Fall 2019

Exploring Potential Cooperation Opportunity between Ride-Hailing Operator and Automotive Battery Supplier

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Creative Component presented to the faculty of
Management Information Systems
in partial fulfillment of the requirements for the degree of
Master of Science

by

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Iowa State University
Ames, Iowa
2019

Abstract

With the growing popularity of ride-hailing services like Uber in recent years, many industries are looking for opportunities to cooperate with ride-hailing companies. Similarly, ride-hailing platforms are also looking for potential opportunities to cooperate with other service providers or product industries to bring more comprehensive, convenient, and personalized services to their customers. This research is dedicated to studying potential cooperation opportunities between ride-hailing platforms and automotive battery suppliers. There are extensive studies and research focuses on the topic of ride-hailing companies' future growth and direction as well as some studies on the impact of the ride-hailing market. Many articles and data provide valuable information for this research. Through extensive literature reviews as well as primary and secondary research methods, this research provides insights for automotive battery suppliers to develop partnerships with ride-hailing platforms that have merged in shared mobility spaces. Additionally, this research is qualitative research to study potential opportunities between automotive battery manufacturers and ride-hailing operators. The insights gained from this study include: 1) Ride-hailing contributes to total vehicle mileage traveled (VMT), vehicle utilization and automotive battery replacement; and this study made a projection on the ride-hailing development trend based on two potential factors; 2) For an automotive battery supplier, there is potential opportunity to develop partner relationships with ride-hailing platforms in the near future. This study builds a detailed review of ride-hailing companies' development trends, presents insights for automotive battery suppliers on how to yield a potential partnership opportunity, and indicates further research directions in the area. More studies are needed to understand the relationship between the ride-sharing company and the automotive battery industry better because of the limited sample size and prior research.

1. Introduction

With the rapid development of the ride-hailing market in recent years, mobility habits have also been gradually changed. The changes in people's mobility behavior will characterize mobility in the future. In the future, the concept of shared mobility will be more integrated into people's lives. Furthermore, the thought of "sharing" instead of "owning" will become more commonplace. Although sharing mobility brings people a more convenient and also innovates a more environmentally-friendly way to travel, it impacts new car sales year by year. According to Guo, Xin, Barnes & Li (2018), this research investigates the impact of ride-hailing companies on the new car market, and it indicates that the adoption of ride-hailing could negatively impact new car sales. There could be an increasing number of people who find car ownership unnecessary in the future. Previously, most automotive battery manufacturers mainly collaborated with original equipment manufacturers (OEMs) or aftermarket to provide battery products. However, with the declining automotive sales volumes and the growth trend of ride-hailing, car battery suppliers should begin to look for more business alternatives to promote product sales volume.

While some prior research studies on the roles of ride-hailing in the automotive industry suggest the partnerships between ride-hailing companies with automakers, the available research and studies on marketing strategies in the partnerships between ride-hailing companies with automotive battery providers are limited. Therefore, this research is designed to address this gap, in particular, for the automotive battery manufacturer. This study discusses the following three main research questions to explore relevant information:

RQ (1). What could be the future development direction of the ride-hailing market?

RQ (2). How does a ride-hailing operator perform maintenance service on vehicles that they or their drivers own?

RQ (3). Is there any potential opportunity for an automotive battery manufacturer to cooperate with ride-hailing companies?

According to the above research questions, the first objective is to identify the ride-hailing market development trend. Secondly, this research is required to understand the ride-hailing company's current and forecasted battery replacement opportunity with its maintenance model. At last, the findings will make a suggestion on the partnership between automotive battery suppliers and ride-hailing companies.

Several sources have been used to investigate the research problems, including relevant literature and interviewing practitioners. This research includes conducting primary research by interviewing a ride-hailing company, conducting secondary research by canvassing a variety of databases, publications, and websites, and then synthesizing the information into a concise set of penetrations that could be used for an automobile battery manufacturer to develop a cooperative relationship with ride-hailing operators. Through primary research, this study makes the findings more relevant to practice. To better conduct this research, such practical knowledge has also been provided through a case study. An in-depth case study focuses on a vehicle battery manufacturer and a sizeable ride-hailing operator provided as an example.

Worth to mention, many secondary research findings were used to designate the continued growth of ride-hailing market projection and also deliver information about ride-hailing companies' maintenance models. Due to the rising population and higher shared mobility demand, more and more people bring ride-hailing to their daily lives. At the same time, the rise of vehicle miles

traveled (VMT) and vehicle utilization will bring a higher frequency of vehicle battery replacements, which will also lead to a potential opportunity for an automobile battery manufacturer. As a result, this research suggests that there is a potential opportunity to develop an indirect or direct partnership between the ride-hailing company and automotive battery supplier. To cooperate with the ride-hailing company that owns fleet size, the automotive battery provider should focus on developing a direct partnership. To cooperate with a ride-hailing company that does not own a fleet, the battery provider could develop an indirect relationship through local mechanics or other maintenance service providers and offer automotive battery promotion to end consumers. With different business model portfolios of ride-hailing companies, an automotive battery provider should adjust marketing strategies with different ride-hailing partners.

The construction of the rest of the paper will be as follows. Firstly, this research discussed automotive battery supplier's business model, technology development, and partnerships. Secondly, this research uncovered the ride-hailing company's business model, maintenance service, and its impact. Based on a broad review of research literature, publications, and interviews, this research suggested the future development trend of the ride-hailing market. The third part is to concentrate on a case study. To better understand the potential partnership opportunity between an automotive battery supplier and a ride-hailing company, this research illustrates results with primary and secondary research and proved the feasibility of business cooperation.

