infrastructure Costs.

7.1.1 Congestion

The foundation for any business is the equation: demand equals supply. In the context of transportation, travel demand must have adequate vehicle supply. Roadways are no different. If the (spatial) supply is equal to or more than the demand (the quantity of vehicles simultaneously in motion) drivers will experience a free-flow (non-congested) movement. However, demand vehicle flow becomes hindered and greatly restricted if the supply is imbalanced.

Congestion clogs up our freeways, arteries and other affiliated thoroughfares. These traffic conditions can conceivably lead to a range of losses. Social costs (the environmental damage as a result of air and noise pollution) are one example. In addition to the latter, there are congestion

costs. Congestion costs is the quantification of fuel consumed with time lost in traffic jams combined mainly on an annual basis. Figure 7.1 depicts over 30 years of congestion costs on a national level. There is a sharp increase in aggregated congestion costs between 1982 and 2010. Post-2010 until 2014 it is fairly stabilized.

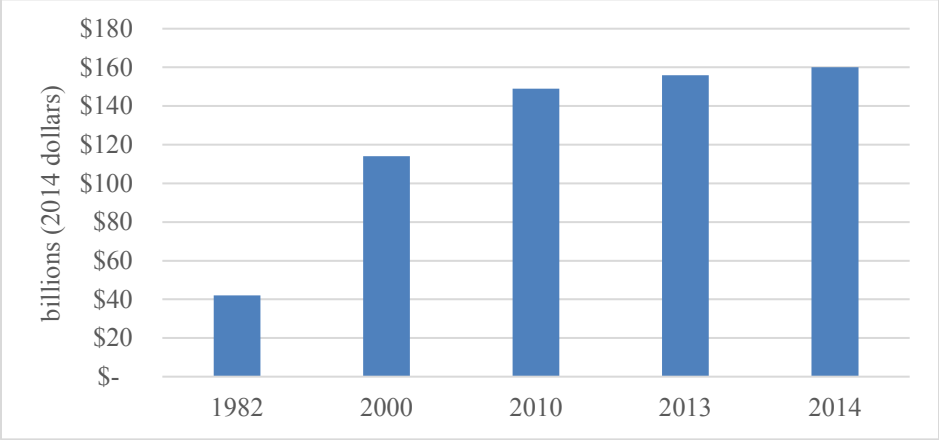

Figure 7.1 United States Congestion Costs 1982 – 2014

Source: Urban Mobility Scorecard, 2015

In Figure 7.2, the congestion costs are apportioned per United States auto commuter. Observe how the same increases over time are analogous to Figure 7.1. That is, it shows the same steep rise in aggregated congestion costs between 1982 and 2010, then becomes almost identical post-2010 until 2014.

In Figure 7.3, shown below, provides the number of hours, every auto commuter in the United States contends with congestion. In 1982, it was 18 hours per auto commuter and by 2000, it ballooned over 200% to 37 hours per auto commuter until 2010. By 2013 it increased again, but stabilized at 42 hours per auto commuter.

Energy costs can exhaust an auto commuters' wallet, especially when gasoline is unnecessarily guzzles while sitting in gridlock. Figure 7.4 indicates how much fuel is wasted.

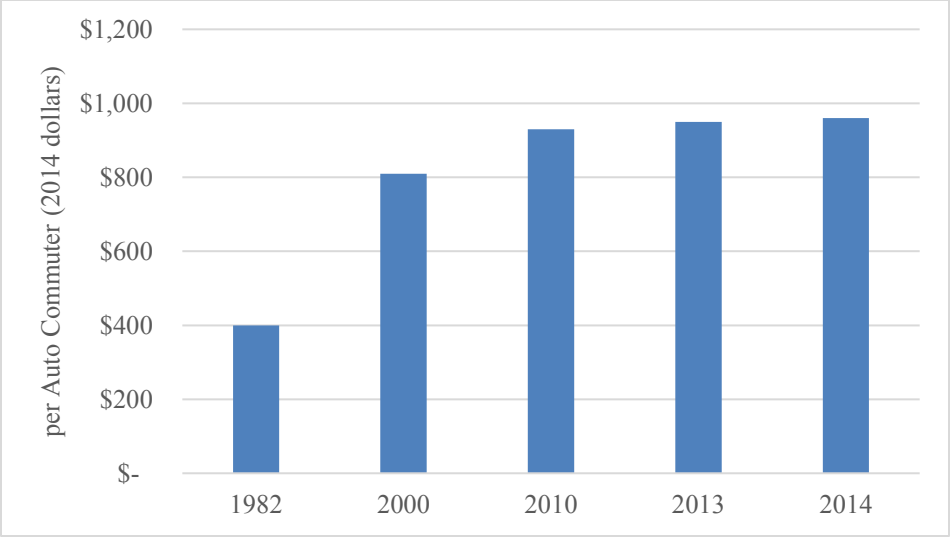

Figure 7.2 Congestion Costs per U.S. Auto Commuter 1982-2014

Source: Urban Mobility Scorecard, 2015

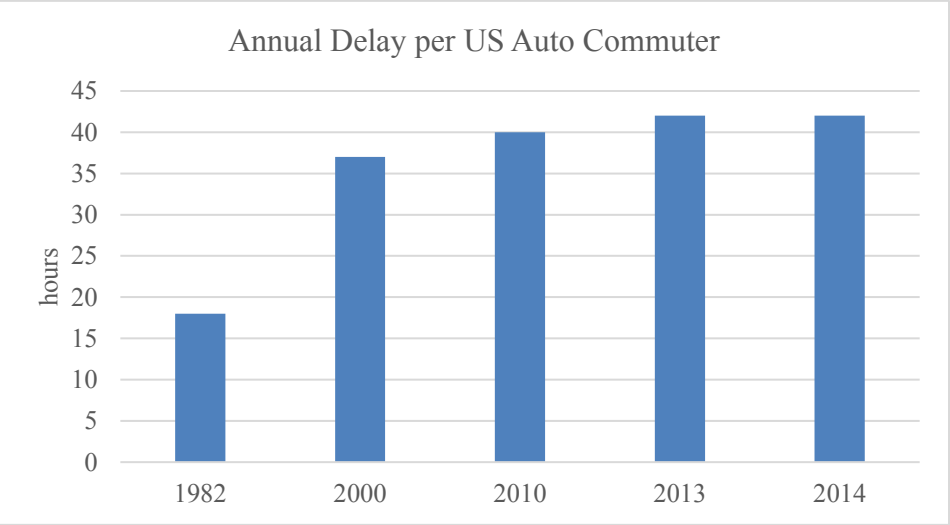

Figure 7.3 Annual Delays per U.S. Auto Commuter 1982 -2014

Source: Urban Mobility Scorecard, 2015

A portion of public transportation operates along a fixed guideway or an exclusive right-of-way (ROW). Therefore, transit has a slight advantage over automobiles.[74] For the most part,

[74] Within this context, roadway based fixed guideways refer to light rail and, in some cases, BRT. Exclusive ROWs refer to road lanes where it is cordoned off for transit-use only. e.g. light rail and BRT. Privately-owned road-based modes share some of the same thoroughfare with buses and light rail.

transit does experience certain levels of congestion - subject to the mode. Figure 7.5 gives an indication the TNC's potential given the amount of time saved when public transportation is utilized. From 1982 until 2005, there was an upsurge in the number of hours saved. A reduction between 2005 and 2010, with minor growth for 2011.[75]

Evidently, public transportation aids in reducing outlays generated by congestion. However, congestion it is not a distinct issue to TAs. Transit, road construction, land development, increases in employment, density levels, loading and unloading of cargo by trucks and tractor-trailers, "other transportation services, and TNCs" all partake in producing congestion *[17]*.

Transit operations include roadway-based modes that at times can be another vehicle in and/or a cause of congestion. To illustrate, buses conduct numerous stops along a street heavily trekking parallel with other cars, trucks and other motorized vehicles where the stop locations can be before and/or after a traffic light. Other examples are:

1. Buses slowly accelerate upon departure or quickly decelerate *[42]*.
2. During rush or off-peak hours, assume a typical urban street where vehicles are behind a bus at a bus stop. This obstructs traffic and renders vehicles behind buses immobile. Worse is the accompanying dwell time which adds to trip delay.
3. Buses collecting and unloading passengers at far-side or near side stops *[42]*.
4. Buses stopping ahead of a proceed indication – particularly at a heavily known location *[42]*.

If TNCs do replace public transportation, some congestion should be expected. i.e.; extent of the number of vehicles on the road. Assuming public transportation ceased to exist, instantaneously, consider what the post-transit net would be on roadways. Will Vehicle-Miles Traveled (VMT) increase? What affect will TNCs have on the infrastructure as a result of:

[75] The source, TTI Urban Mobility Report (UMR) is an annual report that includes congestion metrics. The 2012 UMR was the final year this and several other costs saved by public transportation were provided.

1. Vehicle Quantity. The number of vehicles already available roaming for potential customers and
2. Vehicle Mass. The number of vehicles already in traffic supplying rides.

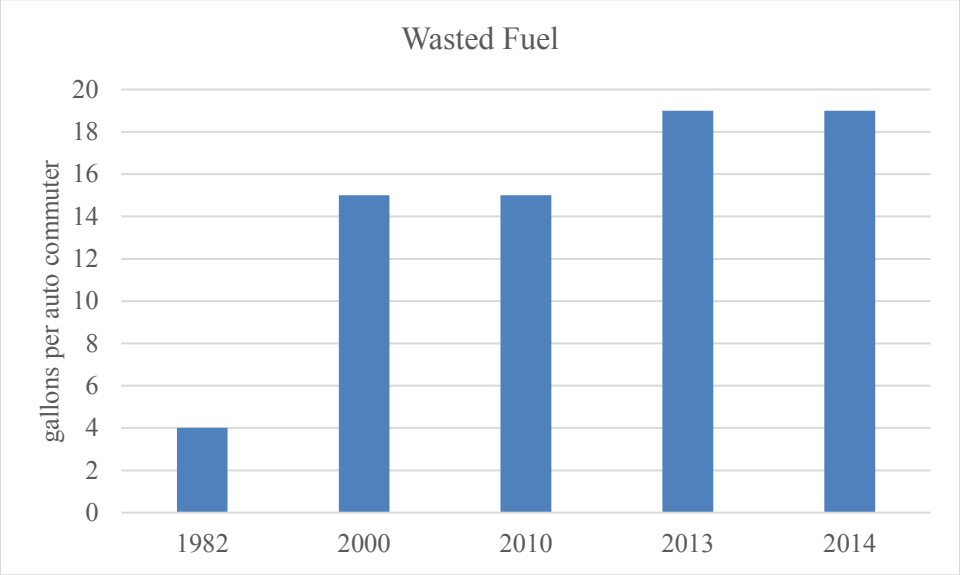

Figure 7.4 Number of Gallons of Fuel Consumed in Congestion 1982 - 2014

Source: Urban Mobility Scorecard, 2015

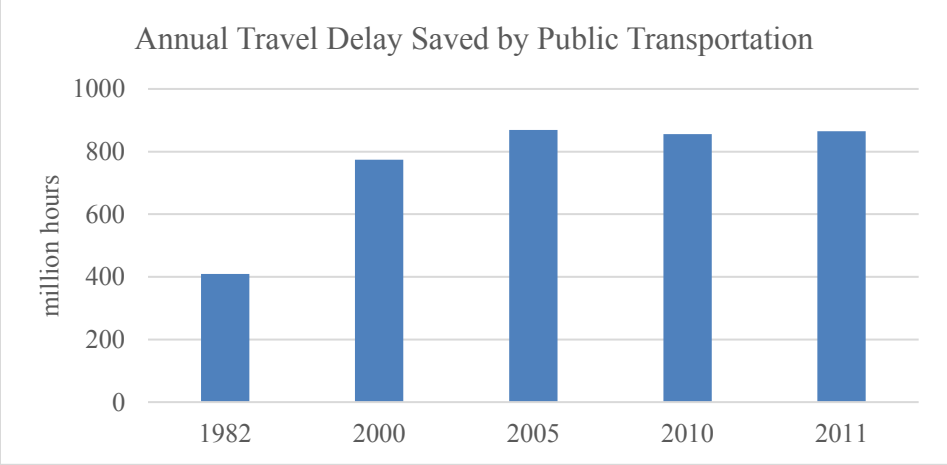

Figure 7.5 Annual Delay Saved by Public Transportation

Source: Urban Mobility Scorecard, 2015

7.1.2 Comparison

Before discussing VMT changes for Austin, it'd be prudent to provide a brief relative overview of how congestion in Austin is contrasted against peer cities within its class. A broader view of congestion data specific to Austin can be found in Appendix C.

According to the 2015 Urban Mobility Scorecard (UMS), Austin is categorized as one of 31 Large Average cities with statistical data indicated for the year 2014. It ranks below cities such as San Jose and Riverside/San Bernardino in California. Depending on the metric it either does better or worse than its group average. Table 7.1, shows how Austin, as a Large Average Urban Area, fares worse than the general average for this category for some metrics that include Yearly Delay per Auto Commuter; Travel Time Index; Excess Fuel per Auto Commuter and Congestion Cost per Auto Commuter. Conversely, the Large Average Urban Area average is higher, when gauging Austin, for Travel Delay; Excess Fuel Consumed; Truck Congestion Cost and Total Congestion Cost [73]. The average for all 31 Large Average Urban Areas and Austin perform poorly when gauged against the national level.

Table 7.1 Austin Compared Peer-to-Peer and Nationally

Congestion Metrics	National Averages	Large Average Urban Area	Austin
Yearly Delay per Auto Commuter (Hours)	42	45	52
Travel Time Index	1.22	1.23	1.33
Excess Fuel per Auto Commuter (Gallons)	19	21	22
Congestion Cost per Auto Commuter (2014 $)	$960	$1,045	$1,159
Travel Delay (000's Hours)	14,710	55,390	51,116
Excess Fuel Consumed (000's gallons)	6,610	25,690	21,654
Total Congestion Cost (2014 $ million)	$340	$1,280	$1,140

Source: Urban Mobility Scorecard, 2015

7.1.3 Net Post-Transit VMT Change

Intriguingly, there is uncertainty whether TNCs will add to or decrease congestion or VMTs. Vehicle Miles Traveled is a metric employed to aid policy-makers in planning where and

if roads need to be newly created or expanded. Its main function is to ascertain how many vehicles trekked upon sections of roadways over a certain amount of time. Thus, VMTs of one year in a city, county or UZA when compared against similar area VMT's (past or future) will give an inkling of probable trends. Undeniably, the public and its municipal officials can easily decipher replacement by TNCs to mean more vehicles on the road. In other words, more vehicles are likely to signify higher volumes of VMTs. The answer to this question is in determining the Net Post-Transit VMT Change *[42]*.

Net Post-Transit VMT Change is an estimated measurement to the question: if revenue service were to end at midnight tonight, only to be solidly replaced by TNCs will it cause VMTs to increase or decrease in the regional area of service that it operates within? To formulate there must be the post-transit removed VMT and post-transit returned VMT. The latter two factors are to be applied to the transit agency, its modes used and whether it is purchased transportation (PT) and/or directly operated (DO) *[42]*. The transit agency selected is the same entity discussed in the case study city: Austin's Cap Metro. The formula is below:

Post-transit returned VMT - Post-transit removed VMT = Net Post Transit VMT Change

Table 7.2, below, is furnished as a reference to merely indicate the modes of Cap Metro as well as the Type of Service associated which is, homogeneously, purchased transportation. Post-transit returned VMT is completed passenger miles replaced by VMT, if transit were to terminate revenue service operations. Aggregated in the total post-transit removed VMT are those VMTs allotted for the roadway functional classes (freeways and arterials). Moreover, as part of the calculation, factors such as circuity and mode shift were quantified and inserted into the equation. Circuity is a ratio of the trip distance to the shortest distance between an origin and destination *[42]*. In other words, transit vehicles will almost always veer off the beaten path in addition to its

fixed mainline route whereas TNCs will highly likely go directly to where it is required – the difference is circuity. A uniform circuity ratio of 1.08 was estimated for all Cap Metro's modes *[42]*.[76] [77]

Table 7.2 Cap Metro Modes, Type of Service, Circuity and Mode Shift Factors

Mode	TOS	Circuity	Mode Shift
Commuter Bus	PT	1.08	39%
Direct Response	PT	1.08	39%
Direct Response - Taxi	PT	1.08	39%
MotorBus	PT	1.08	39%
VanPool	PT	1.08	39%
Hybrid Rail	PT	1.08	39%

Source: *[42]*

Mode shift factor is another segment in the computation for net post-transit VMT change. Assumed is not all post-transit riders will travel in single occupancy vehicles (SOVs) or their own cars. There will be other modes selected by these travelers. Mode shift was accorded a uniform estimate of 39% upon all of Cap Metro's modes.

Post-transit removed VMT means even if revenue service were to end tomorrow, these vehicle miles traveled were already completed by transit vehicles that operate via road mode *[42]*. Elements included in the post-transit removed VMT are passenger car equivalents (PCEs) and peak share for passenger miles traveled (PMT).

Passenger car equivalents values are the number of vehicles in relation to a public transportation roadway-mode vehicle. PCEs vary based upon functional class (freeways and arterials) and congestion bucket. Assumed was that since TNCs were to manage transit service instead of segregating peak and off-peak share for PMT percentages, it was combined. Doing so

[76] According to Eisele, et al., there are "default transit circuity factors by UZA size". Large UZA sized areas are allotted a circuity ratio of 1.08 and Austin was placed in a large sized UZA.
[77] The same can be said of TNCs deviating from its original path upon the driving receiving a ride request slightly off the beaten path. See Footnote 47.

amended the peak share for vehicle miles (VMs) to a high of 96%. Suffice it to say, the net post-transit VMT change for each mode and TOS are listed below in Table 7.3.

According to the FHWA statistical data for daily vehicle miles traveled, the total is 10,848,961 for 2015. If we assume that the estimated net post-transit VMT change for Cap Metro if supplanted by TNCs is a net total of 40,446 VMTs. In the grand scheme, the 0.37% change is clearly an insignificant number of VMTs.

Table 7.3 Estimated Net Post-Transit VMT Change in Austin

Mode	TOS	Total Net-Post Transit VMT Change
Commuter Bus	PT	3,455
Direct Response	PT	-23,892
Direct Response - Taxi	PT	-1,801
MotorBus	PT	44,262
VanPool	PT	2,926
Hybrid Rail	PT	15,496
Net-Post Transit VMT Change:		40,446

Source: *[42]*

7.2 Curbside Logistics

Curbside logistics which is, on occasion, interchangeable with the curbside management, is the ability to strategically manage vehicle quantity at a wayside loading/unloading zone. Within the context of this paper, it is to denote executing a tactical plan of controlling TNC vehicle allocation when congregating at a street side rendezvous point with their riders.

Because TNC vehicles travel upon an assortment of streets, curbside logistics can affect congestion – especially, if not planned for properly. Whether traversing over an arterial or collector, if is pre-packed, the effect could intensify making an existing traffic crowding condition worse. If the adjacent roads are normally sparse, this could also induce the creation of newly congested circumstances.

Naturally, the ultimate objective for any driver is to navigate in free-flow traffic. Yet, realistically, vehicles circulate along the physical confines of curbed-streets and other undeveloped roadways, and constricted infrastructure. A planned management approach of delay mitigation incurred from various congestion buckets is the challenge set before TNCs. Any approach selected for implementation must contemplate a concurrence of TNC vehicle supply and non-TNC vehicles. Prudent would be to contemplate weather and road conditions, too.

Taking into consideration the above, an overabundance of TNCs converged, all at once, and in one location. How would the curbside logistics be dealt with? For instance, at a football game. Particularly, if it involves a major league team championship match that was declared a national security event involving? As an illustration the Mass Transit Super Bowl will be discussed.

The Mass Transit Super Bowl was a nickname for the 48th Super Bowl that took place on February 2, 2014 at the Meadowlands Sports Complex located in East Rutherford, New Jersey. It was part of an overall blueprint that combined publicity and promotion for the game even as it developed coordination amongst the various transportation agencies serving the region. One of the reasons the National Football League (NFL) selecting this particular venue was because of New York City's massive number of hotels neighboring the arena *[23]*.

At that time, even though TNCs were still in its infancy, Uber was already operating in New Jersey whereas Lyft commenced service later that same year.[78] Suffice it to say, as a result of the extreme security measures, vehicles were forbidden to drop-off nor pick-up people. All vehicles were required, even if permitted entrance, to stay within for complete game duration.[79]

[78] Uber began service on November 11, 2013 and by November 11, 2015 it had conducted 9.5 million rides. https://newsroom.uber.com/us-new-jersey/njturns2/

[79] All vehicles entering were subject to screening. The time to carry out these actions contributed to more time loss for the driver.

Unless TNCs negotiated for and were granted special privileges, to unload and take on passengers within the restricted areas, it would have resulted in a disastrous situation for the drivers. Keep in mind, TNC drivers produce income with every completed ride. If restricted from departing the arrival point, it would place an undue burden on the driver, severely reduce TNC reliability and vehicle supply. Moreover, although TNC fares, for the most part, comprises a per-minute fee it'd become extremely cost ineffective for the rider.

At least 23,000 attendees did not enter the venue via the parking lot area *[92]*. It is speculated that many of the anticipated attendees selected New Jersey Transit (NJT) as mode choice. NJT is the transit agency serving New Jersey statewide. There was an underestimated number of approximately 7000 riders that when departing the stadium chose rail as their preferred mode.

7.2.1 Strategies

Mentioned earlier was how vehicles entering the compound were heavily restricted. i.e.; vehicles were not allowed to leave the premises. Assume they were authorized to come and go as needed and all 6814 cars were accounted for, how would the facility cope with the curbside logistics.

There are a number of methods that could be applied:

1. App PIN. In Chapter 2, the Literature Review, was a discussion of the app developed for a pilot program designated Go520. Among other things, unique was the app creating a number that served as an identifier for the rider. Upon entering the vehicle, the rider and driver would need to possess matching codes. Amenities, such as this, enhances the security of both parties. The PIN also operated as the rider's invoice number.[80]

[80] The company that developed the app was Avego which was a TNC at one point. It is now known as Carma, a currently operating TNC.

2. LED Signage. After the app generates the PIN, the next step would be for the driver, when very close by, to activate an LED sign on the passenger (or driver's) side displaying the PIN and possibly the name of the rider.
3. Dedicated Loading Zones. Interconnected with the above two items, the driver can enter special designated parking/loading areas strictly for TLCs.
4. New Construction. If there is adequate evidence to cost justification, building a new or expanding an existing structure for dedicated TLC loading zones can be doable.
5. Exclusive TNC Lanes. If a dedicated loading zone is impractical, an exclusive TNC lane may be an economical alternative.
6. Traffic Demand Management. By installing the Meadowlands Adaptive Signal System for Traffic Reduction (MASSTR) it is almost the same as current dynamic traffic modification programs. The traffic lights changing based upon demand. Currently, this system controls the movement of approximately 400,000 vehicles daily *[24]*.
7. Timed or Capacity-based. Assumed is the TNC is operating as a transit vehicle. The driver can depart as if on a scheduled headway – regardless of the number of passengers in the automobile. It could also wait till it reaches its maximum capacity and then immediately depart.[81]
8. Vehicle Repositioning. NJT had approximately 300 buses on stand-by to assist in the facilitation of attendees.[82] Assumed is NJT had interagency cooperation allowing access to other databases.[83] TNCs have earned a reputation for uncooperativeness. If the TNC can procure from and share its data, the estimate for TNC vehicle supply would be more accurate.

[81] Presumed is the TNC vehicle is a standard sedan. Therefore, maximum capacity is four.
[82] The buses were secluded about 6 miles from the stadium.
[83] Further assumed is it has access to NFL.

9. Curbside Logistics Personnel. The element of human interaction is still warranted in our current era of technology. Some venues such as LaGuardia Airport and Pennsylvania Station have taxi stands staff with people directing and assisting both drivers and potential passengers. The same could be instituted here as well. Although this may come across as a cost ineffective measure, depending on who pays for it, it would be practical and sensible move as a long term investment – the public relations standpoint – would attract repeat gamegoers. For the short term, it would alleviate confusion and potential people and vehicle bottlenecking as people will be quickly directed to where and what.

