Measuring the Impacts of Ride-Hailing Services on the Taxicab Industry in Las Vegas, Nevada

by

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Submission Date:
Word Count: 4,863
# of Tables and Figures: 3

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ABSTRACT

Ride-hailing (or *ride-sharing*) companies are continuing to penetrate through the market of transportation-for-hire services in major metropolitan cities all across the globe, with an endless pursuit to revolutionize travel and redefine the taxicab industry. Since the fall of 2015 Las Vegas, Nevada is another city that has recently been added to the ever growing list of Uber- and Lyft-enabled metropolises. With such Ride-hailing Companies (RHCs) being introduced to cities whose economy is predominately built on the foundations of tourism, questions have inevitably mounted as to the impacts such new services are having on the transportation system, in particular, the taxicab industry. Services such as Uber and Lyft are competing with the taxicab industry for users within the resort corridor and across the valley. This study proposes a multinomial linear regression analysis using a multi-modal time-series travel dataset from Las Vegas to capture the impacts of RHCs on taxicab ridership. After controlling for a number of explanatory variables, including total number of monthly visitors, transit ridership, and several other economic indicators, the results show that RHCs do in fact have a negative (and significant) impact on taxicab ridership. A perhaps counterintuitive finding is that transit ridership actually complements (instead of competes directly with) taxi ridership, which could have significant implications moving forward. This study aims to shed even more light on the growing market of RHCs, with an attempt to estimate and quantify observed impacts in Las Vegas, Nevada, and provide transportation agencies, jurisdictions, stakeholders, and policy- and decision-makers across the nation with tangible evidence that may help guide and steer their transportation planning and investment efforts.

INTRODUCTION

Ride-hailing (also known as ride-sharing, ride-sourcing, vehicle-for-hire, or on-demand ride services) is the act of requesting a ride from a private passenger vehicle through the portal of a hand-held smartphone web application (or *app*). The system is setup by a *Ride-Hailing Company* (RHC), such as Uber or Lyft, whom ultimately serves as the broker between the ride requestor and the driver (who operates and maintains his/her own private vehicle), including assigning an available driver to the requested trip and the handling of all electronic charges and transaction fees. Ride-hailing services have grown exponentially in popularity over the past four years, providing service to a majority of metropolitan regions spanning over 66 countries. The service has meticulously, and almost overnight, revolutionized the taxicab industry with its user-friendly platform, including added convenience, ease of payment, complete door-to-door service, minimal wait times, and comparatively low out-of-pocket cost. It would be disingenuous however not to mention the magnitude of controversy that has surrounded RHC's since their initial conception in 2013, and the on-going litigation battles between taxicab unions, state lawmakers, county commissions, and local city councils regarding regulatory statutes imposed on ride-sourcing companies. The opposition argues that such a service is no different from taxis and that RHCs should be held to the same operating requirements and regulations as taxi companies, including licensing, fare regulation, and vehicle and driver safety standards in order to maintain an equal and fair playing field. Considering that this particular issue on RHCs has already been closely examined (*1-3*), this study attempted to avoid any and all further dialogue concerning the legality of ride-hailing services. Instead, this study focused on the impacts such new service may have on both travel behavior and competitors in Las Vegas, Nevada.

The origins of ride-hailing can date back to as early as the 1950s when car-sharing clubs first emerged in the Unites States, followed by the 1990s when real-time, ride-sharing projects failed prematurely without the wide spread presence of a worldwide communications web network, or telecommunication devices for that matter (i.e., the internet and smartphones). *Uber* (formally "UberCab") then became the first commercialized ride-hailing service in 2011 in the San Francisco bay area, followed by *Lyft* in the summer of 2012, thereby officially introducing direct competition into the industry of the ride-hailing service arena. Both services are currently available in Las Vegas, Nevada, and can be easily identified with a sticker of the respective company's logo attached to the inside of the front windshield of the hailed driver. Whereas in other parts of the world such RHCs may have limited access (or restricted altogether) from entering airport pick-up and drop-off terminals (including the potential of being assessed a fee), Uber and Lyft are allowed to enter McCarran International Airport terminals (departures and arrivals), and are assigned to designated areas therein that have signage indicating where within the terminals ride-hailing services may drop-off/pick-up.