A combination of one or more of the above will achieve the objective of enhancing curbside logistics. However, once the inception of automated vehicles and driverless cars happens, time will tell whether curbside logistics will be another item on the list of things in the past.

7.3 Infrastructure Costs

Many cities across the United States have been struggling for some time with infrastructure to the extent of dilapidation. Whether it is a consequence of procrastinated maintenance, lack of frequent inspections or age, in recent times, there have been incidents involving bridge collapses and road crumbling.

Infrastructure construction costs are capital projects which translates to a municipality possessing adequate financing. Moreover, it can take years for an infrastructure project to be finished – the overall process - planning, permits, community approval, all those steps take a lot of time. Even if time is of the essence, outlays on occasion, run into budget overruns. In the prior Federal government administration, a few instances of such costly instances were also due to Federal law requiring minimum wages; the purchase of American-made products; and mandatory environment impact statement reports *[29]*. Additionally, the Federal Highway Administration

(FHWA) finances "walking trails...with highway fund money" *[29]*. With the same latter resource, FHWA supports "complete streets…and bike lanes" *[29]*. Eminent domain, too, plays a role in the cost of infrastructure *[79]*.

The current Federal administration has touted a "$1 trillion infrastructure package" *[90]*. Over 500 infrastructure projects are currently under review *[72]*. Whether the wish list will be completely fulfilled or not leads to one simple question: Is Austin on the list? The answer is yes. The Traffic Management Systems Initiative (TMSI) is in the file, so to speak. The cost is projected to be $75 million *[72]*. The TMSI applies the principles of ITS to enhance a safer driving experience and help drivers develop better trip choices *[18]*. Present status is unknown how the Austin TMSI project ranks on the Federal infrastructure construction wish list.

As mentioned earlier, Austin is one of the fastest growing cities in the United States. Accordingly, it needs to keep pace with the rapidity of its populace. Equally demanding is commercial activity since it subsequent follows a population to anywhere it establishes itself. Unluckily, Austin also holds the record for owning the most congested roadway in the State of Texas. The I-35 between U.S.290 North to Ben White Boulevard is approximately five miles in length. Traveling along the route take as long as 15 minutes during peak hour travel as opposed to about six minutes under a non-congested environment.

In 2014, The City of Austin published a study appraising infrastructure cost for new housing starts. The report enumerates 14 categories of infrastructure with roadways listed as number two *[45]*.[84] Public transit was specified, but banished to the bottom of the same list and not included in said study *[45]*. The significance is new housing starts "creates capacity" *[45]*

[84] The study focused primarily on three areas: Schools (Elementary through High) and the provision of Electricity, respectively the first and third. All others were merely listed for informational purposes only and not included in same study. http://www.austintexas.gov/edims/document.cfm?id=222468

Suffice it to say, Austin examines its outlook into 2035, and it is quite drastic. Figure 7.6, disaggregates the predicted amount required in order to enlarge Austin's transportation system and keep pace by 2035. The total cost is expected to be $16,520,000,000. The bulk of the expense is in expansion of roadway capacity which is slightly above $12 billion. The remaining amount is split almost evenly between the road and rail modes.

Any of these cost estimates for roadway development may be undervalued because of the assumption that any excess capacity currently will surely be utilized over the years due to growth. And any number of planned roadway projects, between now and 2035, may be deficient in providing prescribed levels of service (LOS). If the foregoing prophecies become realized the ultimate cost will be placed upon vehicle occupants in terms of bigger traffic jams much longer than anticipated travel trips.

The City of Austin requires, minimally, LOS D standards *[45]*. The Fodor Report employs a conservative quantity of 5000 to the LOS D standard to derive its figures *[45]*.[85] Assuming the above, the figures below go into detail leading up to the infrastructure costs per daily VMT per capita of $707.52.[86]

The determination of the Estimated Roadway Cost per Daily VMT per Capita involved a simple two-step calculation as follows. First, is the need to compute for the Estimated Roadway Cost per Person per Household which amounts to $17,122.

$$\frac{\textit{Estimated Roadway Cost per New Household}}{\textit{Average Persons per Household}} = \textit{\$17,122}$$

[85] There is no given Average Daily Traffic (ADT) for the specified LOS. There is a stated quantity, by the City of Austin which requires a maximum ADT of 8,875 for a major arterial road and 1500 for collectors, per lane, respectively. http://www.austintexas.gov/edims/document.cfm?id=222468

[86] The bolded calculations were computed by the author of this paper.

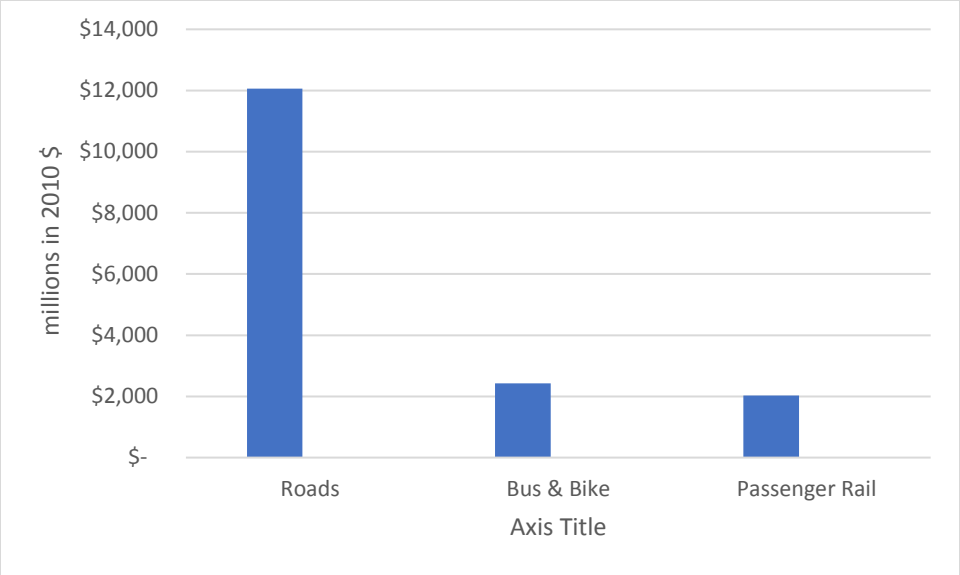

Figure 7.6 Capital Improvements in Transportation for Austin 2010-2035

Source: Fodor

Finally, and at hand, with the foregoing the Estimated Roadway Cost per Daily VMT per Capita can be achieved. The amount is derived at $707.52.

$$\frac{\textit{Estimated Roadway Cost per Person per Household}}{\textit{Daily VMT per Capita}} = \$707.52$$

However, there is also the issue of capacity. Austin needs to construct the necessary infrastructure (supply) to meet the growing demand (vehicles). It is growing by leaps and bounds, according to Forbes. Moreover, if this trend of progress continues whereby Austin does not keep pace with building roadways, congestion will ultimately result. A metric that the State of Texas Department of Transportation employs is called lane miles *[91]*. A lane mile is the number of lanes per mile. For instance, if two miles of roadway has four lanes it has a total of eight lane miles. Within the scope of this paper, its magnitude is due to the need to minimally meet the projected extra roadway space necessary in addressing a mounting population.

Roadway Cost - LOS D Standard for Austin	2014 Dollars
LOS D Standard, Daily Vehicle Trips per Lane (estimated)	5000
Daily VMT per Capita (region)	24.2
New Lane-Miles Required per New Capita	0.00484
2014 Cost per New Lane-Mile of Roadway	$4,913,406
Roadway Cost per New Capita	$23,780.89
Percent of Travel Demand Associated with Residential Development	72%
Average Persons per Household	2.49
Estimated Roadway Cost per New Household	$42,634
Estimated Roadway Cost per Person per Household	$17,122
Estimated Roadway Cost per Daily VMT per Capita (region)	$707.52

Figure 7.7 Estimated Roadway Costs per Daily VMT per Capita - Austin

Source: Fodor

In Table 7.4, by converting the VMTs into lane miles it can be determined how many more, or less, in terms of roadway construction would be needed by Austin to sustain demand. The Texas Department of Transportation (TxDOT) maintains data on the quantity of lane miles throughout the state. It also gives researchers the number of lane miles by functional class. That is, freeway and arterial roads.

The figures in Table 7.4 were calculated by procuring an average of the lane miles for the sub-functional class of roadways for freeways. Then, to compute for the Daily VMT per Lane Mile take the Daily Vehicle Miles (DVM) and divide by the Lane Miles. The final results are a conversation of the DVM into lane miles. The next step is to attain the Post Net Transit VMT from Table 7.3 or 40,446 Post Net Transit VMT and assign a reasonable factor which in this case the assumption will be 40%. This is due to the percentage of roadways that are freeways as opposed to the number of arterial. Unquestionably, in a large urban area there will be more arterials than freeways. Therefore, 40% is a sensible amount.

Table 7.4 Lane Mile Comparison

Freeways	Lane Miles (thousands)	DVM (millions)
Interstate	180.59	4,325.25
Other - Freeway Expressway	530.05	6,434.47
TOTAL Freeways	710.65	10,759.72
Average	355.32	5,379.86
DVM/Lane Miles = Daily VMT per Lane Mile	15.14	
Post Net Transit VMT (Freeway) * 40%	16.18	
Number of Lane Miles to meet Post Net Transit VMT	1.07	
Arterials		
Principal Arterial	1,035.16	7,778.77
Minor Arterial	757.57	3,353.40
Major Collector	1,628.92	5,012.98
TOTAL Arterials	3,421.64	16,145.15
Average	1,140.55	5,381.72
DVM/Lane Miles = Daily VMT	4.72	
Post Net Transit VMT - Arterial	24.27	
Number of Lane Miles to meet Post Net Transit VMT	5.14	

Source: *[91]*

CHAPTER 8: RECOMMENDATIONS

8.1 General

There is some prudence that TAs need to contemplate when proceeding with the employment of a TNC. Part of that foresight needs to incorporate several assumptions. First, assumed are the fares paid by the public will be the same rates as if s/he boarded a bus or any other TA mode in revenue service. The paradigm in Chapter 5 was to give an illustration of what if the TA immediately hired TNCs without any formal bidding process or request for proposals containing discounted fares. It's also a sample of how the TA could, theoretically, subsidize TNC rides under the guise of paying a TNC's full fare.

Realistically, TAs will need to negotiate TNC fares. There are a few reasons for this necessity. First, the current trend of TNC popularity may cause an underestimation in ridership figures. Revisiting Austin, if the transit ridership of over 32 million balloons to 50 or 60 million TNC unlinked trips due to customer satisfaction there is a price point that TAs will only be able to pay. Even if a TA has steady funding sources it cannot afford unlimited trips. If that were to occur the TA would need to develop innovative funding mechanisms, renegotiate with TNCs and/or reconsider passenger fares.

Finally, TNCs in transit service would incur trip circuity. Circuity, in this context, means traveling along an indirect pathway. In the beginning of this subsection, the time range for this origin/destination was estimated to be a minimum of seven minutes. The supposition is the TNC

will be trekking along the most direct, least congested route.[87] Therefore, the TNC whose normal fare structure consists of time and distance would have to accept the realism of a flat-rate fare.

8.2 For Future Study

Like a chameleon, the subject matter of Transportation Network Companies has manifested itself no less than a topic of dynamic substance. Over the past couple of years, the amount of media attention TNCs garnered changed, at times, on a daily basis. Whether the result of alleged controversies, the effects of legal rulings or business decisions, TNCs are not terminating their service anytime soon. As a result, as time goes on that too shall change the overall TNC landscape.

Significant and as it relates to this research is the need for a comprehensive study of the Altamonte Springs model – how it derived the decision to subsidize TNC rides and the amounts of subsidization, and why it did not develop a fully operational TA. In addition, its model extended into several adjacent municipalities. As to the how, why or why not towards permanent replacement by these neighboring districts also needs to be explored.

To recollect, TNCs have, for the most part, have been extremely reluctant to share their data. It is understandable that their reasoning is proprietary. However, government urban planners need to be able to assess future trends in order to reasonably and properly address inadequate supply, if any. It is an inevitability, TNCs will be compelled to distribute their statistical information. In the future, TNC data will most probably be made available. If and when that should occur it would be an incredible boon and in the best interests for researchers to take immediate advantage. Doing so will, perchance, furnish a wealth of notions and answers for research studies with a higher accuracy of key findings.

[87] For further information see Footnote 32.

Schaller implied that there may be a way for transit to decrease trip time by altering the cycles and phases of traffic lights "to maximize the chance for buses to progress from one bus stop to the next stop without encountering a red light…The traffic engineering for this change would need to ensure that overall traffic volumes would still be accommodated" *[71]*. The former could be a future study as well as examining "impacts of TNC growth affected by the availability and attractiveness of transit service, and the likelihood that TNC riders are shifting from transit, walking or biking versus private autos" *[71]*. Schaller also believes that there should be "close attention in assessing the overall impacts of TNCs in the larger transportation network"

Chapter 6 provides details on the four main stakeholders: who they are and how each party benefited and experienced detrimental effects. It is recommended for future study, preferably, whether one and/or more than one of these concerned parties benefited or suffered losses over the short and long-term.

LibreTaxi, an app developed in Siberia eliminates the TNC *[81]*. That is to say a true peer-to-peer transaction can happen where a driver and a rider deal directly with each other without the need for the involvement of a commission-based tech middleman. Interesting would be having the ability to analyze and examine LibreTaxi data to ascertain trends as well as the success (or failure, if the case) and causation behind it.

Lastly, is when TNCs introduce AVs on a more permanent basis as part of its fleet. In Section 1.4.1 are details supporting what would happen if TNCs were to acquire a vehicle, regardless of whether it is a single automobile or fleet, human-operated or automated. Ultimately, it would no longer be defined as a TNC. Yet, it could allow the option for privately-owned human-operated AVs to commence revenue service when it comes to market. That too is suggested for investigation and examination.

It would be insightful over a reasonable amount of time to observe what has transpired between TNCs and public transportation. It has already been duly discussed and witnessed how many jurisdictions have entered into various agreements to partner with TNCs leading to partial and temporary replacement of public transportation. Taking this document's hypothesis into consideration, as well as the many realized illustrations portrayed within, it is also an inescapability for, at the very least, a pilot or demo for a long-term supplantment of public transportation by TNCs.

To illuminate, in the case of the Centennial, Colorado demo where TNC rides were subsidized 100%, but for a limited amount of time with future plans for an expanded pilot. The government of Centennial should seek to revive said pilot for a much longer term. Another option is for Austin, San Francisco and/or a collective of TAs as enumerated in Appendix A to create a long-term project to study and analyze the longstanding of replacement of its public transportation by TNCs.

CHAPTER 9: CONCLUSION

The paper shows how TNCs could replace public transportation in the United States if subsidized at the same level of transit agencies. The final graph, as indicated in Chapter 5, proves conclusively how the hypothesis could actually occur. Moreover, several pilot programs currently ongoing where TAs and municipalities without a formal transit agency have entered into negotiated agreements with TNCs have been deemed fruitful. Most of these commitments are to assist transit with their chronic first mile/last mile dilemma. Originally, and on a smaller scale, the City of Altamonte Springs, Florida experiment was so successful that it developed another trial run and expanded on a larger regional basis to include a number of neighboring municipalities.

The literature review talks about a 35 year old study where a tangible demonstration was implemented that closely resembles this hypothesis. Tidewater Regional Transit replaced six of their poorly operating fixed route buses with taxis. All six were still in revenue service operation by the end of the one-year program. Only one out of the six route's realized an increase in its net cost per passenger. Five routes were adjusted route-wide for underperforming ridership and the other had its service area expanded to merge with another route. The latter had excellent results leading to the addition of jitney service.

A discourse was made about the advantages and disadvantages of the main stakeholders: TAs; drivers, riders and, intrinsically TNCs. Each of these concerned parties wins: riders have another option for mode choice; drivers have an additional source of employment; TNCs gain a new resource for building its reputation and customer base; and the TAs have a potential panacea

for its problems of chronic first mile/last mile, and maximizing service on limited or minimal finding sources.

As a caveat to the TNC, it needs to understand the basic tenet of business: supply equals demand. This means if enough people want a product or service and are willing to pay for it, whoever provides that product or service can create and open for business. In the case of TNCs, the supply equates to drivers. Without drivers, TNCs will cease to exist. Moreover, with the rapid pace of technological evolution and advancement as the global audience keeps witnessing, what is to stop someone from eliminating the matchmaker or TNC altogether and let the marketplace i.e. the driver and potential rider communicate and conduct financial transactions directly? There is already an app developed which functions as described aforesaid. This, too, is recommended for future study.

Additionally, automated vehicles (AVs) is on the cusp of commercial availability. Merely, a few decades ago the wireless phone evolved into what is commonly referred to today as the smartphone. Over time, like the cellphone, it is anticipated for AVs to achieve the designation of becoming fully driverless. Stated earlier is a defined set of criteria what is, and what a TNC is not. A principal objective of Uber is for to accomplish this task. A few inevitable questions that shall arise is whether their current status as a TNC will change, what will happen to the innumerable thousands of drivers that depend on TNCs as a dedicated income source and if these drivers are no longer operating for a TNC what affect shall this have on the United States, and global, economy. In due course, the aforesaid is suggested for investigation and examination.

As the door began to close on this document there were a couple of occurrences related to this paper that need to be pondered. In March 2017, an article proclaimed that Lyft has begun offering “fixed routes and flat fares of a…bus service” as an experiment in San Francisco and

Chicago *[51]*.[88] Uber had dabbled into this foray back in 2015 by running a similar service scheme in Seattle, San Francisco & Chicago *[51]*. As recent as May 2017, Innisfil a town located north of Toronto, was "daunted by the cost of building a traditional public transit system [it] turned to [Uber] for a solution…[Innisfil] is subsidizing the cost of rides for its residents…" Fares will be flat-rate based or discounted subject to the final destination in the town *[64]*. Remarkably, a contractual condition is Uber must provide origin/destination data to Innisfil. It is noteworthy since TNCs historically fought to obscure and withhold that kind of information under the guise of it being proprietary. Likewise, TNCs greatest phobia is that the data should not be exploited to create new competitors. The sole purpose was for the town to ascertain financially whether it is more cost-effective to retain the services of a TNC or to implement fixed-route bus service.

Although the scope of this research was to strictly focus on the United States, there seems to be a potential for transnational organizations to ingest the lessons learned from our country's agencies. If this trend continues we may be compelled to start referring to the FTA as the FTNCA or Federal Transportation Network Company Administration.

[88] According to Hawkins, he verified that fares are still time/distanced based.

REFERENCES

[1] Dockterman, E., Uber and Lyft Are Leaving Austin After Losing Background Check Vote. 2016. Available from: http://fortune.com/2016/05/08/uber-lyft-leaving-austin/

[2] APTA 2014 Public Transportation Fact Book Appendix A: Historical Tables. American Public Transportation Association Available from: http://www.apta.com/resources/statistics/Documents/FactBook/2014-APTA-Fact-Book-AppendixA.xlsx

[3] National Transit Database Glossary. 2015, Federal Transit Administration: Washington, DC, US. Available from: https://www.transit.dot.gov/ntd/national-transit-database-ntd-glossary.

[4] National Transit Database Transit Agency Profiles. 2017, Federal Transit Administration: Washington, DC, US. Available from: https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/60048_0.pdf

[5] Curb $15 credit. City/Chicago [Web] 2015 [cited 2016 December 8]; Available from: https://www.gilt.com/city/chicago/offer/curbchijun15.

[6] National Transit Summary and Trends: Appendix, U.S. Department of Transportation. 2015. Federal Transit Administration: Washington DC. Available from: https://www.transit.dot.gove/sites/fta.dot.gov/files/docs/2015%20NTST%20Appendix.pdf.

[7] The Uber Commute Card. [Web] 2016. July 29, 2016]; Available from: https://www.giltcity.com/newyork/ubernycjuly16.

[8] Uber vs. Lyft: Comparing the Rideshare Titans. [Web] 2016 May 12, 2016 [cited 2017 January 11]; Available from: https://rideshareapps.com/Uber-vs-Lyft-comparison/.

[9] Using Uber Movement to understand the effects of DC Metrorail service disruptions on traffic congestion. [Web] 2017 [cited 2017 January 9]; Available from: https://movement.Uber.com/use-case/DC.

[10] Uber Customer Service: Get Help. [Web] 2017 January 10, 2017 [cited 2017 January 10]; Available from: https://www.ridester.com/how-to-contact-Uber/.

[11] Current Lyft Promotions for 2017//Rider and Driver Promo Guide. [Web] 2017 January 10, 2017 [cited 2017 January 10]; Available from: https://rideshareapps.com/current-lyft-promotions-for-2016/.

[12] Uber Driver Invite Code. [Web] 2017 January 10, 2017 [cited 2017 January 10]; Available from: https://www.ridester.com/Uber-driver-invite-code/.

[13] License Requirements New York City. Drive Uber NYC [Web] 2017 January 11, 2017 [cited 2017 January 11]; Available from: http://DriveUberNYC.com/tlc/.

[14] Florida Transit Information System (FTIS). 2017. Available from: http://ftis.org/urban_iNTD.aspx.

[15] Forbes – America's Fastest Growing Cities 2016. Available from: https://www.forbes.com/pictures/emeg45ehgji/1-austin-texas/#32e1eeb82726

[16] Number of mobile app downloads worldwide in 2016, 2017 and 2021 (in billions). 2017. Available from: http://www.statista.com/statistics/271644/worldwide-free-and-paid-mobile-app-store-downloads/

[17] TNCs Today: A Profile of San Francisco Transportation Network Company Activity. 2017, San Francisco County Transportation Authority: San Francisco, California. Available from: http://www.sfcta.org/tncstoday

[18] My Interstate 35. [Web] 2017 [cited 2017 May 29]; Available from: http://my35.org/capital/about/faq.htm.

[19] Supplement - Definition, in Memidex. 2017, [cited 2017 August 13]; Online Etymology. Available from: http://www.memidex.com/supplment.

[20] Consumer Expenditures - 2016, in Economic News Release, United States Department of Labor, Editor. 2017, Bureau of Labor Statistics. Available from: https://www.bls.gov/news.release/ceasn.nr0.htm

[21] Uber – Splitting a fare with a friend. Available from: https://help.uber.com/h/2ccba301-152e-4747-b207-e4281a1a2ba5

[22] Wikipedia – Automated Car. Available from: https://en.wikipedia.org/wiki/Autonomous_car

[23] Wikipedia – Mass Transit Super Bowl. Available from: https://en.wikipedia.org/wiki/Mass_Transit_Super_Bowl

[24] Wikipedia – Meadowlands Adaptive Signal System for Traffic Reduction (MASSTR). Available from: https://en.wikipedia.org/wiki/Meadowlands_Adaptive_Signal_System_for_Traffic_Reduction

[25] Andersson, M., Hjalmarsson, A., and Avital M. Peer-to-Peer Service Sharing Platforms: Driving Share and Share Alike on a Mass-Scale. 2013: Milan, Italy. Available from: https://www.researchgate.net/publication/268130369_Peer-to-peer_service_sharing_platforms_Driving_share_and_share_alike_on_a_mass-scale

[26] Badger, E., Now we know how many drivers Uber has — and have a better idea of what they're making, in Wonkblog. 2015, The Washington Post Washington, DC. Available from: https://www.washingtonpost.com/news/wonk/wp/2016/01/20/now-we-know-how-many-drivers-uber-has-and-have-a-better-idea-of-what-theyre-making/

[27] Badger, E., Read: Uber's new study of the demographics, earnings and employment decisions of its workers, in Wonkblog. 2015, The Washington Post Washington, DC. Available from: https://www.washingtonpost.com/news/wonk/wp/2015/01/22/read-ubers-new-study-of-the-demographics-earnings-and-employment-decisions-of-its-workers/

[28] Baldassari, E. The newest battleground between public transit and Uber, Lyft is an unlikely one. [Web] 2017 March 25, 2017 [cited 2017 March 30]; Available from: http://www.mercurynews.com/2017/03/24/the-newest-battleground-between-public-transit-and-uber-lyft-is-an-unlikely-one/.

[29] Beyer, S. 7 Reasons U.S. Infrastructure Projects Cost Way More Than They Should. [Web] 2014 April 7 [cited 2017 May 28]; Available from: https://www.citylab.com/life/2014/04/7-reasons-us-infrastructure-projects-cost-way-more-they-should/8799/.

[30] Bonnington, C. How Lyft Shuttle could help cash-strapped public transit systems. [Web] 2017 April 7, 2017 [cited 2017 April 7]; Available from: https://www.dailydot.com/debug/lyft-shuttle-impact-public-transit/.

[31] Brasuell, J. Uber Creeping Into Transit Territory. [Web] 2016 [cited 2016 July 16]; Available from: http://www.planetizen.com/node/87402/uber-creeping-transit-territory.

[32] Brustein, J. Uber and Lyft Want to Replace Public Buses. Bloomberg Technology [Web] 2016 August 15, 2016 August 18, 2016]; Available from: https://www.bloomberg.com/news/articles/2016-08-15/uber-and-lyft-want-to-replace-public-buses.

[33] Cabanatuan, M. Ride services decimate S.F. taxi industry's business. [Web] 2014 September 16, 2014 [cited 2016 December 26]; Available from: http://www.sfgate.com/bayarea/article/Taxi-use-plummets-in-San-Francisco-65-percent-in-5760251.php.

[34] Campbell, H., Top 9 Ways To Contact Uber Support When You Need Help, in The Rideshare Guy - A Blog and Podcast for Rideshare Drivers, H. Campbell, Editor. 2016, Campbell, Harry. Available from: https://therideshareguy.com/top-6-ways-to-contact-uber-when-you-need-help/

[35] Chen, L. At $68 Billion Valuation, Uber Will Be Bigger Than GM, Ford, And Honda. [Web] 2015 December 4, 2015 [cited 2017 January 8]; Available from: http://www.forbes.com/sites/liyanchen/2015/12/04/at-68-billion-valuation-uber-will-be-bigger-than-gm-ford-and-honda/#18e0595e5858.

[36] ComScore, Many of the fastest growing apps are services that improve existing real-world behaviors, such as hailing cabs, exercising and dating, in SlideShare, U.S.A. Report. 2016, SlideShare. Available from: https://www.slideshare.net/comScoremarcom/comscore-2016-us-mobile-app-report

[37] Constine, J. Uber Tests Bus-Style Discounted "Smart Routes". [Web] 2015 July 17, 2016]; Available from: https://techcrunch.com/2015/08/24/uber-smart-routes.

[38] Council, National Research., Between Public and Private Mobility: Examining the Rise of Technology-enabled Transportation Services. 2016: Transportation Research Board. Available from: https://www.nap.edu/read/21875/chapter/1

[39] Dalton, L., Uber and Lyft Want to Replace Public Buses, in Wonk Wire, T. Goddard, Editor. 2016. Available from: http://wonkwire.com/2016/08/15/uber-and-lyft-want-to-replace-public-buses/

[40] Ditta, S., M.C. Urban, and Johal, S., Sharing the Road: The Promise and Perils of Shared Mobility in the GTHA. 2016, University of Toronto School of Public Policy & Government: Toronto, Ontario, Canada. Available from: https://mowatcentre.ca/sharing-the-road/

[41] Durbin, D., and Krisher, T. Uber, Lyft battle governments over the driver fingerprint checks [Web] 2016 June 22, 2016 [cited 2017 January 1]; Available from: http://bigstory.ap.org/article/a2d907fc7ecb42e2a73e0afe8dc626ba/uber-lyft-battle-governments-over-driver-fingerprint-checks.

[42] Eisele, W.L., Schrank, D.L., Kang, D.H.; Polzin, S.E. and Chu, X. Investigation of Improvements to Truck Volume Assignments and Public Transportation Benefits Methodologies in TTI's Urban Mobility Report. 2013, Texas A&M Transportation Institute College Station, Texas. Available from: http://www.worldtransitresearch.info/research/4991/

[43] Elliott, C. Mass transit gets boost from ridesharing. [Web] 2017 January 24, 2017 [cited 2017 February 3, 2017]; Available from: https://www.usatoday.com/story/travel/advice/2017/01/22/uber-lyft-ridesharing-public-transportation/96830100/.

[44] Feigon, S. and Murphy, C., Shared Mobility and the Transformation of Public Transit. 2016. Available from: https://www.nap.edu/catalog/23578/shared-mobility-and-the-transformation-of-public-transit

[45] Fodor, E., Cost of Infrastructure to Serve New Residential Development in Austin, Texas – 2014. 2014, Fodor and Associates: Eugene, Oregon. Available from: http://www.fodorandassociates.com/Reports/Austin_Infrastructure_Cost_Update_2014.pdf

[46] Frank, S. OC Government Transportation: Ridership has Plummeted! [Web] 2017 March 10, 2017 [cited 2017 March 10]; Available from: http://www.capoliticalreview.com/capoliticalnewsandviews/oc-government-transportation-ridership-has-plummeted/.

[47] Fried, B., It's Not Too Late to Fix Cuomo's Awful Uber Bill, in Streetsblog NYC. 2016. Available from: https://nyc.streetsblog.org/2016/12/22/its-not-too-late-to-fix-cuomos-awful-uber-bill/

[48] Giffin, S., Number of smartphone users in the United States from 2010 to 2019, in Statista. 2016, Mediavidi. Available from: https://mediavidi.com/how-to-optimize-your-video-content-strategy-for-mobile/

[49] Hall, J.D., Palsson, C. and Price, J. Is Uber a substitute or complement to public transit?. 2017. Available from: http://individual.utoronto.ca/jhall/documents/Uber_and_Public_Transit.pdf

[50] Hansen, D. Arlington eyes Uber or Lyft rides to supplement some bus routes. [Web version] 2016 August 19, 2016; Available from: http://www.bizjournals.com/washington/morning_call/2016/08/arlington-eyes-subsidized-uber-or-lyftrides-to.html.

[51] Hawken, A.J. Lyft Shuttle mimics mass transit with fixed routes and fares. [Web] 2017 [cited 2017 March 29]; Available from: https://www.theverge.com/2017/3/29/15111492/lyft-shuttle-fixed-route-fare-sf-chicago.

[52] Hawkins, A.J. Even cynical New Yorkers don't mind sharing Uber rides with strangers. [Web] 2015 November 9, 2015; Available from: https:// www.theverge.com/2015/11/9/9698658/uber-uberpool-nyc-october-ride-share-numbers.

[53] Hawkins, A.J. UberHop is Uber's latest idea for killing mass transit. [Web] 2015 December 8, 2015 [cited 2016 August 28]; Available from: https://www.theverge.com/2015/12/8/9873544/uber-hop-commute-mass-transit-seattle-chicago.

[54] Helft, M. How Travis Kalanick Is Building The Ultimate Transportation Machine. [Web] 2016 December 30, 2016 [cited 2017 January 10]; Available from: www.Forbes.com/sites/miguelhelft/2016/12/14/how-travis-kalanick-is-building-the-ultimate-transportation-machine/#4667b9140b9.

[55] Jaffe, E. Uber and Public Transit Are Trying to Get Along. Citylab [Web] 2015 August 3, 2015 [cited 2017 March 1]; Available from: http://www.citylab.com/cityfixer/2015/08/uber-and-public-transit-are-trying-to-get-along/400283/.

[56] Jechow, A., & McGivern, Kylie. Prop 1 fails, marking defeat for Uber and Lyft in Austin. [Web] 2016 May 10, 2016]; Available from: http://kxan.com/2016/05/07/prop-1-fails-marking-defeat-for-uber-and-lyft-in-austin/.

[57] Jones, L. The Pros and Cons of Using an Uber for Drug Dealing, According To A Driver. [Web] 2015 July 10, 2015 [cited 2017 January 11]; Available from: http://laist.com/2015/07/10/uber_driver_explains_the_pros_and_c.php.

[58] Kessler, M.L., TNC: Fad or Future - What can we learn from Uber?. 2016, University of South Florida: Center for Urban Transportation Research. Available from: https://www.nctr.usf.edu/wp-content/uploads/2017/01/UBER-Fad-or-Future-Kessler-2017.pdf

[59] Kuzmyak, J.R., National Ridesharing Demonstration Program: "Maxi-Taxi" Services in the Tidewater Region of Virginia United States Department of Transportation, 1985, US DOT UMTA: Washington, DC. Available from: https://ntl.bts.gov/lib/57000/57900/57962/nationalrideshar00kuzm.pdf

[60] Lacy, S. Juno founder: "Everybody we talked to, they hated Uber with a passion." [Web] 2016 February 17, 2016 [cited 2017 January 8]; Available from: https://pando.com/2016/02/17/juno-founder-everybody-we-talked-they-hated-uber-passion/.

[61] Lazo, L. Arlington studying a plan that would pay for your Uber to Metro. [Web] 2016 August 16, 2016 [cited 2017 May 2]; Available from: https://www.washingtonpost.com/news/dr-gridlock/wp/2016/08/16/arlington-planning-to-subsidize-rideshare-trips-to-the-metro/?utm_term=.1ac4e8e1d922.

[62] Marrero, T. PSTA exploring partnership with Uber for North Pinellas pilot project. [Web] 2015 [cited 2016 May 26]; Available from: http://www.tampabay.com/blogs/baybuzz/psta-exploring-partnership-with-uber-for-north-pinellas-pilot-project/2242743.

[63] Masnick, M., Uber & Lyft As An Extension Of... Or Replacement For... Public Transit, in Tech Dirt. 2016, Tech Dirt. Available from: https://www.techdirt.com/articles/20160819/12465435289/uber-lyft-as-extension-replacement-public-transit.shtml

[64] McQuigge, M., Innisfil, Ont., partners with Uber to provide public transit service. The Globe and Mail. Available from: https://beta.theglobeandmail.com/news/national/innisfil-ont-partners-with-uber-to-provide-public-transit-service/article34989336/

[65] Morris, D.Z. Uber and Lyft Have Absolutely Gutted L.A.'s Taxi Industry. [Web] 2016 April 17, 2016 June 22, 2016]; Tech Uber: Available from: http://fortune.com/2016/04/17/uber-and-lyft-la-taxi-industry/.

[66] Murray, G., et al., Ridesharing as a Complement to Transit, in TCRP Synthesis. 2012, Transit Cooperative Research Program: Washington, DC. Available from: http://www.trb.org/Publications/Blurbs/166923.aspx

[67] Polzin, S.E., Public Transportation. Class Lecture. 2015, University of South Florida: Tampa Florida.

[68] Rayle, L., et al., App-Based, On-Demand Ride Services: Comparing Taxi and Ridesourcing Trips and User Characteristics in San Francisco, United States Department of Transportation, Editor. 2014, Intelligent Transportation Systems: University of California Transportation Center (UCTC). Available from: https://www.its.dot.gov/itspac/dec2014/ridesourcingwhitepaper_nov2014.pdf

[69] Rogers, K. Uber. Lyft put pressure on taxi companies. [Web] 2016 January 27, 2016 [cited 2017 January 8]; Available from: https://www.cnbc.com/2016/01/26/uber-lyft-put-pressure-on-taxi-companies.html

[70] Ronen, L. Lyft IPO Presents Better Multiples and Growth Potential Than Uber. [Web] 2015 September 9, 2015 [cited 2017 January 8]; Available from: http://amigobulls.com/articles/lyft-ipo-presents-better-multiples-and-growth-potential-than-uber.

[71] Schaller, B. Unsustainable? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City. 2017. Schaller Consulting, Brooklyn, New York. Available from: http://www.schallerconsult.com/rideservices/unsustainable.pdf.

[72] Scheck, T. More than 500 infrastructure projects are pitched to Trump, who will favor private money and speed. [Web] 2017 May 11 [cited 2017 May 20]; Available from: https://www.apmreports.org/story/2017/05/11/trump-infrastructure-projects.

[73] Schrank, D, Eisele, B., and Lomax, T. 2015 Urban Mobility Scorecard. Texas A&M Transportation Institute. Available from: https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-scorecard-2015.pdf

[74] Schmitt, A., No, Uber's Not Going to Replace Buses, But It Can Complement Them, in Streetsblog USA. 2016. Available from: https://usa.streetsblog.org/2016/09/09/no-ubers-not-going-to-replace-buses-but-it-can-complement-them/

[75] Schupp, R. MTS Announces New Partnership with Uber. [Web] 2016 July 8, 2016 [cited 2017 May 21]; Available from: https://www.sdmts.com/inside-mts/news-release/mts-announces-new-partnership-uber.

[76] Sloan, R. Ride-Sharing Company Comparisons: Given the financing excitement at Uber and Lyft, are there any other viable competitors? What happened to Sidecar? Uber Series C $361MM Financing (Summer 2013) [Web] 2015 September 20, 2015 [cited 2017 January 10]; Available from: https://www.Quora.com/Ride-Sharing-Company-Comparisons/Ride-Sharing-Company-Comparisons-Given-the-financing-excitement-at-Uber-and-Lyft-are-there-any-other-viable-competitors-What-happened-to-Sidecar.

[77] Smith, A. 2015. U.S. Smartphone Use in 2015. Available from: http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/

[78] Smith, A. 2017. Record shares of Americans now own smartphones, have home broadband. Available from: http://www.pewresearch.org/fact-tank/2017/01/12/evolution-of-technology

[79] Smith, N. The U.S. Has Forgotten How to Do Infrastructure. Bloomberg View [Web] 2017 May 31 [cited 2017 June 3]; Available from: https://www.bloomberg.com/view/articles/2017-05-31/the-u-s-has-forgotten-how-to-do-infrastructure.

[80] Spross, J. Why replacing the bus with Uber is actually pretty smart. Opinion 2016. Available from: http://theweek.com/articles/642980/why-replacing-bus-uber-actually-pretty-smart

[81] Staedter, T. A Free Uber-Like App Finds Rides for People in Rural Areas. [Web] 2017 February 6, 2017 [cited 2017 May 8]; Available from: https://www.seeker.com/a-free-uber-like-app-finds-rides-for-people-in-rural-areas-2242594637.html.

[82] Stangler, C. Why The Uber, Lyft Driver Union Push Could Disrupt The Gig Economy. [Web] 2015 December 18, 2015 [cited 2017 January 8]; Available from: http://www.ibtimes.com/why-uber-lyft-driver-union-push-could-disrupt-gig-economy-2232778.

[83] Transport Workers Union. 2017. Public Transportation and the Rise of the Transportation Network Industry. Available from: http://www.twu.org/wp-content/uploads/2017/05/The-Emerging-Transportation-Network-Industry-040817.pptx

[84] Tsay, S.-P., Accuardi, Z. and B. Schaller, Private Mobility, Public Interest: How public agencies can work with emerging mobility providers. 2016, Transit Center: New York, NY, US. Available from: http://transitcenter.org/publications/private-mobility-public-interest/

[85] Walker, J., More on Uber "Competing" with Transit, in Human Transit, J. Walker, Editor. 2016, Walker, Jarrett. Available from: http://humantransit.org/2016/08/more-on-uber-competing-with-transit.html

[86] Wang, A., The Economic Impact of Transportation Network Companies on the Taxi Industry. 2015, Scripps College: Claremont, California, US. Available from: http://scholarship.claremont.edu/scripps_theses/703/

[87] Wear, B. Cap Metro, fighting ridership slump, nears an overall of bus system. Metro-State [Web] 2017 February 17, 2017 [cited 2017 February 20]; my Statesman: [Available from: http://www.mystatesman.com/news/transportation/cap-metro-fighting-ridership-slump-nears-overhaul-bus-system/hLHE1h3S42ADEVDRJNAFMM/ .

[88] Williams, C., Uber Moves A Little Closer To Public Transit's Turf. [Web] 2016 July 14, 2016 [cited 2017 January 10]; Available from: www.HuffingtonPost.com/entry/Uber-gilt-city-uberpool_us_578661f8e4b08608d3327621?section=.

[89] Wilonsky, R., Uber Dallas strike continues as some luxury sedan drivers protest lower fares, in Transportation. 2015, Dallas News: Dallas, Texas. Available from: https://www.dallasnews.com/news/transportation/2015/09/18/dozens-of-uber-dallas-drivers-protest-transportation-companys-west-end-offices

[90] Zanona, M. Trump's infrastructure plan won't contain list of projects. [Web] 2017 May 17 [cited 2017 May 31]; Available from: http://thehill.com/policy/transportation/333856-trumps-infrastructure-plan-wont-contain-list-of-projects.

[91] *Roadway Inventory Annual Report*. 2015. Texas Department of Transportation. Available from: http://ftp.dot.state.tx.us/pub/txdot-info/tpp/roadway-inventory/2015.pdf

[92] Super Bowl XLVII Report For The New Jersey Transit Corporation Board of Directors. 2014. Available from: https://www.scribd.com/document/236266828/Final-SuperBowl-Report

[93] Marshall, A., As Uber Flails, Its Self-Driving tech Rolls On. [Web] 2017 June 23 [cited 2017 July 18]; Available from: https://www.wired.com/story/uber-crisis-self-driving-pittsburgh/

[94] Newcomer, E., Uber Loses at Least $1.2 Billion in First Half of 2016. [Web] 2016 August 25[cited 2016 October 18]; Available from: https://www.bloomberg.com/news/articles/2016-08-25/uber-loses-at-least-1-2-billion-in-first-half-of-2016

APPENDIX A: LIST OF TRANSPORTATION NETWORK COMPANIES

TNCs are flourishing throughout the United States, the North American continent and internationally. The following lists are to give some idea of the quantity and venues being served. It also provides the public transportation decision-makers options and comparability should a proposal ever be requested.

Subsequently, there are a few bolded cities and TNC Codes. The purpose is to highlight their anomalistic characteristics such as it is either served by a single TNC competing with Uber, or it may only legally permit one TNC to operate within their jurisdiction and/or it is a brand new TNC. This list has been revised periodically. It was last updated on May 7, 2017.

Table A.1 United States

Abilene	U/eR/Rd
Akron	U/L/eR/Rd
Albany, NY	C
Albuquerque	U/Bl/eR/Rd
Alexandria, VA (DC Area)	U/L/Bl/eR/Rd/2/C
Altamonte Springs, FL (Orlando Area)	U/L/Z/eR/Rd
Altoona, PA	U/eR/Rd
Amarillo	U/eR/Rd
Ames	U/eR/Rd
Anchorage, AK	Bl/eR/Rd
Ann Arbor	U/L/eR/Rd/C
Arlington, TX	U/L/eR/Rd
Arlington, VA	U/L/eR/Rd/C
Annapolis, MD (Baltimore Area)	U/L/Bl/Z/eR/Rd
Arvada, CO (Denver Area)	U/L/Z/eR/Rd
Asheville, NC	U/eR/Rd
Aspen, CO	U/Bl/eR/Rd
Athens	U/eR/Rd

Table A.1 (Continued)

Atlanta	U/L/Bl /eR/Rd/C/M
Atlantic City, NJ	U/Bl/L/eR/Rd
Augusta	U/eR/Rd/N
Aurora, CO	U/L/Z/eR/Rd
Austin, TX	U/L/Z/Bl/eR/Rd/C/F/f/g/I/RA/ W/AC/SH/N/ReD/T/SM
Bakersfield	U/L/eR/Rd
Baltimore	U/L/Z/Bl/eR/Rd/C
Baton Rouge	U/eR/Rd
Beaumont	U/eR/Rd
Beaverton, OR	U/L/eR/Rd
Bellevue, WA	U/L/eR/Rd
Bellingham	U/eR/Rd
Berthoud, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Bethel Park, PA	U/L/eR/Rd
Billings, MT	U/eR/Rd
Biloxi, MS	U/eR/Rd
Birmingham, AL	U/Bl/eR/Rd
Blacksburg, VA	U/eR/Rd
Bloomfield, NJ	N
Bloomington, IN	U/L/eR/Rd/C
Boca Raton, FL	U/L/eR/Rd
Boise	U/Bl/eR/Rd/N
Boston	U/L/Bl/eR/Rd/C/f/M
Boulder, CO	U/L/Z/eR/Rd/C
Bowling Green, KY	U/L/eR/Rd
Boynton Beach, FL	U/L/eR/Rd
Bozeman, MT	U/eR/Rd
Brockton, MA	U/L/eR/Rd
Broken Arrow, OK	U/L/eR/Rd
Broomfield, CO (Boulder/Denver Area)	U/L/Z/eR/Rd
Buffalo, NY	C
Burlington, VT	U/Bl/eR/Rd
Cambridge, MA	U/L/eR/Rd
Cape Cod, MA	U/L/eR/Rd
Carefree, AZ (Phoenix, AZ)	U/L/Z/eR/Rd/F
Carmel, IN	U/L/eR/Rd
Cary, NC	U/L/eR/Rd
Casselberry, FL (Orlando Area)	U/L/Z/eR/Rd
Castle Rock, CO (Denver Area)	U/Z/eR/Rd

Table A.1 (Continued)

Cave Creek, AZ (Phoenix, AZ)	U/L/Z/eR/Rd/F
Cedar Park, TX (Austin Area)	Z/eR/Rd/f/F/g/I/RA
Cedar Rapids	U/eR/Rd
Centennial, CO (Denver Area)	U/L/eR/Rd
Champaign. IL	U/eR/Rd
Charleston, SC	U/L/eR/Rd
Charleston, WV	U/L/eR/Rd
Charlotte, NC	U/L/Bl/eR/Rd/C
Charlottesville-Harrisonburg, VA	U/eR/Rd/C
Chandler, AZ (Phoenix, AZ)	U/L/Z/eR/Rd/F
Chapel Hill, NC	U/L/eR/Rd
Chattanooga	U/L/eR/Rd
Cherry Creek, CO (Denver Area)	U/Z/eR/Rd
Chicago	U/L/Bl/eR/Rd/C/V/N/M
Cincinnati	U/L/eR/Rd/N
Clearwater, FL	U/L/Z/eR/Rd/N
Cleveland	U/L/Bl/eR/Rd/C
Coastal Georgia	U/L/eR/Rd
Coeur D'Alene	U/L/eR/Rd
College Park, GA (Atlanta Area)	U/L/eR/Rd
College Park, MD	U/L/eR/Rd
College Station, TX	U/eR/Rd
Colorado Springs, CO	U/L/Bl/eR/Rd/C
Columbia, MO	U/eR/Rd
Columbia, SC	U/Bl/eR/Rd
Columbus, OH	U/L/Bl/eR/Rd/C
Commerce City, CO (Denver Area)	U/L/Z/eR/Rd
Concord, NC	U/L/eR/Rd
State of Connecticut	U/eR/Rd
Corpus Christi, TX	T
Council Bluffs, IA	N
Dallas	U/L/Bl/eR/Rd/C/g
Dayton	U/eR/Rd
Daytona Beach, FL	U/Bl/eR/Rd
Delaware	U/eR/Rd
Delray Beach, FL	U/L/eR/Rd
Denton, TX	U/L/eR/Rd
Denver	U/L/Bl/eR/Rd/C
Des Moines	U/eR/Rd/C
Detroit	U/L/Bl/eR/Rd

Table A.1 (Continued)