What was once unbeknownst to the masses, the names *Uber* and *Lyft* have now essentially become household names, and the sudden rapid growth in these ride-hailing services presents transportation professionals and academic scholars with new opportunities and

challenges in areas of scientific analysis that have yet to be explored from a planning, engineering, and policy perspective. Some of the important questions to be addressed include: (i) has RHCs had a negative or positive impact on transit ridership and revenue? it has yet to be systematically determined and agreed upon whether or not these systems complement one another; (ii) from the taxicab industry perspective, has ridership gone significantly down? (iii) what modifications and/or enhancement to service (if any) can the taxicab industry make in order to successfully compete for riders? (iv)from the traffic engineer's standpoint, has Uber increased, decreased, or had no significant impact on average daily traffic volumes? (v) what about vehicle-miles-traveled (VMT)? The objective of this study was to indirectly measure the impacts ride-hailing services have had on the taxicab industry since being introduced to Las Vegas in the fall of 2015 by controlling for a number of measured transportation variables. Using a comprehensive set of time-series data that includes monthly transit ridership, average daily highway traffic counts, and airport visitor volumes, along with several other economic explanatory indicators, a multinomial, linear regression model was developed that treats taxicab ridership in Las Vegas as the dependent variable. The effects of Uber and Lyft were estimated indirectly due to the inability to retrieve ridership data for these RHCs. Further discussion in the Methodology section describes how exactly this limitation was bypassed.

With the growing popularity and continuous exponential evolution of ride-hailing services across the nation, it is vital for transportation agencies and policy makers alike to understand the observed impacts and implications to the transport system from all angles. This study can help assist decision makers in further ascertaining the extend of the ride-hailing industry and some of the impacts (both positive and negative) that can be expected for areas similar to Las Vegas, metropolises and economies who receive a significant number of domestic travelers and international tourists on an annual basis. The ensuing analysis and discussion is really only the tip of the iceberg in the realm of ride-hailing services and it is the duty and obligation of those who have the ability to conduct such technical analysis to observe, measure, quantify, estimate, and draw objective conclusions/recommendations for those in charge of making the decisions that impact how a transportation system operates and functions.

LAS VEGAS

The city of Las Vegas, Nevada, provides a unique setting to explore the impacts of ride-hailing services. Home to one of the fastest growth rates in the country, with a population of just over two million, Las Vegas is best known for its resort corridor (or "strip") that sees on average around 42 million international and domestic visitors each year. According to the 2010-2014 American Community Survey, the median annual household income for the region is $52,070, and the majority of the labor force (30%) fall into the classification of arts, entertainment, recreation, accommodation, and food services. In other words, 30% of the working population reside in the hotels and casinos alongside, and adjacent to, the strip. In terms of housing, the area witnessed a stampede of home construction between 1990 and 2009, when approximately 60% of the existing homes were built. However, Las Vegas, along with every other city in the United States, was not immune to the economic downturn of 2009 that saw epic failures in both the housing and banking markets. The region of Las Vegas arguably suffered the most from the Great Recession (especially in terms of number of foreclosures), and recent numbers indicate that it has yet to fully recover with a 12% unemployment rate and a poverty level over 15%. One promising figure is the upward trend in a number of economic indicators on the national scale, which ultimately leads to more travelers taking vacations, thereby bringing vital business back to the Las Vegas resort corridor and pumping monetary fuel back into Vegas's economic engine, tourism.

LITERATURE REVIEW

Dr. Susan Shaheen from the Transportation Sustainability Research Center at the University of California, Berkeley, best summarizes the current atmosphere of the ride-hailing industry by concisely labeling the movement as the, "Sharing Economy." With the ever-evolving emerging markets of car-sharing and bike-sharing sprouting across the globe (*4-5*), combined with the growing percentage of individuals owning a personal smartphone, ride-hailing services add another ingredient to the recipe that is the *Sharing Economy*. What ride-hailing brings is essentially an overhaul of both the public transit (*6*) and taxicab industries (*3, 8*). In a 2014 intercept survey by Shaheen et al. in the San Francisco bay area, respondents were asked to report on their ride-hailing travel experience, with the results subsequently being compared to matched taxi trip data from a previous taxi user survey. Their findings showed that although ride-hailing and taxis share similarities in overall functionality, ride-hailing wait times for the survey respondents were significantly <u>shorter</u> and more consistent than those of taxis. It was found that a majority of travelers utilized a ride-hailing service due to ease of payment which is done electronically, and post-trip, versus a typical taxi ride that requires the passenger to manually pay the driver. In addition, ride-hailing offers less travel time when compared to traditional taxi and public transit options, avoiding the need to park, reliability, and safety.