Dubois	U/eR/Rd
El Paso, TX	U/Bl/eR/Rd
Erie, CO (Boulder/Denver Area)	U/L/Z/eR/Rd
Erie, PA	U/eR/Rd
Eton, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Evans, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Evanston, IL	U/L/eR/Rd
Everett, MA	U/L/eR/Rd
Everett, WA	U/L/eR/Rd
Fairbanks, AK	N
Fall River, MA	U/L/eR/Rd
Fargo, ND	U/eR/Rd
Farmington Hills, MI	U/L/eR/Rd
Fayetteville, AR	U/eR/Rd
Fayetteville, NC	U/eR/Rd
Flagstaff, AZ	U/eR/Rd
Flint	U/eR/Rd
Fort Collins, CO	U/Z/eR/Rd/C
Fort Lauderdale, FL	U/L/Bl/eR/Rd
Fort Lee, NJ	N
Fort Myers-Naples	U/L/Bl/eR/Rd/N
Fort Walton Beach, FL	N
Fort Wayne	U/L/eR/Rd
Fort Worth	U/L/eR/Rd/C
Fountain, CO (Colorado Springs Area)	U/L/eR/Rd
Fountain Hills, AZ (Phoenix, AZ)	U/L/Z/eR/Rd/F
Fresno	U/L/eR/Rd
Gainesville	U/L/eR/Rd
Gallup	U/L/eR/Rd
Galveston, TX (Houston Area)	U/Bl/g/eR/Rd/g
Garland, TX	U/L/eR/Rd
Germantown	U/L/eR/Rd
Georgetown, TX (Austin Area)	Z/eR/Rd/f/F/g/I/RA
Gilbert, AZ (Phoenix Area)	U/L/Z/eR/Rd/F
Glendale, AZ (Phoenix Area)	U/L/Z/eR/Rd/C/F
Golden, CO (Denver Area)	U/L/Z/eR/Rd
Goodyear, AZ (Phoenix Area)	U/L/Z/eR/Rd/F
Grand Haven, MI	L/eR/Rd
Greeley, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd

Table A.1 (Continued)

Grand Rapids	U/L/eR/Rd
Green Bay	U/eR/Rd
Greenville, SC	U/eR/Rd
Gulfport, FL (Tampa Bay Area)	U/L/Z/eR/Rd
Gulfport, MS	U/eR/Rd
Hampton , VA	U/L/eR/Rd
Hampton Roads, VA	U/eR/Rd
Harrisburg, PA	U/eR/Rd
Hartford, CT	U/Bl/eR/Rd
Hattiesburg, MS	U/eR/Rd
Henderson, NV (Las Vegas Area)	U/L/eR/Rd/g
Hermosillo	U/L/eR/Rd
Highlands Ranch, CO (Denver Area)	U/L/Z/eR/Rd
Hilton Head, SC	U/L/eR/Rd
Homestead, FL	U/L/eR/Rd
Honolulu	U/L/Bl/eR/Rd/C
Houston	U/L/Bl/eR/Rd/g
Huntsville, AL	U/eR/Rd
Huntersville, NC	U/L/eR/Rd
Hutto, TX (Austin Area)	Z/eR/Rd/f/F/g/I/RA
Indianapolis	U/L/Bl/eR/Rd
Iowa City, IA	U/eR/Rd/N
Jackson, MS	U/Bl/eR/Rd
Jacksonville, FL	U/L/eR/Rd/C
Jefferson City, MO	N
Johnstown, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Johnstown, PA	U/eR/Rd
Juneau, AK	N
Kalamazoo, MI	U/eR/Rd
Kaneohe, HI	U/L/eR/Rd
Kansas City, KS	U/Z/Bl/eR/Rd/C
Ken Caryl, CO (Denver Area)	U/L/Z/eR/Rd
Kent, WA	U/L/eR/Rd
Key West, FL	U/Bl/eR/Rd
Killeen	U/eR/Rd
King of Prussia, PA	U/L/eR/Rd
Kissimmee, FL	U/L/eR/Rd
Kitchener-Waterloo	U/L/eR/Rd
Knoxville, TN	U/eR/Rd

Table A.1 (Continued)

Lafayette, CO (Boulder/Denver Area)	U/L/Z/eR/Rd
Lafayette, LA	U/eR/Rd
Lakewood, CO (Denver Area)	U/L/Z/eR/Rd
Lancaster, PA	U/eR/Rd
Lansing	U/L/eR/Rd
Laporte, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
La Salle, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Las Cruces	U/eR/Rd
Las Vegas	U/L/Bl/eR/Rd/C/g
Laveen, AZ (Phoenix Area)	U/L/Z/eR/Rd
Lawrence, KS	U/eR/Rd
Leander, TX (Austin Area)	U/L/Bl/RA/Z/eR/Rd/F/f/g/I
Lee's Summit, MO (Kansas City Area)	U/Z/eR/Rd
Lexington, KY	U/L/eR/Rd
Lincoln, NE	U/L/eR/Rd/N
Little Rock, AR	U/eR/Rd
Littleton, CO (Denver Area)	U/L/Z/eR/Rd
Longmont, CO (Boulder Area)	U/Z/eR/Rd
Los Angeles	U/L/Bl/eR/Rd/C
Loveland, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Louisville, CO (Boulder Area)	U/L/Z/eR/Rd
Louisville, KY	U/L/Bl/eR/Rd
Lowell, MA	U/L/eR/Rd
Lubbock	U/eR/Rd
Madison	U/L/eR/Rd
Maitland, FL (Orlando Area)	U/L/Z/eR/Rd
Manhattan, KS	U/L/eR/Rd
Marietta, GA	U/L/eR/Rd
Matthews, NC	U/L/eR/Rd
Maui, HI	U/eR/Rd
Memphis	U/L/Bl/eR/Rd/C
Mesa, AZ (Phoenix Area)	U/L/Z/eR/Rd/F
Mesquite, TX	U/L/eR/Rd
Miami	U/L/Bl/eR/Rd/C
Midland, TX	U/eR/Rd
Milliken, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Milwaukee	U/L/eR/Rd/C
Minneapolis	U/L/Bl/eR/Rd/C/N
Missoula, MT	U/eR/Rd

Table A.1 (Continued)

Mobile, AL	U/eR/Rd
Modesto	U/L/eR/Rd
Moore, OK	U/L/eR/Rd
Montgomery, AL	U/eR/Rd
Morgantown, WV	U/eR/Rd
Mount Lebanon, PA	U/L/eR/Rd
Myrtle Beach	U/L/Bl/eR/Rd
Naperville, IL	U/L/eR/Rd
Nashville	U/L/eR/Rd/C
New Hampshire	U/L/eR/Rd
New Jersey	U/L/eR/Rd
New Jersey (Shore)	U/L/eR/Rd
New Orleans	U/L/Bl/eR/Rd/C
New York City	U/L/Bl/eR/Rd/C/V*/J/G/N/M
Newark, NJ	U/L/eR/Rd/N
Newport News, VA	U/L/eR/Rd
Newton, MA	U/L/eR/Rd/C
Norfolk, VA	U/L/Bl/eR/Rd
Norman, OK	U/L/eR/Rd
Northern Montana	U/L/eR/Rd
Ocala, FL	U /eR/Rd
Odessa, TX	U/eR/Rd
Oklahoma City	U/L/Bl/eR/Rd
Olympia	U/eR/Rd
Omaha	U/L/Bl/eR/Rd/N
Orlando	U/L/Z/Bl/eR/Rd/C/N
Oro Valley, AZ (Tucson Area)	U/L/eR/Rd
Overland Park, KS (Kansas City Area)	U/Z/eR/Rd
Oxford, MS	U/eR/Rd
Palm Beach, FL (Miami Area)	U/L/Bl/eR/Rd/C
Palm Harbor, FL (Tampa Bay Area)	U/L/Z/eR/Rd
Palm Springs, CA	U/L/Bl/eR/Rd/C
Park City, UT	U/L/eR/Rd
Parker, CO (Denver Area)	U/L/Z/eR/Rd
Pensacola, FL	U/L/Bl/eR/Rd
Peoria, IL	U/L/eR/Rd/N
Peoria, AZ (Phoenix Area)	U/L/Z/eR/Rd/F
Pflugerville, TX (Austin Area)	U/L/Z/eR/Rd/f/F/g/I/RA
Philadelphia*	U/L/Bl/eR/Rd/C

Table A.1 (Continued)

Phoenix	U/L/Z/Bl/eR/Rd/C/F
Piedmont Triad	U/L/eR/Rd
Pittsburgh	U/L/Z/Bl/eR/Rd/C
Plano, TX	U/L/eR/Rd
Portland, ME	U/L/eR/Rd
Portland, OR	U/L/Bl/eR/Rd/C/M
Post Falls, ID (Coeur D'Alene, ID Area)	U/L/eR/Rd
Providence, RI	U/L/Bl/eR/Rd
Provincetown, MA	N
Provo, UT	U/L/eR/Rd
Queen Creek, AZ (Phoenix Area)	U/L/Z/eR/Rd/F
Raleigh-Durham	U/L/eR/Rd/C/N
Reading, PA	U/L/eR/Rd
Reno	U/L/Bl/eR/Rd
Rhode Island	U/L/eR/Rd
Richmond, VA	U/L/Bl/eR/Rd
Roanoke, VA	U/eR/Rd
Rochester, NY	Bl/eR/Rd
Rockford, IL	U/eR/Rd
Rockville, MD (DC Area)	U/L/Bl/eR/Rd/C
Round Rock, TX *** (Austin Area)	U/L/Z/eR/Rd/F/f/g/I/RA
Sacramento	U/L/eR/Rd/C
Salt Lake City	U/L/Bl/eR/Rd/N
San Antonio	U/L/Bl/eR/Rd/g
San Diego	U/L/Bl/eR/Rd/C
San Francisco	U/L/c/Bl/eR/Rd/C/s/M/H
San Juan, PR	U/L/eR/Rd
San Luis Obispo	U/eR/Rd
San Marcos, TX ****	U/L/eR/Rd
Sanford, FL	U/L/eR/Rd
Santa Barbara, CA	U/L/eR/Rd
Santa Fe, NM	U/eR/Rd
Sarasota, FL	U/eR/Rd/N
Savannah, GA	U/L/Bl/eR/Rd
Scottsdale, AZ	U/L/Z/eR/Rd
Seattle, WA	U/L/Bl/eR/Rd/C/M
Shawnee, KS (Kansas City Area)	U/Z/eR/Rd
Shreveport, LA	N

Table A.1 (Continued)

Silver Spring, MD (DC Area)	U/L/Bl/eR/Rd/C
South Bend, IN	U/eR/eR/Rd
South Pasadena, FL (Tampa Bay Area)	U/L/Z/eR/Rd
Spokane, WA	U/L/Bl/eR/Rd
Springfield, IL	U/eR/Rd
St. Cloud, FL (Orlando Area)	U/L/Z/eR/Rd
St. Louis	U/L/Bl/eR/Rd/C
St. George, UT	U/eR/Rd
St. Paul	U/L/eR/Rd/C/N
St. Petersburg, FL	U/L/Z/eR/Rd/C
State College, PA	U/eR/Rd
Sterling, VA (DC Area)	U/L/Bl/eR/Rd/C
Stillwater, OK	U/eR/Rd
Summerlin, NV (Las Vegas Area)	U/L/eR/Rd/g
Sun City, AZ (Phoenix Area)	U/L/Z/eR/Rd/F
Superior, CO (Boulder Area)	U/L/Z/eR/Rd
Surprise, AZ	U/L/Z/eR/Rd
Tacoma, WA	U/eR/Rd
Tallahassee, FL	U/eR/Rd
Tampa Bay	U/L/Bl/eR/Rd/C
Taos, NM	U/eR/Rd
Taylorsville, UT (SLC Area)	U/L/eR/Rd
Tempe, AZ	U/L/Z/eR/Rd
Thornton, CO (Denver Area)	U/L/Z/eR/Rd
Toledo, OH	U/L/eR/Rd
Topeka, KS	U/eR/Rd
Towson, MD	U/L/eR/Rd
Troy, MI	U/L/eR/Rd
Tucson	U/L/Z/eR/Rd/C/N
Tulsa	U/L/Bl/eR/Rd/T
Tuscaloosa, AL	U/eR/Rd
Tysons Corner, VA	U/L/eR/Rd
Vancouver, WA	U/L/eR/Rd
Ventura, CA	U/L/eR/Rd
Virginia - DC Area	N
Virginia Beach, VA	U/L/eR/Rd
Waco, TX	U/eR/Rd
Waipahu, HI	U/L/eR/Rd
Warren, MI	U/L/eR/Rd

Table A.1 (Continued)

Washington D.C.	U/L/Bl/eR/Rd/C/S/V/m/N/M
Waukesha, WI	U/L/eR/Rd
Wellington, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
West Lafayette, IN	U/eR/Rd
Westminster, CO (Denver Area)	U/L/Z/eR/Rd
Wheat Ridge, CO (Denver Area)	U/L/Z/eR/Rd
Wichita	U/L/eR/Rd
Wichita Falls, TX	U/L/eR/Rd
Wilmington, DE**	U/L/eR/Rd
Wilmington, NC	U/eR/Rd
Windsor, CO (Denver/Ft. Collins Area)	U/Z/eR/Rd
Winter Garden, FL (Orlando Area)	U/L/Z/eR/Rd
Winter Park, FL (Orlando Area)	U/L/Z/eR/Rd
Worcester, MA	U/eR/Rd
York-Gettysburg, PA	U/eR/Rd
Youngstown, OH	U/eR/Rd
Yuma, AZ	U/eR/Rd

Table A.2 California

Anaheim	U/L/Bl/Rd/C/eR
Antioch	U/L/Rd/eR
Berkeley	U/L/Rd/eR/c/s/K
Burbank	U/L/Rd/C/eR
Carlsbad	U/L/Rd/eR
Concord	U/L/Rd/eR
Corona	U/L/Rd/eR
Cupertino	U/L/Rd/eR
Daly City	U/L/Rd/eR
Davis	U/L/Rd/eR
Dublin	U/L/Rd/eR
Elk Grove	U/L/Rd/eR
Fairfield	U/L/Rd/eR
Fremont	U/L/c/Rd/eR
Glendale	U/L/Rd/C/eR
Hayward	U/L/Rd/eR/K
Healdsburg	U/L/Rd/eR
Huntington Beach	U/L/Rd/eR
Inglewood	U/L/Rd/eR

Table A.2 (Continued)

Irvine	U/L/Rd/C/eR
La Jolla	U/L/Rd/eR
The Lagunas (Orange County, CA)	U/L/Rd/eR
Lake Tahoe	U/L/Rd/eR
Livermore	U/L/Rd/eR
Lodi	U/L/Rd/eR
Long Beach	U/L/Rd/C/eR
Los Angeles	U/L/Rd/eR
Manteca	U/L/Rd/eR
Mill Valley	U/L/Rd/eR
Milpitas	U/L/Rd/eR
Mission Viejo	U/L/Rd/eR
Modesto	U/L/Rd/eR
Moreno Valley	U/L/Rd/eR
Mountain View	U/L/c/Rd/eR
Napa	U/L/Rd/eR
Newport Beach	U/L/Rd/eR
Oakland	U/L/Bl/Rd/eR/c/s/H
Oceanside	U/L/Rd/eR
Palm Desert	U/L/Rd/eR
Palo Alto-Menlo Park	U/L/Rd/eR
Pasadena	U/L/Rd/C/eR
Pleasanton	U/L/Rd/eR
Pomona	U/L/Rd/C/eR
Poway	U/L/Rd/eR
Rancho Cucamonga	U/L/Rd/eR
Redlands	U/L/Rd/eR
Richmond	U/L/Rd/eR/c
Riverside	U/L/Bl/Rd/eR
Roseville	U/L/Rd/eR
Sacramento	U/L/Rd/eR
San Bernardino	U/L/Rd/eR
San Diego	U/L/Rd/eR
San Jose	U/L/Bl/Rd/C/eR/c/K
San Leandro	U/L/Rd/eR
San Mateo	U/L/Rd/eR
San Rafael	U/L/Rd/eR
San Ramon	U/L/c/Bl/eR/Rd/C
Santa Clara	U/L/Rd/eR
Santa Clarita	U/L/Rd/eR

Table A.2 (Continued)

Santa Monica	U/L/Rd/eR
Santa Rosa	U/L/Rd/eR
Sonoma	U/L/Rd/eR
Stockton	U/L/Rd/eR
Sunnyvale	U/L/Rd/eR
Thousand Oaks	U/L/Rd/eR
Vallejo	U/L/Rd/eR
Ventura	U/L/Rd/eR
Walnut Creek	U/L/Rd/eR

2 = Way2Go
AC = Arcade City
Bl = Blacklane
c = carma
C = Curb
D= Drive Society
eR = eRideshare
F=Fare
f=fasten
g = getme
G = gett
H = Hovee
I = Instaryde
J = Juno
K = Kango
L = Lyft
m = mytaxi
M = Moovn
N = NexTaxi
RA = Ride Austin
ReD = ReDriver
Rd = Rdvouz
S = Split
s = summon
SH = SafeHer
SM = ScoopMe
T = T-Ride
U = Uber
V = Via
W = Wingz
Z = zTrip

Table A.3 Canada

Edmonton, AB, CANADA	U/N
Ft. McMurray, AB, CANADA	N
Hamilton, CANADA	U
Kingston, CANADA	U
Lethbridge, AB, CANADA	N
London, Ontario, CANADA	U
Vancouver	M
Whistler, BC, CANADA	N
Windsor	U
Montreal	U
Niagara Region, CANADA	U
Toronto	U

Table A.4 Current List of TNCs

TNC Name	TNC Website	Revenue Service Venues	Type of TNC
Addison Lee	www.addisonlee.com	London, United Kingdom Only	TNC
Arcade City	www.arcade.city	Austin, Texas	Uber-style App
Arro	www.goarro.com	New York City	Taxi-hailer App
Bandwagon	www.bandwagon.io/about-1/	New York City's 2 main airports: JFK & LGA	TNC-like App
BiTaksi	www.bitaksi.com	Istanbul & Ankara	Taxi-hailer App
BlaBlaCar	www.blablacar.com	Paris, France; India; Mexico; Brazil plus 18 other countries - Not US	
Blacklane	www.blacklane.com	49 countries + US; Berlin, London, Paris	Uber-style App
BookCab	www.bookcab.in	India	
Cabify	www.cabify.com	Latin America; Spain, Portugal	TNC
carma	www.carmacarpool.com	12 cities within the San Francisco Area (Headquartered in Ireland)	Uber style App
Chariot for Women	www.safeher.com	Boston, Massachusetts	
Curb	www.gocurb.com	Alexandria, Virginia	TNC
Didi Chuxing	www.xiaojukeji.com	Beijing, China	TNC
DriveSociety	www.drive-society.launchrock.com		TNC
Easy Taxi	www.easytaxi.com/cities/	30 Countries in Latin/S America; Asia, United Arab Emirates Area of Middle East	Uber-style App
eRideShare	www.erideshare.com	Worldwide (457+ cities in US/Canada)	No fee yet.
FARE	www.ridefare.com	Phoenix, AZ & Austin, Texas; 150 mile radius for each market	
Fasten	www.fasten.com	Boston, Massachusetts & Austin, Texas	
Fillcar		India	
Flywheel	www.flywheelnow.com	Redwood City, California	
Get Me	www.getme.com/cities.html	Las Vegas, Nevada, Austin, Dallas, Houston, Galveston & San Antonio, Texas	
Gett (formerly GetTaxi)	www.gett.com	NYC	
Grab	www.grab.com/us/	Singapore; Malaysia; Indonesia; Thailand; Vietnam; Philippines & US	TNC
Hail-O	www.hailoapp.com/locations/	London, Manchester, Liverpool, Leeds, United Kingdom; Dublin, Ireland; Madrid, Barcelona, Spain & Singapore	TNC
Haxi	www.haxi.me/about	London, United Kingdom	TNC

Table A.4 (Continued)

TNC Name	TNC Website	Revenue Service Venues	Type of TNC
HopSkipDrive	www.hopskipdrive.com	Los Angeles, San Francisco Bay Area & Orange County California	TNC
Hovee	www.hovee.com	San Francisco, Oakland Area of California	Carpool App
InstaRyde	www.instaryde.com	Austin, Texas; Toronto & Mississauga, Ontario, Canada	TNC
Jugnoo	www.jugnoo.in	India	Suspended Surge Pricing as of 4/22/16 due to Odd-Even Rule.
Juno	www.gojuno.com	New York City	TNC
Kabbee	www.kabbee.com/minicabs/taxis/	London, United Kingdom Only	
Kango	www.kangoapp.co	San Francisco, California; From El Cerrito to Hayward; including Berkeley/Oakland Area	
Lyft	www.lyft.com	United States; and some International Countries	As of Dec 31, 2015 - 65 US cities (probably more at press time and mainly in major cities). Surge cap @ 400%. Lyft is in one city that Uber is not, as opposed to Uber where Lyft follows not-too-far behind.
Meru Cabs	www.merucabs.com/mobile/	India	Taxi-agreggator company. Book a taxi through its app.
Mondo Ride	www.mondoride.com	Saudi Arabia & Kenya	
moovn	www.moovn.com	Dubai; Johannesburg; Nairobi; Dar-Es Salaam, Tanzania; Select US Cities & Vancouver	TNC
MyDriver	www.mydriver.com	21 countries throughout Europe	
my taxi	www.us.mytaxi.com	Germany Based; Vienna, Austria; Graz, Switzerland; Zurich, Spain; Barcelona, Madrid; Warsaw, Poland & Washington, District of Columbia	
NexTaxi	www.nextaxi.com	United States and Canada	

Table A.4 (Continued)

TNC Name	TNC Website	Revenue Service Venues	Type of TNC
Ola	www.olacabs.com	India	
Orahi	www.orahi.com	India	Calls itself "India's most trusted carpool app". But also claims to be a ride-sharing app. Offers separate service only for females. Very cheap with no membership fees.
Rdvouz	www.rdvouz.com	Worldwide	No vehicles.
Revv	www.revv.co.in	India	Car rental svc
RideAustin *	www.rideaustin.com	Austin	TNC - non-for-profit
RideBuzz	www.ridebuzz.org	Amherst & Western Massachusetts; potentially nationwide	Non-for-profit - No APP
Sakha Consulting Wings	www.sakhaconsultingwings.com	Delhi, India	
ShareYourRide	www.shareyourride.net	United States, Australia, Canada, France, New Zealand	Uber type app - No TNC
Shuddle	www.shuddle.us	San Francisco	TNC - specializing in kids
Sidecar	www.side.cr	San Francisco	TNC
Split	www.split.us	Washington, DC	TNC
Summon	www.instantcab.com	San Francisco	TNC
TappCar	www.tappcar.com	Edmonton & Calgary, Alberta ,Canada	TNC
Tappsi	www.tappsi.co	Latin & South America; Primarily in Columbia	Taxi-hailer app
TaxiForSure	www.taxiforsure.com	India	Taxi-hailer app
Taxify	www.taxify.eu	Estonia	
Tripda	www.tripda.com	Sao Paolo, Brazil	As of May 28, 2015 - globally 160MM+ drivers in 58 countries & 300+ cities. This can and will change with its recent concession to its Chinese adversary: Didi Chuxing.

Table A.4 (Continued)

TNC Name	TNC Website	Revenue Service Venues	Type of TNC
Uber	www.uber.com	USA/International	Very cheap fares direct correlation to the extremely limited areas it serves.
Via	www.ridewithvia.com	New York City, Chicago, Washington, District of Columbia	
Way2Ride	www.way2ride.com	New York City	Taxi-hailer app
Wingz	www.wingz.me	See List of Airports	
Yandex	www.taxi.yandex.com	Russia	Taxi-hailer app
Zimride	www.zimride.com	United States	Car sharing
zTrip	www.ztrip.com	All major Airports; 10 Major Cities in the United States	Sedan/SUV; Black Sedans;Taxis & Yellow Cabs
Zum	www.ridezum.com	San Francisco, California	TNC for kids
360 Ride	www.360ride.in	India	Ridesharing app

APPENDIX B: ANALYSIS OF NEW YORK CITY

The example in Chapter 5 presented how a TNC could be implemented in revenue service if subsidized on the same level of a transit agency and perhaps save some of those funds. There are many more examples that can be made of and with the same effect. The State of New York Metropolitan Transportation Authority (NYSMTA), provides an ultimate representative illustration for a couple of reasons.

First, New York City is considered to be the "outlier" *[67]*. Mainly, due to the unrivaled amount of daily unlinked trips completed when juxtaposed against other properties in the United States. According to Polzin, "New York is 40% of transit in the United States. When people talk about transit, sometimes [it is said that] there's New York and then there is the other 60% of transit. And when you look at that data, it's sometimes helpful to pull New York out…it is very dominant…[it] probably has the vast majority of subway service in the country" *[67]*. As a result, New York transit data may be viewed as an abnormal,

Second is it is due to the number of different mode choices presented to the prospective passenger. For example, a commuter living in the outskirts of Manhattan but within the limits of the City of New York, such as The Rockaway Peninsula or Southeastern Queens, has access to: subway or heavy rail; commuter rail; commuter bus; motorbus or regular fixed-route service; ferryboat; or their own personal vehicle.[89]

[89] Walking and biking are options. Walking is for local trips and biking can be somewhat limited subject to accessibility across any of the toll bridges that serve that area.

B.1 Origin/Destination Pair

The origin and destination, as indicated below, are served by Commuter Rail, Heavy Rail or subway, and Bus. Ridership figures, as seen in Table B.1 are factors in determining the subsidization and were extracted directly from MTA. Additionally, the figures for Grand Central Station (GCT) are only for those subway lines serving this origin/destination.

1. Origin: Grand Central Terminal – 42nd Street, New York City, New York
2. Destination: Harlem – 125th Street, New York City, New York
3. Route Length: ~4.3 miles.[90]
4. Time: approximately ~ 10-60 minutes[91]
5. Local transit agencies: MTANYCT and MNRR [92]
6. O/D Subway Lines: 4, 5, and 6
7. O/D Main Bus Routes: M1, M101, M103, and M15-SBS

Table B.1 Selected NYCT Bus & Subway Ridership 2014 vs. 2015

	2014 Data	Daily Average*	2014-2015	%
NYCT Bus Routes				
M1	3,587,900	9,830	-344,430	-9.6%
M101	8,900,689	24,385	-607,045	-6.80%
M103	3,608,043	9,885	-137,732	-3.80%
M15 SBS	15,604,594	42,752	-1,047,809	-6.70%
Subway Lines				
GCT	46,074,652	126,232	662,912	1.40%
125 St	9,574,765	26,232	11,802	0.10%

[90] It is extremely close to the average trip length for the bus and subway modes. https://ride.guru/estimate/89%20E%2042nd%20St,%20New%20York,%20NY%2010017,%20USA/New%20York,%20NY%2010035,%20USA Moreover, MNRR's Employee Timetable reveals the length, in miles, from GCT.

[91] Time estimates provided by Google Maps on December 12, 2016 and results from employing an AM rush hour time slot. It is ~10 minutes for MNRR and ~18-19 minutes by heavy rail. By bus, ~45-60 minutes and if by car, ~16-45 minutes. The road mode estimates includes an assumption for any potential traffic congestion. TNC = 22 mins https://uberfarefinder.com/estimate/89%20E%2042nd%20St,%20New%20York,%20NY%2010017,%20USA/New%20York,%20NY%2010035,%20USA

[92] Three different modes are operated along this route: Heavy rail, Bus and Commuter Rail. NYSMTA operates these through NYCTA and Metro-North Railroad (MNRR).

Not just the size of the vehicle needed in revenue service, but the sufficient quantity on hand to implement. Noticeably, what makes this scenario quite appealing is that the Aggregated Average Trip Length for heavy rail and bus is exact or extremely close to it. Interestingly, although there is a slight increase in the ridership between 2014 and 2015, there is a nominal decrease in the bus routes that serve this origin-destination pair. In his 2017 report, Schaller he attributes the recent trend of ridership decrease to TNCs *[71]*.

Table B.2 Aggregated NYC Subway Data 2014 vs. 2015

	2014	2015	2014-2015	%
Annual	1,751,287,621	1,762,565,419	11,277,798	0.64%
Daily Average	4,798,048	4,828,946	30,898	0.64%

Source: New York MTA

B.2 Modes

B.2.1 Bus

Below are the national industry-wide aggregated, average trip lengths for the motorbus and heavy rail modes:[93]

1. Bus: 4.3 miles
2. Heavy Rail: 4.7 miles

Next, is the determination of efficiency. In other words, based upon assumed capacity what percentage of the vehicle is being cost-effective? Understood is that the underutilization is a cost that could be mitigated.

The first step is to calculate the Average Occupancy. In order to do so, the Aggregated Vehicle Revenue Miles was divided by the Aggregated Passenger Miles. Table 5.11, shows how the factors in how Average Occupancy was computed. When taking the Aggregated Passenger

[93] The average trip length for Commuter Rail is 23.9 miles.

Miles and then dividing it by the Aggregated Vehicle Revenue Miles the Average Bus Occupancy is 11 passengers.

Table B.3 Average Bus Occupancy

Aggregated Passenger Miles:	22,456
Aggregated Vehicle Revenue Miles:	2,095
Average Bus Occupancy:	11 passengers

In Table B.4, the Aggregated Fare Revenue is divided by the Aggregated Annual Ridership or Number of Boardings. In transit industry parlance, this is called unlinked trips. The average bus fare is $1.09.

Table B.4 Average Bus Fare

Aggregated Fare Revenue:	$5,773
Aggregated Annual Unlinked Trips:	5,274
Average Bus Fare:	$1.09

The Assumed Aggregated Average Vehicle Revenue Capacity (bus with standees) is not a known assessment in NTD. In order to calculate it, essential is the need to develop a formula which is indicated below. Next, was the extraction of the readily available data from the Florida Transit Information System's (FTIS) Urban Integrated National Transit Database or Urban iNTD. All the transit agencies that reported buses in their fleet and their corresponding capacities were catalogued. Unfortunately, many of the properties were not included and deleted for lack of reporting either the number of vehicles, the capacities or a combination thereof. Moreover, the capacities were either with or without the standees - which can make a difference as far as levels of efficiency are concerned. For example, a bus may have 35 seats, but also has extra space where another 20 can stand for the duration of their trip only enhances the economies of scale. Also, to be taken into account is some bus companies have a safety policy in place whereby standees are

not permitted – even where this is space availability to do so. Policies, such as the latter, are primarily implemented by commuter bus firms.

The number of transit agencies with full reports were 583, down from 681 with partial or no reports. The total number of buses was 62,069, down from 67,242 vehicles. After adding the total number of available seats (190,126) and the total number of available standees (112,025) the final figure for the Aggregated Average Vehicle Revenue Capacity (with standees) is 64.[94]

The Assumed Aggregated Average Vehicle Revenue Capacity (bus with standees) is calculated as follows:

$$\frac{\textit{Number of Active Bus Vehicles in Fleet} \times \textit{(Seating Capacity + Standing Capacity)}}{\textit{Total Number of Active Bus Vehicles in Bus Fleet}} = 64$$

Armed with the Average Vehicle Revenue Capacity, the Level of Efficiency can be assessed. The Average Occupancy devoid of rounding, to the first decimal point, was 16.75%. By rounding it is slightly increased to 17.2%. Either way it can be reasonably assumable that it is moderately inefficient when compared to the Level of Efficiency of a TNC.[95] As a reminder, the TNC sedan can be allotted into quarters. If the vehicle, in question, carries four passengers it can be simply apportioned as indicated in Table B.5. Notice how even one passenger in a TNC has a higher Level of Efficiency than the bus.

Table B.5 Level of Efficiency - Bus

Average Occupancy	11
Assumed Average Vehicle Revenue Capacity (standees)	64
Level of Efficiency	17.2%

Collectively, Table B.6 gives the total subsidization for bus mode on an industry-wide basis. The Average Subsidy per Passenger for buses is $3.83. Bear in mind how the national

[94] The aggregated average number of seats for a bus is 38.9 or 39. The calculation included the following modes: MB (motorbus), CB (commuter bus) and BRT (Bus Rapid Transit).

[95] The assumption, of course, is the TNC employed is a standard sedan with the volume of four passengers.

aggregated Level of Efficiency is 17.2%. Once again, one passenger average occupancy traveling in TNC basic service is 25%. As will be seen later on, the bus subsidy is more than what it would be for a TNC.

Table B.6 Average Subsidy per Passenger

Aggregated Total Expenses	$25,998
Aggregated Fare Revenue	$5,773
Level of Efficiency	17.2%
Subsidization for Bus Operations	$20,225
Annual Unlinked Trips	5,274
Average Subsidy per Passenger	$3.83

The calculation derived for Average Bus Vehicle Speed can be seen in Table B.7. The purpose for this is necessary in order to compute and compare TNC fares which are commonly based upon distance and time. The basic formula for the latter is Speed = Distance divided by Time.

Table B.7 Average Vehicle Speed - Bus

Vehicle Revenue Miles	2,095
Vehicle Revenue Hours	163
Average Vehicle Speed	12.82 MPH

B.2.2 Commuter Rail

The above gives a detailed breakdown of how bus subsidization was tallied. As critical as Commuter Rail is to this analysis and discussion, it greatly differs due to its Average Trip Length of 23.9 miles. Because TNC fares are time/distance based, it would be advantageous and cheaper for a passenger to travel via commuter rail as their mode choice. Unlike TNCs, commuter rail fares are distance based and offer substantial time-based discounts. For example, Metro-North offers commutation tickets based on weekly and monthly need. The fares are discounted subject to the type of ticket and the origin/destination pair. Table B.8 shows the commuter rail's fare framework for this O/D.

Table B.8 Metro-North Commuter Rail Fares for This O/D

Ticket Types	Fare
One Way Peak	$8.00 *
One Way Off-Peak	$6.00 *
Round-Trip Peak	$6.00
Round-Trip Off-Peak	$2.00
Ten-Trip Peak	$80.00
Ten-Trip Off-Peak	$1.00
Weekly	$57.50
Monthly	$80.00
City Ticket	$4.25
One Way S/C, H/C, Medicare	$4.00
One Way Peak: Child	$4.00*
Ten-Trip S/C, H/C & Medicare	$40.00
On Board Penalty	$6.00*
Monthly - School	$21.00
Family Fare	$1.00
R/T Family Fare	$2.00

Source: New York MTA

Briefly, each of the fares have corresponding terms and conditions. Be it as it may, the best scenario is the Monthly Ticket which provides unlimited rides to a passenger for the calendar month it is purchased for. This, as well, has its benefits subject to the number of days of actual use. As economical as the City Ticket is, it is severely restricted. It is limited as it can only be purchased for weekend travel, must be purchased before boarding, and it can only be used for the direction and day it is purchased.

Suffice it to say, from an aggregated subsidization standpoint, commuter rail is quite expensive when contrasted with the bus mode and its cousin: heavy rail. As will be shown in the subsequent tables, the Average Subsidization for Commuter Rail is $11.78 per passenger. When contrasted with TNC this mode would be, irrefutably, the victor.

The first step for Commuter Rail Average Occupancy is similar to how it was calculated for the bus. By replicating the same equation, the Aggregated Vehicle Revenue Miles was divided by the Aggregated Passenger Miles. Table B.9, shows the then dividing it by the Average Commuter Rail Car Occupancy is 34 passengers.

Table B.9 Average Commuter Rail Occupancy

Aggregated Passenger Miles	11,718
Aggregated Vehicle Revenue Miles	343
Average Commuter Rail Occupancy	34

In Table B.10, the Aggregated Fare Revenue is divided by the Aggregated Annual Ridership or Number of Boardings. In transit industry parlance this is called unlinked trips. The average commuter rail fare is $5.87.

Table B.10 Average Commuter Rail Fare

Aggregated Fare Revenue	$2,878
Aggregated Annual Unlinked Trips	490
Average Commuter Rail Fare	$5.87

The Assumed Average Vehicle Revenue Capacity is not a known assessment in NTD. In order to calculate the formula, similar to what was specified earlier on page 98, is generated on page 102. The data was extraction, too, from FTIS/Urban iNTD. All the transit agencies that reported commuter rail cars in their fleet and their corresponding capacities were categorized. Unfortunately, some of the properties were not included and deleted for lack of reporting either the number of vehicles, the capacities or a combination thereof. Moreover, the capacities were either with or without the standees - which can make a difference as far as levels of efficiency are concerned. For example, a commuter rail car may have 125 seats, but may have additional space for some willing to stand for the duration of their trip. This extra room enhances the economies of scale. Likewise, some passenger rail companies have a policy where the train may skip stations if the conductor and/or crew members believe there is a question of safety involved. For example, a fully packed train may bypass a scheduled station stop because there is an inability for riders to board a crowded train.

The number of transit agencies with full reports were 25, down from 28, with partial or no reports. The total number of commuter rail cars were 6,293, down from 7,305 railcars. After adding

the total number of available seats (32,405) and the total number of available standees (21,250) the final figure for the Aggregated Average Commuter Rail Vehicle Revenue Capacity (with standees) is 198.[96]

The Aggregated Average Vehicle Revenue Capacity (commuter railcar with standees) is calculated as follows:

$$\frac{\textit{Number of Active Commuter Rail Vehicles in Fleet} \times \textit{(Seating Capacity + Standing Capacity)}}{\textit{Total Number of Active Vehicles in Commuter Rail Fleet}} = 198$$

Readied with the Average Commuter Rail Vehicle Revenue Capacity, the Level of Efficiency can be assessed. The Average Occupancy, in shown in Table B.11, is 17.3%. Similarly, it can be reasonably assumable that it too, like the bus, is inefficient when compared to the Level of Efficiency of a TNC.[97] As a reminder, the TNC sedan can be apportioned into four parts. If the vehicle, in question, carries four passengers it can be simply distributed in quarters. That is, one person is of 25%, two equals 50%, and so on. Notice how even one passenger in a TNC has a higher Level of Efficiency than commuter rail.

Table B.11 Level of Efficiency – Commuter Rail

Average Occupancy	34
Assumed Average Vehicle Revenue Capacity (standees)	198
Level of Efficiency	17.3%

Collectively, Table B.12 gives the total subsidization for commuter rail mode on an industry-wide basis. The Average Subsidy per Passenger for commuter rail is $11.78. As will be evident, subsequently, this is much more than what it would be if a TNC received subsidization. TAs need take into account the levels of efficiency as well. Analyzing the latter two factors will assist TAs in their decision-making when determining TNC or more than one TNC applicability.

[96] The aggregated average number of seats for a commuter rail car is 197.87 or 39.
[97] The assumption, of course, is the TNC vehicle is a standard sedan with the volume of four passengers.

Table B.12 Average Subsidy per Commuter Rail Passenger

Aggregated Total Expenses	$8,652
Aggregated Fare Revenue	$2,878
Subsidization for Bus Operations	$5,775
Annual Unlinked Trips	490
Average Subsidy per Passenger	$11.78

Table B.13 Average Vehicle Speed – Commuter Rail

Vehicle Revenue Miles	343
Vehicle Revenue Hours	10.7
Average Vehicle Speed	32 MPH

Table B.13 gives the calculation for Average Commuter Rail Vehicle Speed. The purpose for this is necessary in order to compute and compare TNC fares which are commonly based upon distance and time. The basic formula for the latter is Speed = Distance divided by Time.

B.2.3 Rapid Rail or Subway

Table B.14 regurgitates facts and figures already outlined in Table B.1, primarily, for simpler reference. The top set of figures represent the number of passenger entries into each station. It does not mean nor represent a complete and total ridership figure for this O/D pair. On the contrary, NYCTA maintains estimates for this O/D pair and for many others within their system. But similar to TNCs, it maintains their information as proprietary. Thus, making it difficult to gain insight as to actual TNC ridership statistics.

Table B.14 NYCTA Heavy Rail Ridership Figures

	2014 Data	**Daily Average***	**2014-2015**	**%**
Subway Lines				
GCT [98]	46,074,652	126,232	662,912	1.40%
125 St	9,574,765	26,232	11,802	0.10%

Source: New York MTA

[98] GCT is served by the 4,5,6,7 and S subway lines. This research, focuses specifically on the 4, 5, and 6 lines. The data does not separate these from the 7 and S lines.

Already explained in the Methodology section, was the how and why this O/D was decided upon. NYC subway transports millions of riders on a daily basis. Schaller asserts that TNCs transported 133,000,000 passengers in 2016.

Table B.15 Aggregated NYC Subway Data 2014 vs. 2015

	2014	2015	2014-2015	%
Annual	1,751,287,621	1,762,565,419	11,277,798	0.64%
Daily Average	4,798,048	4,828,946	30,898	0.64%

By the same token, heavy rail or subway fares in New York, and at many other properties are at a flat-rate. This is regardless of the time or day of the week. Similar to the bus, the Average Trip Length of 23.9 miles. Because TNC fares are time/distance based, it would be advantageous and cheaper for a passenger to travel via commuter rail as their mode choice. Unlike TNCs, commuter rail fares are distance based and offer substantial time-based discounts. For example, Metro-North offers commutation tickets based on weekly and monthly need. The fares are discounted subject to the type of ticket and the origin/destination pair. Table B.16 shows the NYCTA fare framework for this O/D. Take note of how there is a diversity of fare options applicable to the mode chosen. More are the heterogeneousness of discounted fares.

Table B.16 Subway/Bus Fares for this O/D

Ticket Type	Fare
One Way	$2.75
Single Ride Ticket	$3.00*
7-Day	$32.00
30-Day	$121.00
One Way S/C, H/C, Medicare	$1.35
Express Bus:	$6.50
One Way S/C, H/C, Medicare	$3.25
Express Bus Plus 7-Day:	$59.50
Paratransit/Access-A-Ride	$2.75

* $1 extra fee for a new MetroCard

Source: New York MTA

Suffice it to say, from an aggregated subsidization standpoint, heavy rail or subway is substantially less than commuter rail and not as expensive when contrasted to the bus mode. The ensuing charts will evidently exhibit how TNCs are highly competitive.

The Heavy Rail Average Occupancy is prepared analogously to how it was gauged for commuter rail. By reproducing the same equation, the Aggregated Vehicle Revenue Miles was divided by the Aggregated Passenger Miles. Table B.17, shows how Average Occupancy for Heavy Rail was processed. When taking the Aggregated Passenger Miles and then dividing it by the Aggregated Vehicle Revenue Miles the Average Commuter Rail Car Occupancy is 11 passengers.

Table B.17 Average Heavy Rail Occupancy

Aggregated Passenger Miles	18,339
Aggregated Vehicle Revenue Miles	657
Average Heavy Rail Occupancy	143

In Table B.18, the Aggregated Fare Revenue is divided by the Aggregated Annual Ridership or Number of Boardings. In transit industry parlance this is called unlinked trips. The average heavy rail fare is $1.31.

Table B.18 Average Heavy Rail Fare

Aggregated Fare Revenue (in millions)	$5,126
Aggregated Annual Unlinked Trips (in millions)	3,928
Average Heavy Rail Fare	$1.31

The Assumed Average Heavy or Rapid Rail Vehicle Revenue Capacity is not an identified valuation in NTD. In order to calculate the total, a formula similar to what is specified in page 170, can be seen below. The data was also taken from FTIS/Urban iNTD. All the transit agencies that reported heavy rail cars in their fleet and their corresponding capacities were enumerated. Unfortunately, some of the transit agencies were not included and deleted for lack of reporting

either the number of vehicles, the capacities or a combination thereof. Moreover, the capacities were either with or without the standees - which can make a difference as far as levels of efficiency are concerned. For example, a heavy rail car may have 52 seats, but will have additional space for those willing to stand for the duration of their journey. The extra room improves the economies of scale.

The number of transit agencies with full reports were 15, down from 17, with partial or no reports. The total number of heavy or rapid rail cars were 11,623 railcars.[99] After adding the total number of available seats (9,297) and the total number of available standees (15,250) the final figure for the Aggregated Average Rapid Rail Vehicle Revenue Capacity (with standees) is 143.[100]

The Aggregated Average Vehicle Revenue Capacity (rapid railcar with standees) is calculated as follows:

$$\frac{\textit{Number of Active Rapid Rail Vehicles in Fleet} \times \textit{(Seating Capacity + Standing Capacity)}}{\textit{Total Number of Active Vehicles in Rapid Rail Fleet}} = 143$$

Equipped with the Average Rapid Rail Vehicle Revenue Capacity, the Level of Efficiency can be assessed. The Average Occupancy, in shown in Table B.19, is 19.5%. Similarly, it can be reasonably assumable that it too, like the bus, is inefficient when compared to the Level of Efficiency (LoE) of a TNC.[101] As a recapitulation, if the basic TNC vehicle holds four people, the LoE can be simply apportioned. Observe how one rider in a TNC has a higher LoE than a bus or commuter rail.

Table B.19 Level of Efficiency – Rapid Rail

Average Occupancy	28
Assumed Average Vehicle Revenue Capacity (standees)	143
Efficiency	19.5%

[99] This number was unchanged even after the deletions.
[100] The aggregated average number of seats for a commuter rail car is 142.7 rounded to the nearest whole number.
[101] The assumption, of course, is the TNC employed is a standard sedan with the volume of four passengers.

Table B.20 Average Subsidy per Passenger – Rapid Rail

Aggregated Total Expenses (in millions)	$14,403
Aggregated Fare Revenue (in millions)	$5,126
Subsidization for Rapid Rail Operations (in millions)	$9,277
Annual Unlinked Trips (in millions)	3,928
Average Subsidy per Passenger	$2.36

Collectively, Table B.20 gives the total subsidization for rapid rail mode on an industry-wide basis. The Average Subsidy per Passenger for rapid rail is $2.36. As will be evidently revealed accordingly, this is where it will become highly competitive with a TNC. Table B.21 gives the calculation for Average Vehicle Speed for Commuter Rail. The purpose for this is necessary in order to ascertain commuter rail fares, to compare, since TNC fares are commonly based upon distance and time. The basic formula for Speed is Distance divided by Time.

Table B.21 Average Vehicle Speed – Commuter Rail

Vehicle Revenue Miles	657
Vehicle Revenue Hours	33
Average Vehicle Speed	20 MPH

B.2.4 TNC

Ever since Uber became the first TNC to enter the New York City Metropolitan Area market, ten others followed subsequently. Table B.22 is a list of 11 TNCs that operate in New York City. From an original list of 12, Bandwagon is the only app to promulgate that it is not officially a TNC. It purposely seeks to distance itself from Uber by practicing to be an ethical law-abiding entity.

Table B.22 List of TNCs Operating in New York City

Blacklane	Curb	eRideshare	Gett
Juno	Lyft	Moovn	NexTaxi
Uber	Via	zTrip	

As a reprisal, if the TNC is to replace public transportation centering on the cost of subsidization, it would be extremely cost ineffective to patronize TNCs such as Blacklane. Blacklane, principally, is a high-end for-hire livery service. It offers three levels of service, the least expensive service is branded Business Class. When applying their fares to this O/D pair it ranges from $80-$94.20. The latter is subject to time of travel.

Curb, formerly known as RideCharge, Way2Ride and Taxi Magic, "…works only with professional taxi and for-hire drivers" *[5]*. This is opposed to TNCs like Uber and Lyft who unprofessional drivers or those pursuing part-time income and utilize their car on a personal basis. Its fare structure parallels metered taxis. Curb adds $1.95 as a standard "service fee" to cover some of their costs. Subject to the area served it sometimes charges an advanced reservation fee. Akin to Curb is NexTaxi. It also is not a TNC, *per se*, and is allied with professional taxicab companies. NexTaxi charges are based upon the prevailing taxi's rates.

Another organization that is misguidedly referred to as a TNC is eRideshare. It markets itself as a carpooling app. Membership is free, and is intended for personal use. If any compensation is exchanged it is directly between rider and driver – eRideshare does not collect nor charge fares.

Moovn, a newly developed TNC operates in New York City and worldwide. It can be found in some of the more dense areas of the United States like Atlanta, Boston, Chicago, San Francisco and Washington, District of Columbia. Distinctively, it does not publish its fare structure. As a result, it was not included in the comparative analysis. It is only being mentioned since it open to revenue service operation for this O/D.

Finally, zTrip, a lot like Blacklane, offers a higher end black car service to and from the New York City area airports. Because their prices are not published, it is assumed that its fares are

comparable. With the foregoing, the subsequent discussion and examination will orbit around the remaining five TNCs. Table B.23 outlines assumptions for the TNCs.

Table B.23 TNC Assumptions for This Origin/Destination

Trip Length (in miles)	4.3
TNC Vehicle Revenue Speed (in MPH)	11.7
TNC Average Fare	$5.22
TNC Trip Duration (in minutes)	22

Assumed is the TNC Trip Length is the same as if the passenger elected to ride transit as its mode choice. This can change of the driver diverts of the beaten path as a result of congestion or traffic enforcement.