A key finding of a 2016 report published by the American Public Transportation Association (APTA) on shared mobility (*6*)was that shared mobility actually complements public transit (especially for the 1st and last mile portion of the trip), thereby enhancing overall urban mobility. The report argues that by providing more shared-mode services, individuals are more likely to use public transit, own fewer vehicles, and spend less income on overall transportation expenses. One of their final recommendations is to encourage public entities to engage with private shared-mode service companies (especially for paratransit) to ensure that all benefits are achieved to the maximum extent possible and are uniformly and equitably distributed. Suffice to say, APTA is ultimately recommending that public transit agencies should engage with private shared mobility service companies, as opposed to competing with, and that cooperative business relationships should be forged in order to ensure an overall positive travel experience for all users of the system (including all ages and abilities).

Over the relatively short period of time that ride-hailing services have become available for public use, RHCs are already providing new features and/or enhanced forms of service to further solidify their presence in the market, meet current user-demand, and attract new clients to the system. For example, carpooling with fellow riders has become an option for RHCs, resulting in a shared-cost in travel fees and a reduction in the number of vehicle trips on the network (i.e., a social benefit is achieved, *9*). Other forms of ride-hailing services include information couriers, food delivery service, surge pricing mechanisms during peak periods of travel, and vehicle-type preference, such as requesting a limousine or other high-end vehicle. RHCs are also engaging with public transit agencies to discuss potential dual service operations, including reaching out to paratransit service providers. In recent national headlines, automakers are now partnering with RHCs across the globe to fund research and development on the coupling of autonomous vehicles with ride-hailing services, thereby eliminating altogether the need for a human driver to operate the vehicle and potentially avoid future legal battles over labor disputes (*10*). Lastly, ride-hailing for parents has now become a feature amongst RHCs that allow a 3rd party to request, track, and monitor the trip of said person's child (including more stringent and thorough background checks of the drivers).

METHODOLOGY

Las Vegas, Nevada, provides both a unique setting and opportunity for discovering potential insights that ride-hailing services can create for a region that is arguably in a category of its own. The bloodline for the region is a resort corridor of hotels and casinos that carries over 40 million tourists each year. The region in its entirety has one of the highest population growth rates over the past several decades (2.15M in 2015), and companies including Zappos and Faraday Future are re-locating themselves to the valley. In addition to receiving a large share of international visitors on annually , the area also competes closely with Orlando, FL with respect to the number of hosted convention center and exhibit hall events. The new T-Mobile arena had its grand opening this past May, introducing another special-event trip generator to the resort corridor, combined with a growing University of Nevada, Las Vegas, campus and discussions of a future National Football League stadium. Yet no light- or heavy-rail mass transit system currently exists that can efficiently transport large groups of travelers and attract potential riders away from a personal automobile. The Regional Transportation Commission of Southern Nevada (RTC-SN) is continuing to analyze the feasibility of constructing such a system (including identifying funding sources) but such discussions have gone on now for several decades; meanwhile the automobile remains the dominant mode of transportation. RTC-SN is the transit operating agency, traffic signal management center, and Metropolitan Planning Organization in the region. Figure 1 below shows a plan view of the region's roadway network, along with identifying major activity centers critical to the analysis presented herein.