The formula for Speed is Distance/Time. In Table 5.31, the journey is 4.3 miles with an approximate time of speed is 22 minutes. The result is 11.7 Miles per Hour. The TNC Average Fare ($5.22) for this jaunt is based upon the fares of UberPOOL ($5.00) and Via ($5.44). [102]

Table B.24 shows the framework for the basic fare structure of the TNC in NYC. When contrasted, Uber, Lyft and Juno are very indistinguishable.

Table B.24 Basic TNC Fare Framework for New York City

	Uber X	**Uber XL**	**Uber SUV**	**Uber BLACK**	**Uber WAV**	**Uber POOL***	**Lyft**	**Lyft Line***	**Lyft Plus**	**Lyft Premier**	**Juno BLISS**
Per Mile rate	$1.75	$2.85	$4.50	$3.75	$1.75		$1.75	$1.75	$1.15	$3.75	$1.75
Per Min rate	$0.35	$0.50	$0.80	$0.65	$0.35	$0.35	$0.35	$0.35	$0.50	$0.65	$0.35
Base Fare	$2.55	$3.85	$14.00	$7.00	$2.55	$2.55	$2.55	$2.55	$3.85	$7.00	$2.55
Min Total	$4.65	$7.20	$19.30	$11.40	$4.65		$4.65	$4.65	$5.50	$11.40	$4.65
Min Fare	$8.00	$10.50	$25.00	$15.00	$8.00	$5.00	$8.00	$8.00	$10.50	$10.50	$8.00

* UberPOOL provides riders with a transit-style fare.

In Table B.25, Uber, Lyft and Juno are amazingly competitive. Uber WAV, is the service for those that are wheelchair bound and need to be transported in this specially designated vehicle. Enticing is how Uber WAV fares are the same as the regular service. Gett and Via are deliberately not in Table B.25 since they do not publicly disclose their fares in detail.

[102] Lyft Line is a shared service where the passengers can divide the fare evenly. Gett also has a flat rate of $10 but has boundaries such as trip time and distance.

Table B.25 Total TNC Fares for GCT-125th Street Route

TOTAL TNC FARES	Distance	Time	Booking Fee	Base Fare	TOTAL FARE
UberX	$7.35	$7.04	$0	$2.55	$16.94
Uber XL	$11.97	$10.06	$0	$3.85	$25.88
Uber SUV	$18.90	$16.10	$0	$14.00	$49.00
UberBLACK	$17.63	$13.08	$0	$7.00	$37.70
UberWAV	$7.35	$7.04	$0	$2.55	$16.94
UberPOOL (shared ride option)		$7.04		$2.55	$9.59
UberPOOL (rush hours only)					$5.00
Lyft (4-seat vehicle)	$7.35	$7.04	$0	$2.55	$16.94
Lyft Line (shared 2 passengers max)	$7.35	$7.04	$0	$2.55	$16.94
Lyft Plus (6-seat vehicle)	$4.95	$10.11	$0	$3.85	$18.90
Lyft Premier	$15.75	$13.08	$0	$7.00	$35.83
Gett (Flat Rate- NYC < 1/2 hour & 4 miles)					$10.00
ViaPass (Unlimited MONTHLY Pass)					$255.00
ViaPass (Unlimited WEEKLY Pass)					$69.00
Via - Pre-purchased Rides					$5.44
Via - Pay-per-ride; No credit remaining					$7.00
Via - each additional rider					$3.00
Curb: Metered Fare	$17.70		$1.95	$2.50	$22.15
JunoBLISS	$7.35	$7.04		$2.55	$16.94

What's more, the spectrum in fares for this O/D is the difference between the types of vehicle a potential passenger prefers. That is, the more luxurious the vehicle, the higher the fare. And it also is dependent on the types of service. For if the rider opts for the commuter-type of service this is where one shall see a variance between paying the full fair versus the discounted rate. For example, if one decided upon UberPOOL, the "carpooling option", the fare is five dollars. If that same passenger were to select UberX, the regular service, instead the fare would amount to slightly under $17. Currently, Via offers an unlimited commutation pass based on weekly or monthly usage. Although these passes are coupled with restrictions they may or may not be advantageous to the purchaser - especially when comparing transit fares.[103] The transit fares are vastly different by more than 50%. Most likely the final decision would be based on such trade-

[103] Some restrictions include, but not limited to, brush hours only and within a very specifying geographic zone or boundary.

offs as the amenities each entity offers. For instance, persuading factors like a seat guarantee, reliability and convenience can sway someone making a final decision.

B.3 Subsidization

B.3.1 Bus

When applying the identically logical sequence as indicated in the previous section the same can be said of the bus mode as well. To recap, the TNC could offer a lucrative financial option for public transportation bureaus based upon the amount of subsidization.

Bus fares, contingent upon the transit agency's policy, can either be flat and/or distance-based. Some properties charge a nominal fee for transfers and may not have an interagency agreement whatsoever. The subsidization for the bus mode was already established in Table B.6. Presumed can be that a transit agency will negotiate with a TNC, or conceivably more than one, for a fare that is fair to all the stakeholders involved.

For now, assumed is the TNC collects its standard fare. In essence, TNCs operate regular revenue service and all passengers pay their existing rates. The up-to-date TNC rate, for this O/D pair, amounts to $17.60.[104] If the bus fare per passenger is $2.75 and the aggregated subsidy is $3.83 the total is $6.58 per passenger. Observably, this is 62.6% less than the regular TNC rate for the same route. If the TNC were to be subsidized, that amount would come to $12.38 for a single occupant. Yet, if two passengers it would be $3.58 per passenger or a total of $7.16 per trip, three would be $0.65 per passenger or $1.95 per trip, and if four, the TNC would see a surplus or profit of $0.82 per passenger or $3.28 per trip. Also assumed is two or more persons traveling pay their own way. i.e.; riders pay the average TNC fare of $5.22 individually.

[104] The TNCs in this case, Uber, Lyft and Juno all have the same fare basis. With the announcement at the end of April 2017 of the impending merger of Juno and Gett the assumption is, for the time being, that nothing will change without advanced notice or at all.

Figure B.1 shows the different amounts of subsidization applicable to the full TNC fare with corresponding percentages of average TNC passenger efficiency. Aggregately, at a 17.19% LoE, a bus would need to carry ~11 people steadily in order to be considered efficient. A single person in a TNC already provides the public with a higher LoE of 25%. Two persons in a TNC would be the equivalent of 32 or a 50% LoE, and so on. At 75% LoE, three constantly people in a TNC would be equal to 48 commuters by bus and the best consequence would be a fully loaded TNC which would require a bus to realize a crowded vehicle. Indubitably, the TNC offers a higher LoE and is quite competitive with buses which could be of great monetary savings.

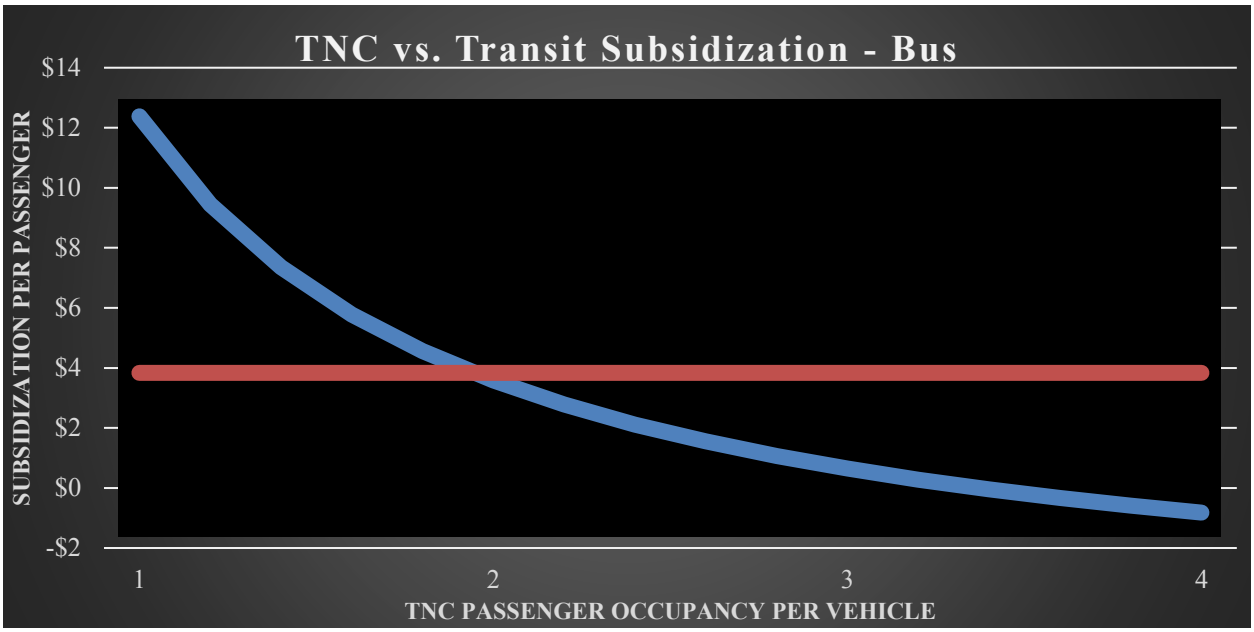

Figure B.1 TNC vs. Transit Subsidization – Bus

B.3.2 Commuter Rail

With the above calculations, the ensuing discussion can now focus on subsidization. Suffice it to say, commuter rail was mentioned, because it is another mode choice option for this O/D and commuter rail vehicles, intrinsically, have a capacity capability that a TNC cannot match.

Commuter rail fares are distance-based unlike TNCs fares which are founded on time and distance. The subsidization for this mode was already established in Table B.12. Presumed can be

that the transit agency will negotiate with a TNC, or more than one perhaps, for a fare that is fair to all the stakeholders involved. This approach can potentially lead to a revenue surplus.

Momentarily assumed is a non-negotiated fare. In other words, TNCs operate normal revenue service and all passengers pay their present-day rates. The current TNC rate, for this trip, amounts to $17.60.[105] If the rail fare is $8.00 and the nationally aggregated subsidy is $11.72, this totals to $19.78, which is higher than the TNC rate. But if it were to subsidize the TNC, for a single occupant, that amount would come to $12.38. Yet, if two passengers were to be subsidized it would be $3.58 or a total of $7.16 per trip, three would be $0.65 or $1.95 per trip, and if four, the TNC would see a surplus or profit of $0.82 per passenger or $3.28 per trip. Also anticipated is when there are multiple occupiers each passenger pays their own individual average TNC fare of $5.22. A compelling argument can be made that it would be economic sense where two people are traveling via TNCs, since the savings in subsidization would be slightly under 40%.

Consequently, a surplus would be extremely beneficial to the transit agency since every dollar of said surplus received by the TNC reduces the dependency on financial support and decreases the taxpayers' burden. Public transportation, as a whole, has struggled with existing and/or attempting to develop the establishment of new dedicated funding sources. Commonly, because it is taxpayer dollars being sought some people do not welcome any increases to what many consider an already cumbrous tax liability. Moreover, there are members of the public that believe their hard-earned funds are being misspent, wasted and squandered. Therefore, the question of how well are transit agencies maximizing their funds or what degree of efficiency is the cost benefit. Because these resources are funded primarily by the taxes, rest-assured the public

[105] The TNCs in this case, Uber, Lyft and Juno, all have the same fare basis. With the announcement at the end of April 2017 of the impending merger of Juno and Gett the assumption is, for the time being, that nothing will change without advanced notice or at all.

wants the percentage or level of efficiency (LoE) which must be contemplated, too. The latter was measured already in Table B.11.

Efficiency means, under this context, what is the return on investing into equipment involving capital dollars. In other words, are the railcars or buses adequately sized for what is being acquired on behalf of the capacity of customers transported from place to place? Would it be much more economical for the property to purchase transportation as opposed to directly operating? In this scenario, if the LoE is 17.3%; is transit making the most of its equipment/ROI?

Figure B.2 shows the different amounts of subsidization applicable to the full TNC fare with corresponding percentages of efficiency. Aggregately, at a 17.28% LoE, a railcar would need to carry ~34 people consistently in order to be considered efficient. A single person in a TNC already provides the public with a minimum 25% LoE. Two persons in a TNC would be the equivalent of ~99 or a 50% LoE, and so on. At 75% LoE, three constantly people in a TNC would be equal to 149 commuters by rail and the perfect consequence would be a fully loaded TNC which would require a railcar to achieve the equivalency of SRO status. Unmistakably, the TNC offers a higher LoE and could be of great financial savings to the commuter rail agency.

B.3.3 Rapid Rail or Subway

When examining the previous modes in contrast, the rapid rail or subway is most imperative. It is a quick form of public transportation, predominantly cheap and can simultaneously move volumes of people. Central is how competitive it is when compared to the TNC. Subway fares are flat rate and/or distance-based tariff, conditional upon the rules and regulations of the property in question. Some transit agencies charge a nominal fee for transfers and may not have an interagency agreement of any kind. The subsidization for the rapid rail or

subway mode can be found in Table B.20. Presumed is that a transit agency will settle with a TNC, or conceivably more than one, for a fare that is fair to all the stakeholders involved.

The same approach in the Bus Mode segment can be implemented to rapid rail or subways. To reaffirm, supposedly the TNC fees are standard and all passengers pay the TNCs existing rates. The latest TNC rate, for this excursion, amounts to $17.60.[106] The present-day subway fare is $2.75 and the aggregated subsidy is $2.36, the total is $5.11 per passenger in rapid rail mode. Observably, this is 71% less than the regular TNC rate for the same route. But if the TNC were to be subsidized, that amount would come to $12.38 for a single occupant. On the other hand, two passengers would be subsidized at $3.58 per passenger or a total of $7.16 per trip, three would be $0.65 per passenger or $1.95 per trip, and if four, the TNC would see a surplus or profit of $0.82 per passenger or $3.28 per trip. If two or more people trek together, each pay the average TNC fare of $5.22, respectively.

Figure B.3 shows the different amounts of subsidization applicable to the full TNC fare with corresponding percentages of efficiency. Table B.19 establishes LoE for rapid rail. Aggregately, at a 19.51% LoE, a rapid railcar would require ~29 individuals, sturdily, to be marginally efficient. A single person in a TNC already provides the public with a higher LoE of 25%. Two persons in a TNC would be the equivalent of 50% LoE or 72 passengers and so on. At 75% LoE, three people in a TNC would be equal to 107 customers by subway and the best consequence would be a fully loaded TNC which would require a subway car hold 143 people.

When juxtaposed, the TNC naturally provides a higher LoE and is exceptionally competitive with the subway from a monetary viewpoint and due to its flexibility since it is unrestricted to a fixed guideway.

[106] The TNCs in this case, Uber, Lyft and Juno, all have the same fare basis. With the announcement at the end of April 2017 of the impending merger of Juno and Gett the assumption is, for the time being, that nothing will change without advanced notice, if at all.

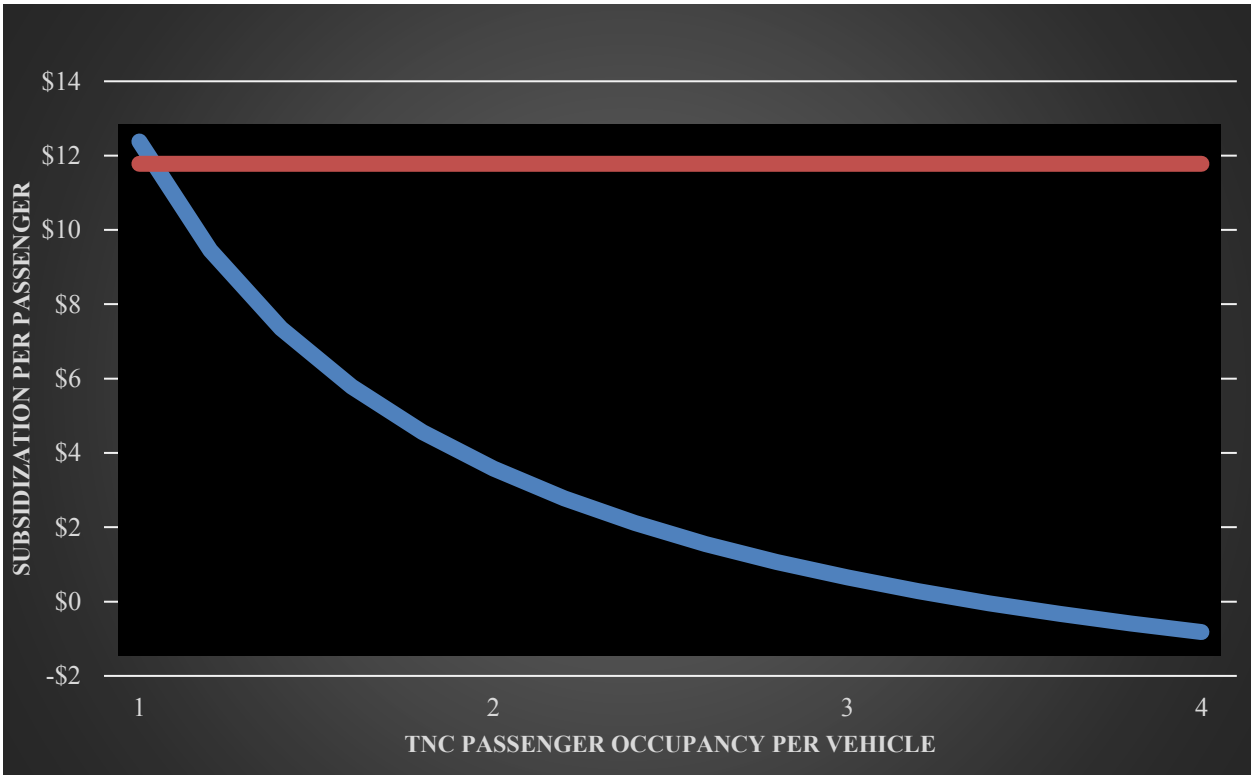

Figure B.2 TNC vs. Transit Subsidization – Commuter Rail

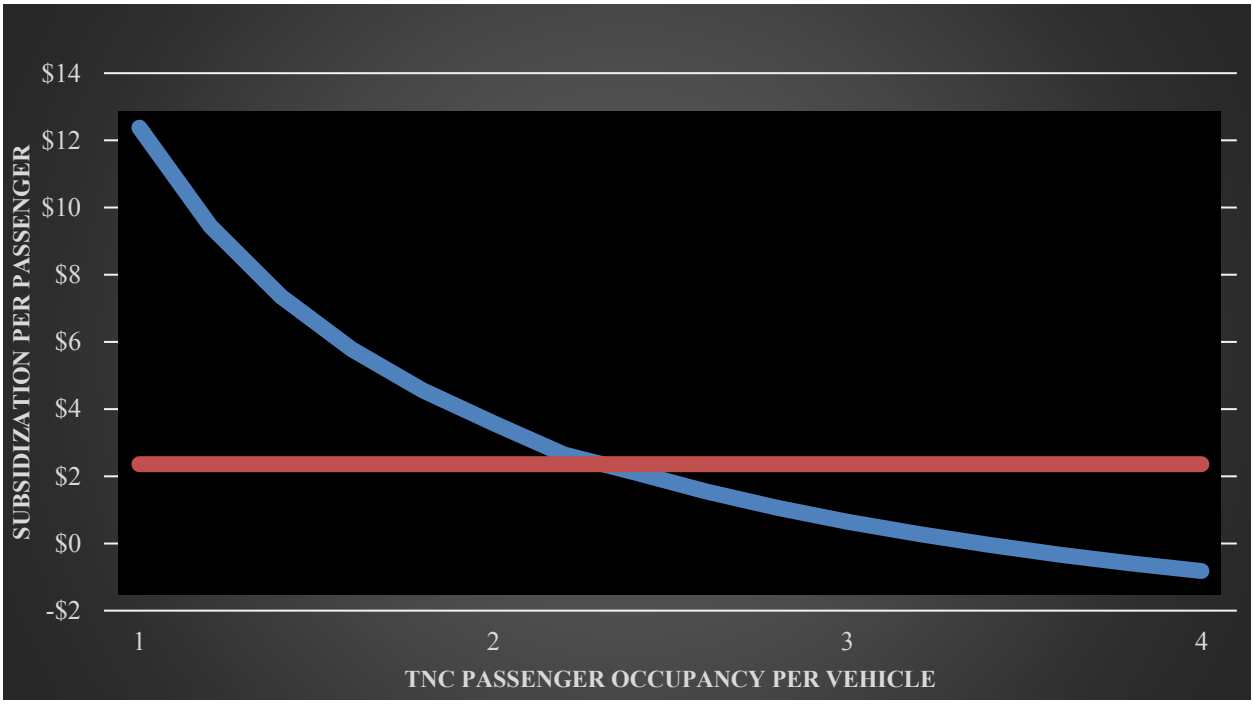

Figure B.3 Subsidization of TNCs vs. Subway Mode

B.3.4 Overall

On the whole, it would appear that TNCs could supplant either the bus or subway. Table B.26 gives an overall view at the NYCT general expenses and subsidy for both modes when combined. From the data, the TNC might replace both modes for this agency.

Table B.26 Combined Subsidization of NYCT Heavy Rail and Bus

NYCT	Bus	Subway	Combined
Operating Expenses (OE)	$2,892,642,241	$5,022,082,486	$7,914,724,727
Fare Revenues	949,897,633	$3,171,793,085	4,121,690,718
Total Operating Loss	(1,942,744,608)	(1,850,289,401)	(3,793,034,009)
Annual Unlinked Trips	795,718,057	2,743,004,452	3,538,722,509
Subsidization	$(2.44)	$(0.67)	$(1.07)
OE per Vehicle Revenue Hour	$804.73	265.17	$1,069.90

Source: NTD 2014 Transit Agency Profile

Utilizing the comparative analysis utilized earlier, based upon subsidization alone, at $1.07 plus NYCT's subway and bus flat rate fare of $2.75, the total fare would be $3.82. This is 79% less than the current TNC fare. It would take exactly 2.8 people to travel simultaneously for the exact same subsidy. If three people were to consistently fill the TNC, the subsidy amounts to $0.65 per passenger or $1.95 per trip, whereas a fully occupied vehicle would cost nothing since the TNC would earn a profit of $0.82 per passenger or $3.28 per trip.

APPENDIX C: CONGESTION METRICS FOR AUSTIN

Below are over a dozen illustrations that provide a quantitative picture of some items such as the population growth, number of commuters, average daily vehicle miles on the freeways and arterials of Austin and the amount of time Austinites may be delayed in congestion. In addition to their primary focus on Austin, the time frame is from 1982 until 2014. Conclusively, all the graphs indicate increases over thirty-two years in everything from financial costs to costs in time.

As Austin keeps growing, the trend reveals that there is no slowing down nor decrease anytime soon. That being said, unless Austin's transportation planners embrace serious long-term solutions for the creation of supply to meet the demand costs will only continue to increase.

Austin is described as a Large Average Urban Area by the Texas Transportation Institute. Figure C.1 compares congestion in Austin to its peer cities as well as on the national level.