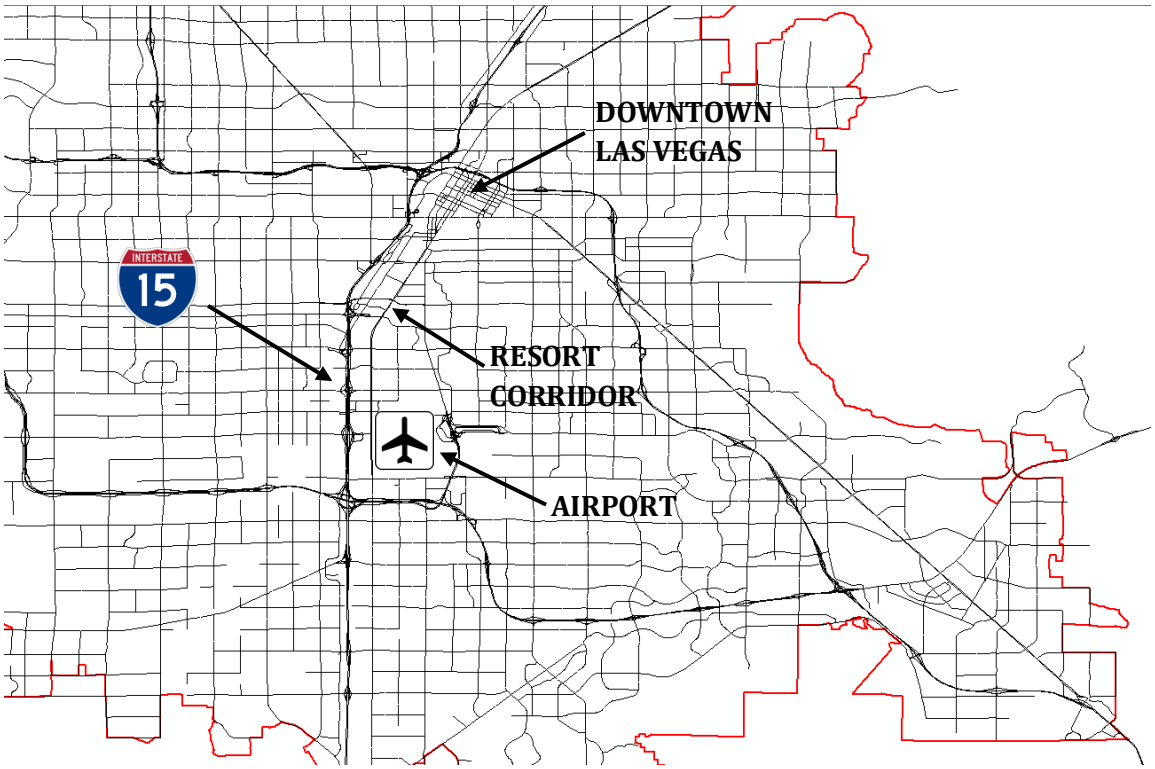

FIGURE 1 Las Vegas Valley Urbanized Area (RED) and Highway/Arterial Network (Black)

The objective of this study was to measure the impacts that ride-hailing services have had on the taxicab industry in Las Vegas since being introduced to the region in the fall of 2015. The Transportation Network Companies Uber and Lyft received approval by the local authorities to operate and provide their services to the region starting in September, 2015. Historical data was retrieved by the RTC-SN including monthly counts for a number of transport operators in the region and from multiple sources, the Las Vegas Convention and Visitors Authority, and the Las Vegas City Employees' Association. The dataset covers the time period between July, 2010 and March, 2016 and includes the following variables of information (per month):

1. Transit ridership and revenue for the entire region and for the resort corridor only;
2. Average daily traffic counts on major highways; and
3. Total number of visitors passing through McCarran International Airport.

Table 2 below provides a summary of the descriptive statistics for the explanatory variables selected for the proposed linear regression models, including the dependent variable, taxi ridership:

TABLE 2 Descriptive Statistics of Proposed Model Variables (Number of Observations = 69)

MODEL VARIABLE	Min	Max	Median	Std. Dev
Taxi Ridership*	1,598,387	2,769,288	2,280,404	2.37e+05
Transit Ridership	915,512	1,416,790	1,187,880	1.31e+05
Transit Revenue ($)	1,275,415	2,377,536	1,941,731	3.01e+05
Unemployment Rate (%)	0.057	0.150	0.097	0.028
Avg. Daily Traffic	80,041	126,907	101,223	9,459
Airport Volume	2,915,992	4,104,971	3,588,995	2.73e+05
Avg. Daily Room Rate ($)	87.4	144.9	111.1	10.89

*Dependent Variable

In addition, several other pieces of information were also collected that were used as proxies for economic indicators, including Las Vegas unemployment rates and average daily room rates for the resort corridor hotels. Limitations of the study include, among others, the inability to directly measure the impacts of ride-hailing services by using actual Uber and Lyft monthly ridership data. Instead, the proposed linear regression model attempted to indirectly measure its impact by introducing a dummy variable to the data set that assigns a value of "1" when ride-hailing service is present and "0", otherwise. Table 2 displays the results of the linear regression models (Equation 1) that were estimated using the statistical programming software *R*. Model 1 and Model 2 use, respectively, transit ridership and transit revenue as one of their explanatory variables.

$$Log\ (Y) = \alpha + \beta_i(X_i) + \varepsilon \qquad \textbf{(1)}$$

where Y = monthly taxicab ridership, and X = (for i = 1 to 6, with a <u>monthly</u> frequency)

1. Monthly transit <u>ridership</u> on the resort corridor for Model 1, and monthly transit revenue on the resort corridor for Model 2;
2. Uber/Lyft dummy variable (0 or 1);
3. Unemployment rate;
4. Average daily highway traffic;
5. Airport visitor volume; and
6. Average daily room rate.