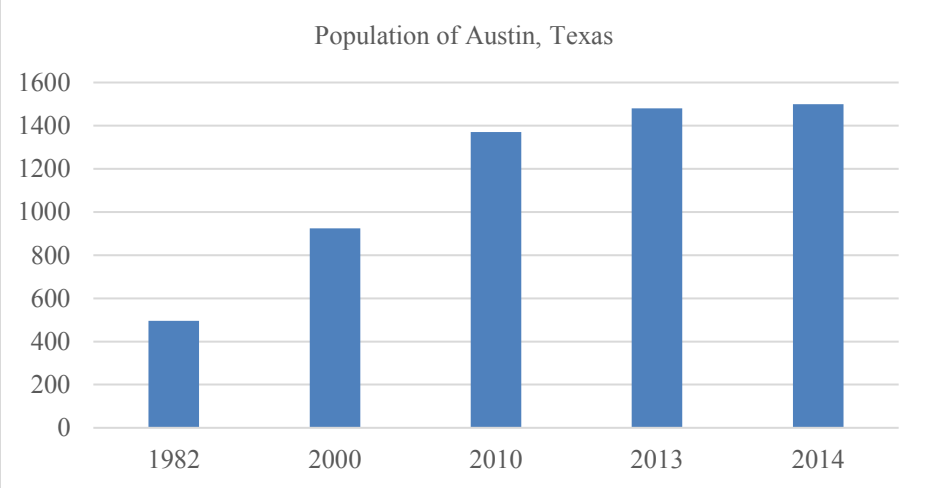

Figure C.1 Population of Austin, Texas 1982-2014

Source: Urban Mobility Scorecard, 2015

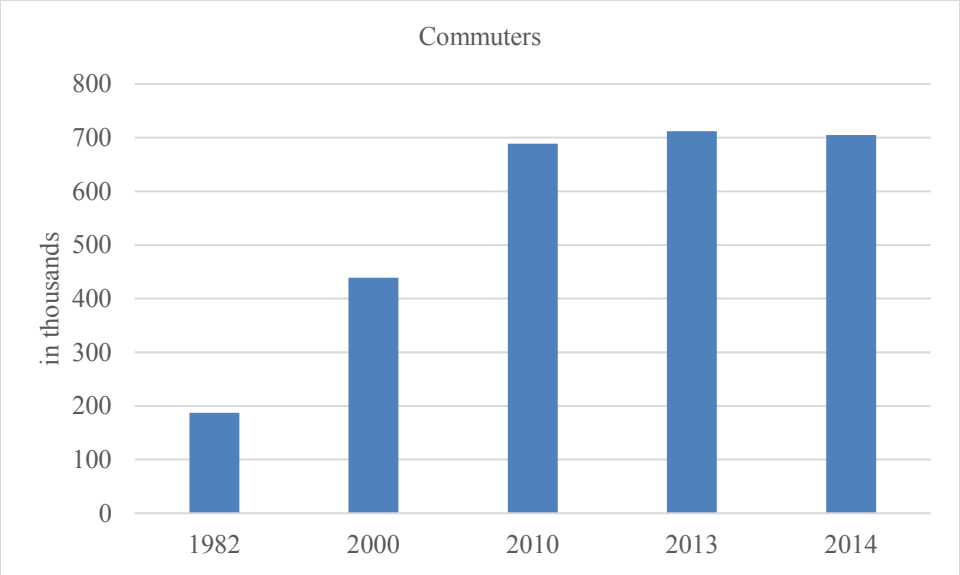

Figure C.2 Number of Commuters in Austin, Texas 1982-2014

Source: Urban Mobility Scorecard, 2015

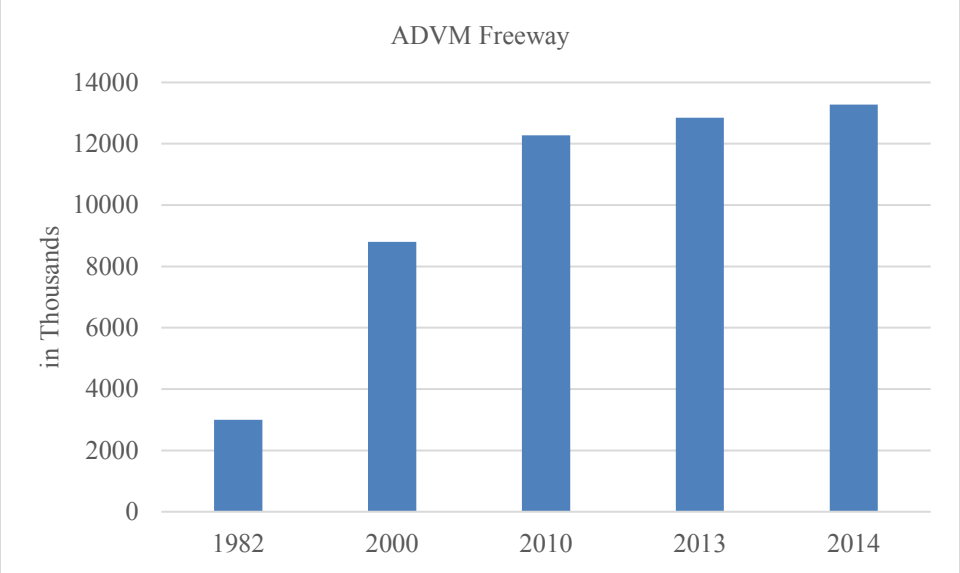

Figure C.3 Average Daily Vehicle Miles - Austin's Freeways 1982-2014

Source: Urban Mobility Scorecard, 2015

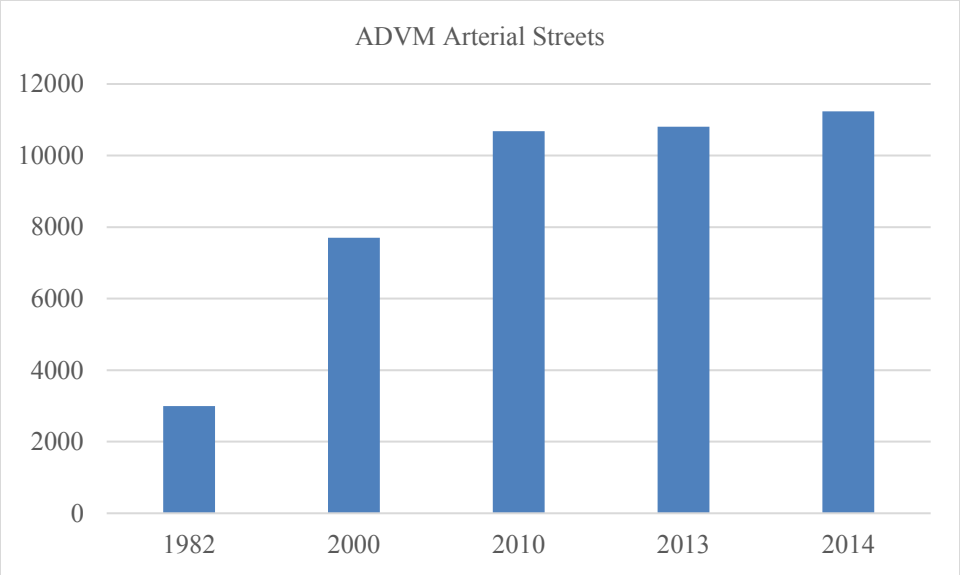

Figure C.4 Average Daily Vehicle Miles - Austin's Arterials 1982-2014

Source: Urban Mobility Scorecard, 2015

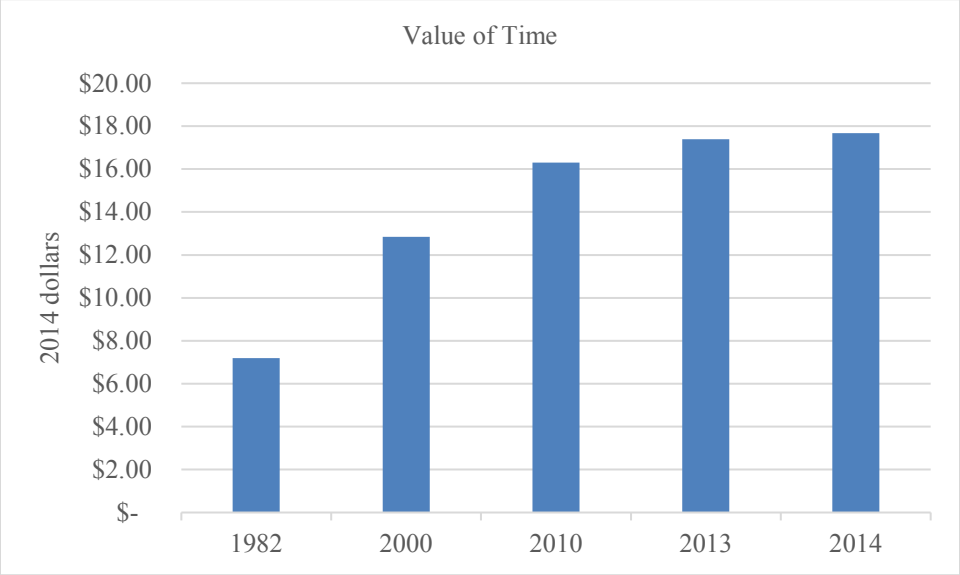

Figure C.5 The Value of Austinites Time – 1982-2014

Source: Urban Mobility Scorecard, 2015

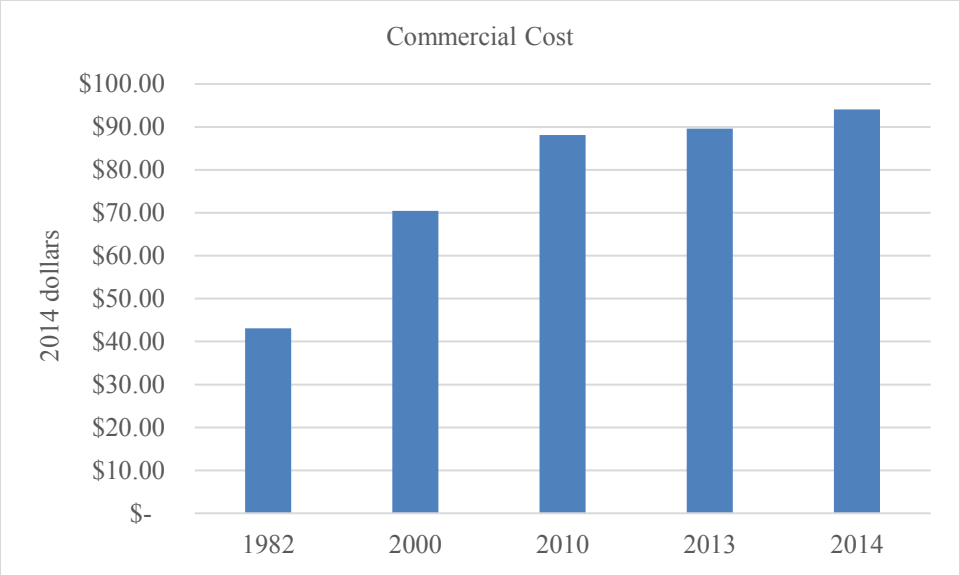

Figure C.6 Commercial Cost to Austinites - 1982-2014

Source: Urban Mobility Scorecard, 2015

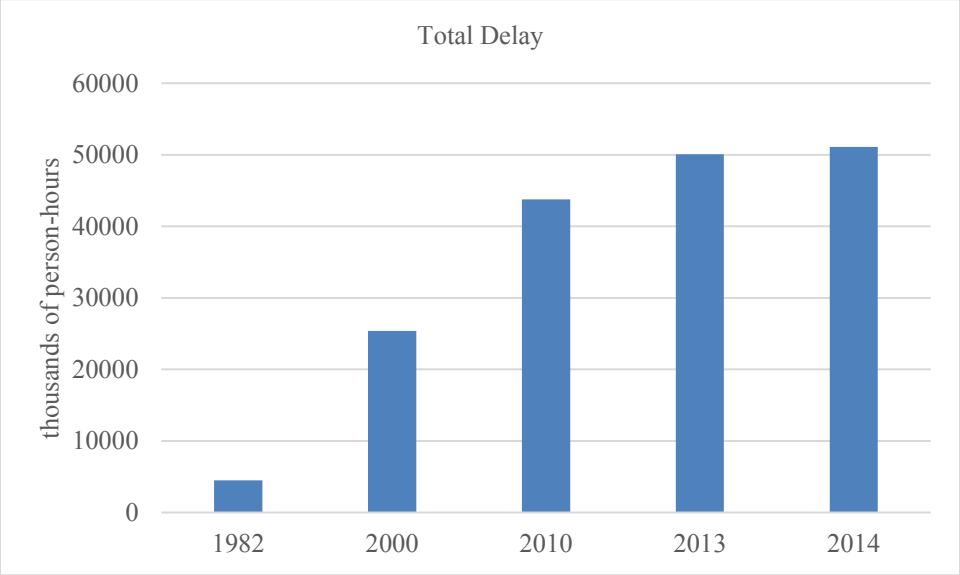

Figure C.7 Total Delay to Austinites in Terms of Time

Source: Urban Mobility Scorecard, 2015

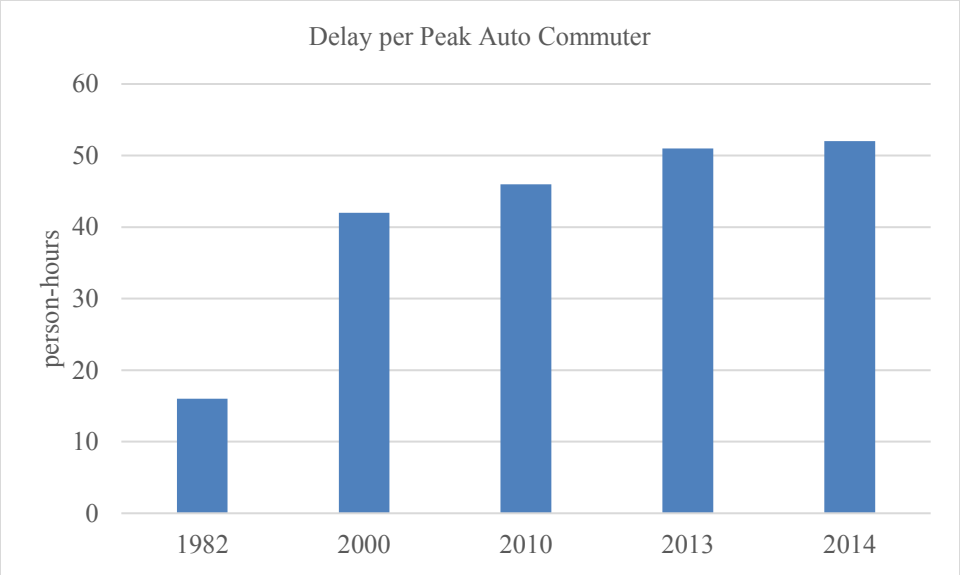

Figure C.8 Delay per Peak Austin Auto Commuter in Person-Hours

Source: Urban Mobility Scorecard, 2015

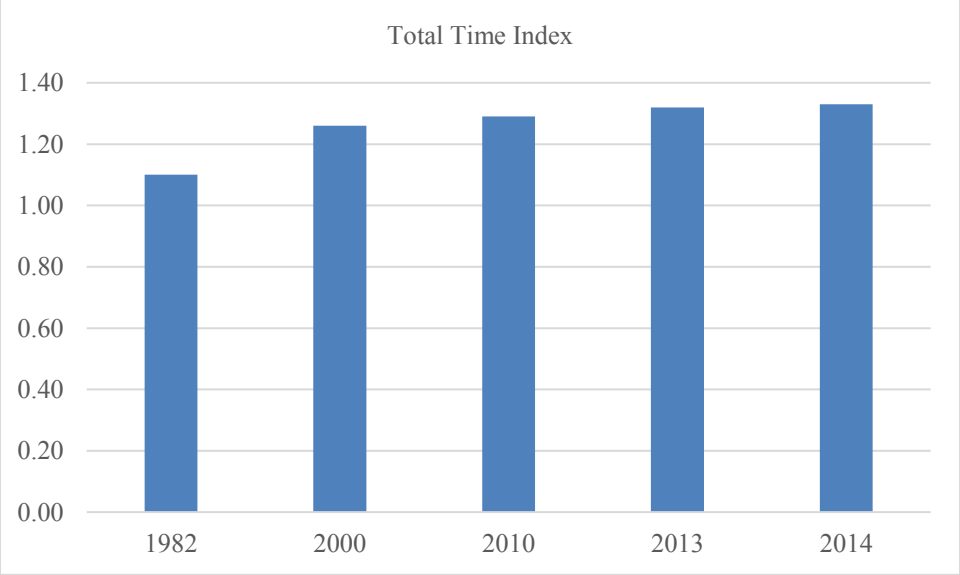

Figure C.9 Total Time Index - Austin, Texas - 1982-2014

Source: Urban Mobility Scorecard, 2015

Figure C.10 Commuter Stress Index for Austin, Texas - 1982-2014

Source: Urban Mobility Scorecard, 2015

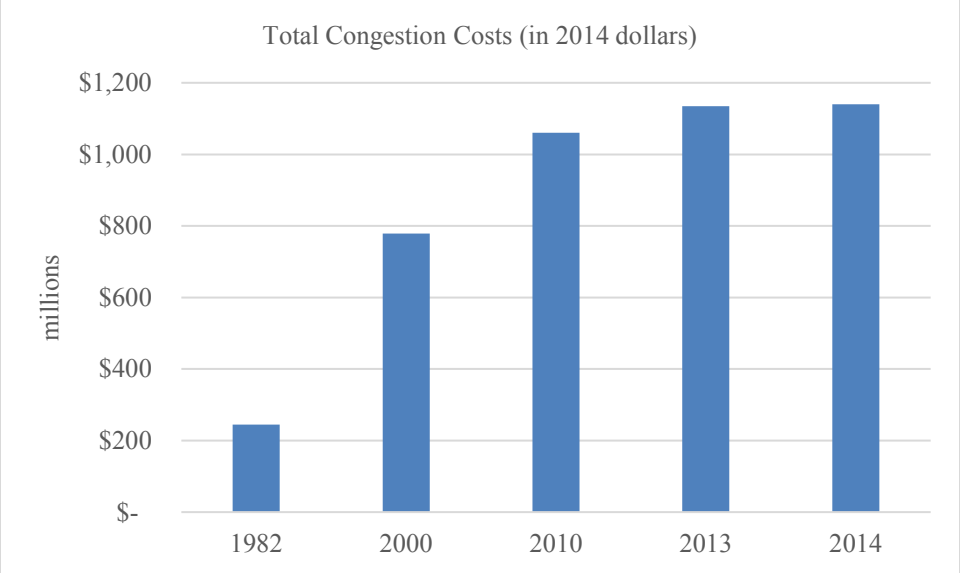

Figure C.11 Total Congestion Costs for Austin, Texas - 1982-2014

Source: Urban Mobility Scorecard, 2015

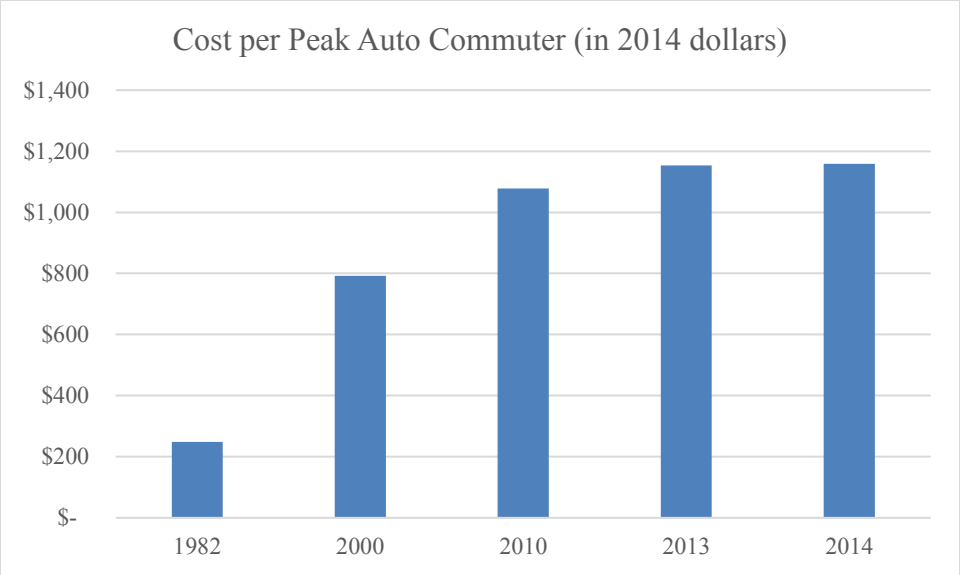

Figure C.12 Cost per Austin Peak Auto Commuter – 1982-2014

Source: Urban Mobility Scorecard, 2015

Table C.1 Comparison of Austin to Peer-to-Peer City and Nationally

Congestion Metrics	National Averages	Large Average Urban Area	Austin
Yearly Delay per Auto Commuter (Hours)	42	45	52
Travel Time Index	1.22	1.23	1.33
Excess Fuel per Auto Commuter (Gallons)	19	21	22
Congestion Cost per Auto Commuter (2014 $)	$960	$1,045	$1,159
Travel Delay (000's Hours)	14,710	55,390	51,116
Excess Fuel Consumed (000's gallons)	6,610	25,690	21,654
Truck Congestion Cost (2014 $ million)	$60	$235	$182
Total Congestion Cost (2014 $ million)	$340	$1,280	$1,140

Source: Urban Mobility Scorecard, 2015

APPENDIX D: GLOSSARY

API - Application Program Interface

App (application) – Within this context, it is specialized software engineered for an explicit purpose on an individual's smartphone. The term smartphone is also, at times, interchanged with the term cell phone.

APTA – American Public Transportation Association

AV (Autonomous vehicle) – A vehicle capable of sensing its environment and navigating without human input *[22]*.

ETA – Estimated Time of Arrival

Fixed Costs – Expenditures that shall occur regardless of whether income is or is not produced. Within this context, examples are labor and fuel. e.g., a bus or railroad in revenue service operation during the wee early morning hours may have very few or no passengers. Regardless, the crew will be paid and the power consumed to propel the equipment will need to purchased and paid for.

F/L – First Mile/Last Mile. A passenger lives and/or works nowhere near their closest transit stop or station.

FTA – Federal Transit Administration

GRH – Guaranteed Ride Home Program

GPS (Global Position System) –A navigational system using satellite signals to fix the location of a radio receiver on or above the earth's surface.

LoE – Level of Efficiency

LoS – Level or Levels of Service

Load Factor – A load factor, or rate of occupancy, is a ratio of passenger miles to vehicle revenue miles. In other words, how many people are carried on a bus.

New Housing Start – New home construction.

NOETS (New Online-Enabled Transportation Services) – Original classification before the term TNC was conferred by the State of California's Public Utility Commission.

NTD – National Transit Database

O/D – Origin/Destination

Peer-to-Peer – an informal system or non-commercial framework where individuals and/or entities that own underutilized products, goods or services are induced to share with others through bartering and/or a nominal fee.

Property – a term that is interchangeably used with transit agency.

Reporter – A transit agency that is required to file certain vital statistical data in the National Transit Database pursuant to 49 U.S.C §5335.

Slugging – Formed by bus drivers, its etiology is from the word "slug" or faux currency. Those coins are called slugs. Bus drivers would often see passengers waiting at bus stops only to be waiting for cars. Also known as phony or fake passengers.

SRO – Standing Room Only

TA – Transit agency

TCRP – Transit Cooperative Research Program

TNC (Transportation Network Company) – Legal classification for commercial enterprises such as Uber, Lyft, etc. Categorized by the State of California, through Assembly Bill No. 2293.

It subsequently became law with the effective date of July 1, 2015. A supplementary explanation can be found within the section that discusses the criteria for TNC determination.

Variable Costs – Expenditures that shall incur based upon differed levels of need. Within this context an example would be labor overtime.

3P – Public-Private Partnership

APPENDIX E: LIST OF SUPPLANTABLE TRANSIT AGENCIES

Previously discussed in Chapter 5**,** was how a substantial list of potential TAs suitable for replacement was determined. The calculation for suitability was based upon the load factor for TAs, nationally. In 2015, the computation was determined by NTD to be 10.10. At the time this paper was in its genesis, the NTD data indicated the load factor to be 11.08.[107] While a difference of one passenger may seem paltry, take into account that it is the average national figure. An observation of the national ridership figure declining by a single digit is still suggestive. Below are 397 TAs with a load factor equal to or less than the current amount of 10.10.

Table E.1 List of Possible Transit Agencies for Replacement

Agency Name	Mode	Service	Load Factor
Alameda-Contra Costa Transit District	MB	DO	10.1
Delaware Transit Corporation	MB	DO	10.0
Regional Transit Service, Inc. and Lift Line, Inc.	MB	DO	10.0
Lexington Transit Authority	MB	DO	9.9
Hillsborough Area Regional Transit Authority	MB	DO	9.9
Metro Transit System	MB	DO	9.9
The Eastern Contra Costa Transit Authority	MB	PT	9.8
Unitrans - City of Davis/ASUCD	MB	DO	9.8
Greater Roanoke Transit Company	MB	DO	9.8
City of Brownsville - Brownsville Metro	MB	DO	9.7
Board of County Commissioners, Palm Beach County, PalmTran, Inc.	MB	DO	9.6
Pace - Suburban Bus Division	MB	DO	9.6
Prince George's County Transit	MB	PT	9.6
CNY Centro, Inc.	MB	DO	9.6
Southeastern Regional Transit Authority	MB	PT	9.5
Indian River County	MB	PT	9.5
Rhode Island Public Transit Authority	MB	DO	9.5
Alameda-Contra Costa Transit District	MB	PT	9.4
San Mateo County Transit District	MB	DO	9.4
Centro of Cayuga, Inc.	MB	DO	9.4
Metropolitan Transit Authority of Harris County, Texas	MB	DO	9.2
Riverside Transit Agency	MB	DO	9.2

[107] NTD data was for 2015 and 2014, respectively.

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
Municipality of Anchorage - Public Transportation Department	MB	DO	9.2
Niagara Frontier Transportation Authority	MB	DO	9.2
LACMTA - Small Operators	MB	PT	9.1
Greater Lynchburg Transit Company	MB	DO	9.1
Foothill Transit	MB	PT	9.0
Torrance Transit System	MB	DO	9.0
Charlotte Area Transit System	MB	DO	9.0
San Joaquin Regional Transit District	MB	DO	9.0
Blacksburg Transit	MB	DO	8.8
Lane Transit District	MB	PT	8.8
Williamsburg Area Transit Authority	MB	DO	8.7
University of Iowa	MB	DO	8.7
Pierce County Transportation Benefit Area Authority	MB	DO	8.6
Suburban Mobility Authority for Regional Transportation	MB	DO	8.5
Westmoreland County Transit Authority	MB	PT	8.5
Clark County Public Transportation Benefit Area Authority	MB	DO	8.5
University of Georgia Transit System	MB	DO	8.5
Regional Transportation Commission of Washoe County	MB	PT	8.5
Sacramento Regional Transit District	MB	DO	8.5
Lehigh and Northampton Transportation Authority	MB	DO	8.5
City of Phoenix Public Transit Department dba Valley Metro	MB	PT	8.4
City of Corvallis	MB	PT	8.4
Spokane Transit Authority	MB	DO	8.4
Pioneer Valley Transit Authority	MB	PT	8.4
Yolo County Transportation District	MB	PT	8.4
City of Washington	MB	PT	8.3
Ames Transit Agency dba CyRide	MB	DO	8.3
Ann Arbor Area Transportation Authority	MB	DO	8.3
San Diego Metropolitan Transit System	MB	PT	8.3
Capital Area Transit	MB	DO	8.3
Champaign-Urbana Mass Transit District	MB	DO	8.3
Transport of Rockland	MB	PT	8.2
San Mateo County Transit District	MB	PT	8.2
Jacksonville Transportation Authority	MB	DO	8.2
Sioux City Transit System	MB	DO	8.2
Milwaukee County Transit System	MB	DO	8.2
Northern Arizona Intergovernmental Public Transportation Authority	MB	DO	8.1
Santa Clara Valley Transportation Authority	MB	PT	8.1
Research Triangle Regional Public Transportation Authority	MB	DO	8.1
Space Coast Area Transit	MB	DO	8.1
Durham Area Transit Authority	MB	PT	8.1
City of Gardena Transportation Department	MB	DO	8.1
Connecticut Department of Transportation - CTTRANSIT Stamford Division	MB	DO	8.1
River Valley Metro Mass Transit District	MB	PT	8.0
City of San Luis Obispo	MB	PT	8.0
Charleston Area Regional Transportation Authority	MB	PT	8.0

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
Bi-State Development Agency of the Missouri-Illinois Metropolitan District, d.b.a.(St. Louis) Metro	MB	DO	8.0
Greensboro Transit Authority	MB	PT	8.0
Omnitrans	MB	DO	8.0
Monterey-Salinas Transit	MB	DO	8.0
City of Harrisonburg Department of Public Transportation	MB	DO	7.9
Connecticut Department of Transportation - CTTRANSIT New Haven Division	MB	DO	7.9
Metropolitan Transit Authority	MB	DO	7.9
Whatcom Transportation Authority	MB	DO	7.9
Transit Authority of River City	MB	DO	7.8
Des Moines Area Regional Transit Authority	MB	DO	7.8
Merrimack Valley Regional Transit Authority	MB	PT	7.8
Connecticut Department of Transportation - CTTRANSIT - CapMetroford Division	MB	DO	7.7
Capital District Transportation Authority	MB	DO	7.7
Ride-On Montgomery County Transit	MB	DO	7.7
Cache Valley Transit District	MB	DO	7.7
City of Albuquerque Transit Department	MB	DO	7.7
Gold Coast Transit	MB	DO	7.7
Blue Water Area Transportation Commission	MB	DO	7.6
VIA Metropolitan Transit	MB	DO	7.6
Gainesville Regional Transit System	MB	DO	7.6
Council on Aging of St. Lucie, Inc.	MB	DO	7.5
Howard Transit	MB	PT	7.5
Memphis Area Transit Authority	MB	DO	7.5
New York City Department of Transportation	MB	PT	7.5
Butte County Association of Governments	MB	PT	7.5
Fresno Area Express	MB	DO	7.5
Duluth Transit Authority	MB	DO	7.5
Kitsap Transit	MB	DO	7.4
Greater Portland Transit District	MB	DO	7.4
Williamsport Bureau of Transportation	MB	DO	7.4
Pinellas Suncoast Transit Authority	MB	DO	7.4
Bloomington Public Transportation Corporation	MB	DO	7.3
Denver Regional Transportation District	MB	PT	7.3
Jefferson Parish Department of Transit Administration	MB	PT	7.3
Mountain Metropolitan Transit	MB	PT	7.3
Link Transit	MB	DO	7.3
Pinellas Suncoast Transit Authority	MB	PT	7.2
Stark Area Regional Transit Authority	MB	DO	7.2
Greater Lafayette Public Transportation Corporation	MB	DO	7.2
Interurban Transit Partnership	MB	DO	7.1
Connecticut Department of Transportation -CTTRANSIT New Britain	MB	PT	7.1
Metropolitan Council	MB	PT	7.1
Johnson County Kansas, aka: Johnson County Transit	MB	PT	7.1
Montebello Bus Lines	MB	PT	7.1
Connecticut Department of Transportation- CT Transit Waterbury- NET	MB	PT	7.0

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
Kansas City Area Transportation Authority	MB	DO	7.0
North Carolina State University Transportation Department	MB	PT	7.0
New Orleans Regional Transit Authority	MB	PT	7.0
Chapel Hill Transit	MB	DO	7.0
Metropolitan Transit Authority of Harris County, Texas	MB	PT	7.0
Redding Area Bus Authority	MB	PT	7.0
Greater Richmond Transit Company	MB	DO	6.9
City of Commerce Municipal Bus Lines	MB	DO	6.9
North County Transit District	MB	PT	6.8
Sonoma County Transit	MB	PT	6.8
New Jersey Transit Corporation	MB	PT	6.8
Muncie Indiana Transit System	MB	DO	6.8
Worcester Regional Transit Authority	MB	DO	6.8
Lakeland Area Mass Transit District	MB	DO	6.7
Shreveport Area Transit System	MB	DO	6.7
Greater Dayton Regional Transit Authority	MB	DO	6.7
Regional Public Transportation Authority, dba: Valley Metro	MB	PT	6.7
City of Santa Rosa	MB	DO	6.7
Polk County Transit Services Division - Polk County Board of County Commissioners	MB	DO	6.7
Cedar Rapids Transit	MB	DO	6.6
Tompkins Consolidated Area Transit	MB	DO	6.6
Laguna Beach Municipal Transit	MB	DO	6.6
Broome County Department of Public Transportation	MB	DO	6.5
Transit Authority of Northern Kentucky	MB	DO	6.5
City of Fairfax CUE Bus	MB	DO	6.5
Clermont Transportation Connection	MB	DO	6.5
Utah Transit Authority	MB	DO	6.5
Everett Transit	MB	DO	6.5
Modesto Area Express	MB	PT	6.5
City of Los Angeles Department of Transportation	MB	PT	6.5
Lee County Transit	MB	DO	6.5
Topeka Metropolitan Transit Authority	MB	DO	6.5
Cobb County Department of Transportation Authority	MB	PT	6.4
Kings County Area Public Transit Agency	MB	PT	6.4
Intercity Transit	MB	DO	6.4
Alternativa de Transporte Integrado -ATI	MB	PT	6.4
Gwinnett County Board of Commissioners	MB	PT	6.4
Pace - Suburban Bus Division	MB	PT	6.4
Broward County Community Bus Service	MB	PT	6.3
Transportation District Commission of Hampton Roads	MB	DO	6.3
Erie Metropolitan Transit Authority	MB	DO	6.3
Central Contra Costa Transit Authority	MB	DO	6.3
Central Ohio Transit Authority	MB	DO	6.3
Western Contra Costa Transit Authority	MB	PT	6.3
Snohomish County Public Transportation Benefit Area Corporation	MB	DO	6.3
The Tri-County Council for the Lower Eastern Shore of Maryland	MB	DO	6.3

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
Escambia County Area Transit	MB	PT	6.3
Chittenden County Transportation Authority	MB	DO	6.2
Waco Transit System, Inc.	MB	DO	6.2
Southeast Area Transit	MB	DO	6.2
Corpus Christi Regional Transportation Authority	MB	DO	6.2
Fayetteville Area System of Transit	MB	DO	6.2
Santa Clarita Transit	MB	PT	6.2
City Utilities of Springfield	MB	DO	6.2
Athens Transit System	MB	DO	6.2
Birmingham-Jefferson County Transit Authority	MB	DO	6.1
Marin County Transit District	MB	PT	6.1
Cape Cod Regional Transit Authority	MB	PT	6.1
Collier Area Transit	MB	PT	6.1
City of Fargo, DBA: Metropolitan Area Transit	MB	PT	6.1
Yakima Transit	MB	DO	6.1
University Of New Hampshire - University Transportation Services	MB	DO	6.0
Mid Mon Valley Transit Authority	MB	PT	6.0
Central Oklahoma Transportation and Parking Authority	MB	DO	6.0
Metropolitan Tulsa Transit Authority	MB	DO	6.0
St. Cloud Metropolitan Transit Commission	MB	DO	6.0
Norwalk Transit District	MB	DO	6.0
Housatonic Area Regional Transit	MB	DO	6.0
Kalamazoo Metro Transit System	MB	DO	5.9
Central Arkansas Transit Authority	MB	DO	5.9
Rockford Mass Transit District	MB	DO	5.9
Red Rose Transit Authority	MB	DO	5.9
City of Huntsville, Alabama - Public Transportation Division	MB	DO	5.9
Middletown Transit District	MB	DO	5.9
Bloomington-Normal Public Transit System	MB	DO	5.8
Dallas Area Rapid Transit	MB	DO	5.8
Albany Transit System	MB	DO	5.8
Berks Area Regional Transportation Authority	MB	DO	5.8
Napa Valley Transportation Authority	MB	PT	5.8
Kanawha Valley Regional Transportation Authority	MB	DO	5.8
Norwalk Transit System	MB	DO	5.8
The Wave Transit System	MB	DO	5.8
Yuma County Intergovernmental Public Transportation Authority	MB	PT	5.8
Laredo Transit Management, Inc.	MB	DO	5.8
Indianapolis and Marion County Public Transportation	MB	DO	5.8
Transfort	MB	DO	5.8
Cooperative Alliance for Seacoast Transportation	MB	DO	5.8
Connecticut Department of Transportation – CT Transit New Britain -Dattco.	MB	PT	5.7
Iowa City Transit	MB	DO	5.7
Broward County Transit Division	MB	PT	5.7
City of Columbia	MB	DO	5.7
Fort Worth Transportation Authority	MB	DO	5.6

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
Salem Area Mass Transit District	MB	DO	5.6
MS Coast Transportation Authority	MB	DO	5.6
Metropolitan Evansville Transit System	MB	DO	5.6
Milford Transit District	MB	DO	5.6
Minnesota Valley Transit Authority	MB	PT	5.6
Orange County Transportation Authority	MB	PT	5.5
City of Tallahassee	MB	DO	5.5
City of Alexandria	MB	DO	5.5
Yuba-Sutter Transit Authority	MB	PT	5.5
City of Rochester Public Transportation	MB	PT	5.5
Butler County Regional Transit Authority	MB	DO	5.5
Wichita Transit	MB	DO	5.4
Santa Fe Trails - City of Santa Fe	MB	DO	5.4
Manatee County Area Transit	MB	DO	5.4
Fairfax Connector Bus System	MB	PT	5.3
Santa Maria Area Transit	MB	PT	5.3
Lafayette Transit System	MB	PT	5.3
County of Volusia, dba: VOTRAN	MB	DO	5.3
Pueblo Transit System	MB	DO	5.2
Transit Services of Frederick County	MB	DO	5.2
Su Tran LLC dba: Sioux Area Metro	MB	DO	5.2
GO Transit	MB	DO	5.2
Golden Empire Transit District	MB	DO	5.2
South Florida Regional Transportation Authority	MB	PT	5.2
Massachusetts Bay Transportation Authority	MB	PT	5.2
City of Lawrence	MB	PT	5.1
Ben Franklin Transit	MB	DO	5.1
Nashua Transit System	MB	PT	5.1
River Cities Transit	MB	DO	5.1
Lowell Regional Transit Authority	MB	PT	5.1
Hill Country Transit District	MB	DO	5.0
The Tri-State Transit Authority	MB	DO	5.0
City of Visalia - Visalia City Coach	MB	PT	5.0
DDOT - Progressive Transportation Services Administration	MB	PT	5.0
Winston-Salem Transit Authority - Trans-Aid of Forsyth County	MB	DO	5.0
METRO Regional Transit Authority	MB	DO	4.9
City of Appleton - Valley Transit	MB	DO	4.9
Greenville Transit Authority	MB	DO	4.9
Victor Valley Transit Authority	MB	PT	4.9
Montachusett Regional Transit Authority	MB	PT	4.9
Centro of Oneida, Inc.	MB	DO	4.9
Jackson Transit Authority	MB	DO	4.9
Portage Area Regional Transportation Authority	MB	DO	4.8
Valley Regional Transit	MB	DO	4.8
City Transit Management Company, Inc.	MB	DO	4.8
Bay County Transportation Planning Organization	MB	PT	4.8
Suffolk County Department of Public Works - Transportation Division	MB	PT	4.8

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
Placer County Department of Public Works and Facilities	MB	DO	4.8
Peninsula Corridor Joint Powers Board dba: Caltrain	MB	PT	4.8
City of Ocala, Florida	MB	PT	4.7
County Commissioners of Charles County, MD	MB	PT	4.7
ART (Asheville Redefines Transit)	MB	DO	4.7
Loudoun County Commuter Bus Service - Office of Transportation Services	MB	PT	4.7
Kenosha Transit	MB	DO	4.7
County of Lackawanna Transit System	MB	DO	4.7
Cape Fear Public Transportation Authority	MB	PT	4.7
Ulster County Area Transit	MB	DO	4.6
Pasco County Public Transportation	MB	DO	4.6
Western Reserve Transit Authority	MB	DO	4.6
York County Transportation Authority	MB	DO	4.5
Belle Urban System - Racine	MB	DO	4.5
Livermore / Amador Valley Transit Authority	MB	PT	4.5
Sarasota County Area Transit	MB	DO	4.4
Denton County Transportation Authority	MB	DO	4.4
City of Jackson Transportation Authority	MB	DO	4.4
Fort Wayne Public Transportation Corporation	MB	DO	4.4
Michiana Area Council of Governments	MB	PT	4.4
City of Moorhead, DBA: Metropolitan Area Transit	MB	PT	4.3
South Bend Public Transportation Corporation	MB	DO	4.3
Riverside Transit Agency	MB	PT	4.3
Decatur Public Transit System	MB	DO	4.3
LaCrosse Municipal Transit Utility	MB	DO	4.3
Rock Island County Metropolitan Mass Transit District	MB	DO	4.3
Madison County Transit District	MB	PT	4.3
StarTran	MB	DO	4.3
Augusta Richmond County Transit Department	MB	PT	4.3
Capital Area Transit System	MB	DO	4.2
Arlington Transit - Arlington County	MB	PT	4.2
City of Redondo Beach - Beach Cities Transit	MB	PT	4.2
Toledo Area Regional Transit Authority	MB	DO	4.2
Mesa County	MB	PT	4.2
Cambria County Transit Authority	MB	DO	4.2
County of Lebanon Transit Authority	MB	DO	4.1
Chattanooga Area Regional Transportation Authority	MB	DO	4.1
Central Oregon Intergovernmental Council	MB	PT	4.1
Fort Worth Transportation Authority	MB	PT	4.0
Skagit Transit	MB	DO	4.0
City of Elk Grove	MB	PT	4.0
Springfield Mass Transit District	MB	DO	4.0
Luzerne County Transportation Authority	MB	DO	4.0
Chatham Area Transit Authority	MB	DO	4.0
Research Triangle Regional Public Transportation Authority	MB	PT	3.9
Berkshire Regional Transit Authority	MB	PT	3.9
Knoxville Area Transit	MB	DO	3.9
City of Waukesha Transit Commission	MB	DO	3.9
City of Montgomery-Montgomery Area Transit System	MB	DO	3.7

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
City of Loveland Transit	MB	DO	3.7
Transit Authority of Omaha	MB	DO	3.6
Bay Metropolitan Transit Authority	MB	DO	3.6
Macatawa Area Express Transportation Authority	MB	DO	3.5
Cities Area Transit	MB	DO	3.5
Fayette Area Coordinated Transportation	MB	DO	3.5
Green Bay Metro	MB	DO	3.4
Missoula Urban Transportation District	MB	DO	3.4
City of Tulare	MB	PT	3.4
Altoona Metro Transit	MB	DO	3.4
Delaware Transit Corporation	MB	PT	3.4
King County Department of Transportation - Metro Transit Division	MB	PT	3.3
Billings Metropolitan Transit	MB	DO	3.3
Solano County Transit	MB	PT	3.3
Delaware County Transit Board	MB	DO	3.2
Great Falls Transit District	MB	DO	3.2
City of Petaluma	MB	PT	3.2
Shenango Valley Shuttle Service	MB	DO	3.2
Dutchess County Division of Mass Transportation	MB	DO	3.1
City of Valparaiso	MB	PT	3.1
Eau Claire Transit	MB	DO	3.1
The Gulf Coast Center	MB	DO	3.0
Western Piedmont Regional Transit Authority	MB	DO	3.0
Laketran	MB	DO	3.0
Rides Mass Transit District	MB	DO	2.9
City of Lodi - Transit Division	MB	PT	2.9
MetroWest Regional Transit Authority	MB	PT	2.9
Monterey-Salinas Transit	MB	PT	2.9
Transit Joint Powers Authority for Merced County	MB	PT	2.8
Beaumont Municipal Transit System	MB	PT	2.7
Greater Attleboro-Taunton Regional Transit Authority	MB	PT	2.7
Suburban Mobility Authority for Regional Transportation	MB	PT	2.7
Transit Authority of River City	MB	PT	2.7
San Joaquin Regional Transit District	MB	PT	2.6
GO Transit	MB	PT	2.5
City of Fairfield - Fairfield and Suisun Transit	MB	PT	2.5
Central Midlands Transit	MB	PT	2.4
Ozark Regional Transit	MB	DO	2.4
Shoreline Metro	MB	DO	2.4
City of Appleton - Valley Transit	MB	PT	2.3
Metropolitan Tulsa Transit Authority	MB	PT	2.3
City of Glendale Transit	MB	DO	2.2
East Chicago Transit	MB	DO	2.2
City of Turlock	MB	PT	2.2
Central Florida Regional Transportation Authority	MB	PT	2.1
Corpus Christi Regional Transportation Authority	MB	PT	2.0
County of Lackawanna Transit System	MB	PT	1.9
Ohio Valley Regional Transportation Authority	MB	DO	1.9
Fayette Area Coordinated Transportation	MB	PT	1.8

Table E.1 (continued)

Agency Name	Mode	Service	Load Factor
Martin County	MB	PT	1.7
Okaloosa County Board of County Commissioners	MB	PT	1.7
Brunswick Transit Alternative	MB	DO	1.5
Huntington Area Rapid Transit	MB	DO	1.5
City of Long Beach	MB	DO	1.4
The Greater New Haven Transit District	MB	DO	1.4
Omnitrans	MB	PT	1.3
City of Fort Lauderdale	MB	PT	1.3
Rio Metro Regional Transit District	MB	DO	1.2
Washington County Transportation Authority	MB	PT	1.2
Gary Public Transportation Corporation	MB	DO	1.2
Norwalk Transit District	MB	PT	1.2
City of Santa Rosa	MB	PT	1.2
Utah Transit Authority	MB	PT	1.1
Terre Haute Transit Utility	MB	DO	1.1
Concho Valley Transit District	MB	DO	1.1
University of Minnesota Transit	MB	PT	1.0
City of Jackson, Department of Planning and Development, Transit Services Division	MB	PT	1.0
Borough of Pottstown - Pottstown Area Rapid Transit	MB	PT	1.0
Santee Wateree Regional Transportation Authority	MB	DO	1.0
Placer County Department of Public Works and Facilities	MB	PT	1.0
Sonoma County Transit	MB	DO	0.9
Central Oklahoma Transportation and Parking Authority	MB	PT	0.8
Transfort	MB	PT	0.8
Metro-North Commuter Railroad Company, dba: MTA Metro-North Railroad	MB	PT	0.8
Fort Bend County Public Transportation	MB	PT	0.8
Medina County Public Transit	MB	DO	0.7
STAR Transit	MB	DO	0.5
Worcester Regional Transit Authority COA	MB	PT	0.2
Putnam County Transit	MB	PT	0.0
Orange-Newark-Elizabeth, Inc.	MB	DO	0.0
Port Imperial Ferry Corporation dba NY Waterway	MB	DO	0.0
Bergen County Community Transportation	MB	DO	0.0
Middlesex County Area Transit	MB	DO	0.0
Somerset County Transportation	MB	DO	0.0
A&C Bus Corporation & Montgomery & Westside Owners Association	MB	DO	0.0
Cumberland Dauphin-Harrisburg Transit Authority	MB	PT	0.0
Chapel Hill Transit	MB	PT	0.0
Waccamaw Regional Transportation Authority	MB	DO	0.0
Lake County Board of County Commissioners	MB	PT	0.0
City of Clemson/ Clemson Area Transit	MB	DO	0.0
Saginaw Transit Authority Regional Service	MB	DO	0.0
City of Maple Grove	MB	PT	0.0
Brazos Transit District	MB	DO	0.0
River Bend Transit	MB	PT	0.0
City of Scottsdale - Scottsdale Trolley	MB	PT	0.0
Ventura Intercity Service Transit Authority	MB	PT	0.0

APPENDIX F: COPYRIGHT PERMISSIONS

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ABOUT THE AUTHOR

Matthew L. Kessler completed his Bachelor of Science, *Magna Cum Laude*, in Logistics and Transportation Management at the City University of New York Graduate Center and an Associate in Applied Science in Transportation Management at Queensborough Community College. Over the years, he earned several diplomas including one in Paralegal/Pre-Law Studies from Hofstra University with Honors.

In addition to having more than 25+ years of combined experience in multi-modal transportation and logistical operations, he has served on advisory committees to the State of New York Metropolitan Transportation Authority and the Port Authority Trans-Hudson, a passenger railroad serving Jersey City and Newark (New Jersey) riders commuting into lower Manhattan. Additionally, he also was appointed to the City of New York Queens County Community Board 14, assigned to its Transportation Committee.

Matthew was a National Center for Transit Research (NCTR) Scholar, under the direct supervision of Dr. Steven E. Polzin, the Director of the Mobility Policy Research Department at CUTR and Mr. Joel M. Volinski, Director of NCTR, assisting them on various projects funded by FDOT as well as other transportation agencies.

Originally from New York, he currently lives in Tampa, Florida. His hobbies include composing music, and railroading where he volunteered at the Florida Gulf Coast Railroad.