RESULTS

TABLE 2 Monthly Taxicab Ridership Model Results (Using *R*)

Monthly Taxicab Ridership	*Coefficient*	*Standard Error*	*t - Score*
Constant	1.25e+01	1.75e-01	71.56 ***
Transit RIDERSHIP (Strip)	1.46e-07	8.94e-08	**1.64**
Uber/Lyft (dummy variable)	-1.77e-01	2.61e-02	-6.76 ***
Unemployment Rate	2.29e+00	3.90e-01	5.87 ***
Average Daily Hwy Traffic	2.66e-06	1.28e-06	2.08 *
Airport Visitor Volume	1.40e-07	6.01e-08	2.33 *
Average Daily Room Rate	8.50e-03	9.43e-04	9.01 ***
	Adjusted R^2: 0.776	*F-Statistic:* 40.23 *on 6 and 62 DF*	
Monthly Taxicab Ridership			
Constant	1.26e+01	1.79e-01	70.46 ***
Transit REVENUE (Strip)	7.48e-08	3.95e-08	**1.89** .
Uber/Lyft (dummy variable)	-1.72e-01	2.64e-02	-6.52 ***
Unemployment Rate	2.32e+00	3.88e-01	5.97 ***
Average Daily Hwy Traffic	2.63e-06	1.26e-06	2.09 *
Airport Visitor Volume	1.30e-07	5.93e-08	2.19 *
Average Daily Room Rate	8.53e-03	9.37e-04	9.10 ***
	Adjusted R^2: 0.779	*F-Statistic:* 40.94 *on 6 and 62 DF*	

n = 69

· *Statistically significant at the 10% level,*

* *Statistically significant at the 5% level,*

** *Statistically significant at the 1% level,*

*** *Statistically significant at the 0.1% level.*

The results fall directly in line with the initial hypothesis that ride-hailing services have had a negative and significant impact on taxicab ridership in Las Vegas, Nevada. The coefficient sign for the Uber/Lyft dummy variable is negative, and all of the explanatory variables are statistically significant except for the transit ridership variable, which arguably fell on the border of the acceptance and critical region and by a very small margin. In order verify such a narrow result and further test the significance of this variable and its potential impact on taxicab ridership, Model 2 was estimated using monthly transit revenue earnings, for the resort corridor lines only, as a proxy for transit ridership. Table 2 shows this variable with a t-score that falls within the critical region and is statistically significant at the 10% level. Another interesting result is the positive direction on the transit ridership and revenue coefficients, which signifies a complementary relationship between taxi ridership and public transit use along the Las Vegas resort corridor. In addition, the *apriori* prediction of the unemployment rate coefficient being negative was overturned; however, given the relatively slow growth in economic recovery for the entire Las Vegas valley (compared to the nation as a whole), this could be one explanation as to why the estimated elasticity is positive.

IMPLICATIONS

The results presented indicate that the taxicab industry in Las Vegas, Nevada, has indeed taken a significant hit in ridership with the recent presence of the RHCs, Uber and Lyft. This provides another example of how RHCs are impacting local transportation providers and how riders will switch to newly provided services if they show proof of being either less costly, can reduce door-to-door travel time, and/or provide an overall more convenient means of travel. The taxicab industry in Las Vegas may have to return to the drawing board and re-evaluate their business and operation models before the current wave of vehicle-for-hire services of RHCs consumes all of the demand in its wake. Time is of the essence for these taxi providers since the travel season has arrived and Las Vegas tourists have available to them for the first time this summer the option of taking Uber and/or Lyft from the airport to the resort corridor (and along the strip thereafter).

The results here are derived from a dataset with a sample size of 69 observations (or months) that span over five years. Seven of those observations include periods where ride-hailing services are present. Perhaps on-going observations would be ideal in order to solidify the results,especially with the summer time periods approaching. A serious and thought-provoking question that arises is this perhaps the end of the taxicab industry? Darwin's evolutionary theory of natural selection proved that a group of species who are better equipped to survive in their surrounding habitat will flourish at a greater rate than their competing counterparts who are less equipped, or, "*survival of the fittest*." The same theory can be applied to the vehicle-for-hire industry within the habitat of the transportation network. Companies who are better equipped and are more attractive than their counterparts will flourish, and so too may be the fate of RHCs in Las Vegas, Nevada, with taxicabs eventually fading out and becoming "extinct." In fact, Uber even made the proclamation before entering the market of vehicle-for-hire services that they

were indeed the supreme and "fittest" form of taxicab by initially calling themselves "UberCab," which can be broken down into the phrase "Supreme-Taxicab," after translating from German to English.

From the transit agency standpoint, one major implication of this study brings to surface a significant question that may perhaps be a game changer for ride-hailing services: Should public agencies embrace, rather than compete against, the ride-hailing service companies and adapt their models to complement one another (rather than compete) for the sake of the users? One piece of evidence that may be useful in helping the transit agency address this question is to observe the positive (and significant) coefficients tied to both the transit ridership and revenue variables in Table 2. Although these values of elasticities apply to the taxicab ridership variable, which is the independent variable, one could make a rational argument that if transit use has a direct, and positive, relationship with taxicab ridership, then the same result would also hold true between transit use and ride-hailing services. In other words, similar to the "red bus, blue bus paradox," the independence from irrelevant alternatives may apply. Transit agencies should therefore approach RHCs (and vice versa) to discuss potential partnerships and business endeavors to explore how possible ventures could lead to improved services and expansion to more clientele. On the surface, such a recommendation may seem counterintuitive to a politician or transit agency general manager, but the numbers would suggest otherwise.

CONCLUSIONS

In 1975, Martin Wohl (*11*) made a compelling argument that the taxicab industry is arguably the optimal form of public transit (over bus and rail) with respect to travel time, reliability, and convenience in an urban setting. Moreover, if regulated effectively, could operate at a profit and, "…without public subsidy." The author made the case that public transit agencies, rather than operating on fixed guideways and schedules, should instead opt to manage a fleet of pseudo-taxicab vehicles that serve demand in real-time and on any street corner. Little did he know that his statement would actually hold relevance over 30 years later when ride-hailing services (instead of transit agencies) would revolutionize the taxicab industry and operate effectively at a profit (and without public subsidy). It is almost an eerily coincidence how TNCs have unknowingly followed suit to the recommendations laid forth by Wohl. Similarly, soon we should see in operation on-demand air service systems such as those proposed by Peeta et al (*12*).

With RHCs continuing to push the envelope and explore new techniques for improving and expanding service, the future of ride-hailing services has the potential to further revolutionize the functionality of the taxicab industry as well as the entire transportation system. For example, automakers are now jockeying for positions in a race towards an era that one news reporter labeled "Mobility Services" (*13*) and are teaming up with RHCs, including partnerships

between General Motors and Lyft, Toyota and Uber, and Fiat Chrysler and Google. These automakers are already investing large amounts of resources towards autonomous vehicle technologies, and one by one states are passing legislation that allows self-driving vehicles to operate on public roadways. Even the public sector is catching the wave of autonomous vehicles with the recent authorization of nearly $4B in research and development by Secretary of Transportation Anthony Fox and the United States Department of Transportation. Suffice to say, when it comes to self-driving vehicles being made commercially available to the public, it is not a question of if it will happen, but when. Having now witnessed automakers establishing partnerships with RHCs, it is axiomatic to assume that the future of ride-hailing services will utilize self-driving vehicles and surpass the need altogether to hire drivers that can operate their own personal vehicle. Such an approach makes since from a legal standpoint given the number of lawsuit settlements, labor disputes, and litigation battles going on around the world between RHCs and their vehicle operators. Autonomous vehicles would do away with human drivers altogether, setting the stage for improved safety and efficiency of the ride-hailing system from an economic, environmental, and social standpoint. Other long-term impacts of ride-hailing services are vehicle ownership rates; households that would have otherwise owned two to three vehicles can now function effectively with only one vehicle and utilize companies like Uber and Lyft for any and all types of trips.

Ultimately, we stand to gain a wealth of valuable information with the outcomes of this study that can systematically be used to apply certain strategies (either through design, policy, or partnerships) that achieve a region's stated goal of sustainable transport and an efficient means of managing a city through its various portals of functionality. Future work may include analyzing average daily traffic counts and/or vehicle-miles-traveled (VMT) in order to further gauge the impact of ride-hailing services on the transportation network and observe whether or not these metrics are increasing or decreasing. Political leaders in the Las Vegas valley region can utilize the results presented herein when considering future policy and operating requirements as RHCs continue to penetrate the market of vehicle-for-hire services. Ongoing observations will continue as the summer months approach, bringing with it touristswishing to travel to and from the airport and within the resort corridor.

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