2. Automotive Battery

To date, with the development of new energy vehicles, more and more researches begin to focus on and discuss the topic of new energy vehicle batteries. Conventional vehicles usually are powered mainly by fuel. A new energy vehicle drives the vehicle through its battery. Various pieces of literature introduced fundamental knowledge according to diverse types of automobile

batteries. This study learned that the primary function of an automotive battery is to convert the battery's chemical energy to electrical energy, deliver voltage to the starter and then supply power for a vehicle to start the engine. Moreover, the automotive battery also supplies the extra power necessary when the vehicle's electrical load exceeds the supply from the charging system — an automotive battery stores electricity for a vehicle's future to use. For example, our radio on the car connects to the automotive battery. There is a vast range of choices and technologies for people on their automobile batteries. For example, lead batteries are very well established both for automotive and industrial applications. However, there are some competing technologies, such as Li-ion, sodium-sulfur, and flow batteries have also been used for energy storage (May, Davidson, & Monahov, 2018). When the power supply of the engine is insufficient or not started, the battery will provide power to the electrical appliances in the car, such as the sound system and lighting system. When the engine starts to provide a regular power supply, the battery will collect and store the electric energy for future use. From 1910 to 1930, gasoline vehicles gained market share rapidly because of its low price, abundancy, and high specific energy of fuels made from petrol. With technological innovations and societal demand for limiting petrol consumption and carbon dioxide (CO2) emissions, new electric motor technologies have been developed. To compete with a lead-acid battery, the benchmark vehicle battery technology, Nickel-metal-hydride (NiMH), and lithium-ion battery technologies have arrived in volume production for hybrid and electric vehicles (Garche, Karden, Moseley, & Rand, 2017).

There are various types of automotive batteries. According to the engine types, the Starting, Lighting, and Ignition (SLI), Enhanced Flooded Batteries (EFB), Absorbent Glass Mat (AGM), and 12V Li-ion batteries are fit for the vehicle with Internal Combustion Engine (ICE) as primary

propulsion. The 48V Li-ion batteries are fit for a vehicle with ICE plus battery-electric motor or Li-Ion battery electric motor as primary propulsion (Tsoulfas, Pappis, & Minner, 2002).

The SLI battery is the most common type of lead-acid battery been used for the vehicle. The function of the SLI battery in a conventional car is to provide short bursts of energy so that to run light electrical loads and start the engine. This type of battery is suitable for all climates with reliable starting power; also, it cost lower than other types of battery. However, the shorter life pan and limited ability to power large accessory loads could become its disadvantages ("How Does A Car Battery Work? | Firestone Complete Auto Care," n.d.).

The AGM and EFB are two types of batteries for start-stop cars. The AGM and EFB batteries can improve vehicle performance and reduce long-term automotive battery costs. The primary function of AGM and EFB batteries is to support vehicle start-stop applications and limited higher electrical demands of today's vehicles. EFB battery has its competitive advantage on exceptional cyclic durability and improved charge acceptance. AGM battery has its competitive advantage for high-end and advanced fuel-efficient vehicles with enormous power demands ("Absorbent Glass Mat (AGM) Car Battery | Autobatteries.com | Clarios," n.d.). AGM battery is an excellent premium choice for people who owned a vehicle with electrical features such as GPS, heated seats, and audio systems. It is also useful for special vehicles to use AGM and EFB batteries, such as ambulances and police cars. For battery is exposed to extreme driving conditions, AGM and EFB batteries can be fitted to improve battery performance.

The lithium-ion battery is widely used in electric vehicles (EV) with its characteristics of high energy density, high power density, and low self-discharge rate (Han et al., 2019). The 12v li-ion battery has mostly been used for mild hybrid or fully hybrid vehicles, and the 48v li-ion battery can be used for plug-in hybrid (PHEV) or Battery electric vehicles (BEV). Even most of the

modern electric cars were made by lithium-ion batteries, there is always a second battery, a lead-acid battery, under the hood of any electric vehicle. For example, for mild hybrid and full hybrid vehicle, the lead-acid battery's function is to support start-stop and limited higher electrical loads. For PHEV or BEV, the lead-acid battery's function is to support 12v loads and redundancy for critical systems, and it is required for safety (Lu, Han, Li, Hua, & Ouyang, 2013).

Battery technology has been developed over the last several years to keep up with the increased demand for automobile batteries. Automotive battery manufacturers are continually improving their products and service they provide to the customer. All the supply of vehicle battery productions was based on the demand of people's utilization. The mutual understanding between vehicle battery manufacturers and potential customer demand will be required. To better understand the demand for vehicle battery and how often they replace vehicle battery will be necessary for a manufacturer to develop business. If there is no battery inside a vehicle, a vehicle will not be able to start its electrical system. The car battery provides all the electricity necessary to power all the electrical components in one vehicle. Moreover, for most types of vehicles, a battery is necessary to start its engine. However, we all know that every part of a car has a life span, as does the battery. When an automobile battery reaches its maximum capacity, or it is too old to be used, it is time for people to consider replacing the battery with a new one.

2.1.Automotive Battery Supplier

2.1.1. Business Model

There are many automotive battery suppliers around the world. Panasonic is the largest Lithium-ion battery producer for electric mobility in 2019, followed by Contemporary Amperex Technology (CATL) BYD. The principal business of the automotive battery supplier is to selling battery products to the aftermarket and original equipment (OE). The automotive battery supplier

is a crucial resource for automotive aftermarket and automakers to supply a stable automotive battery supply chain. Through the interview with automotive battery company, this study learned that it is not easy for a battery manufacturer to send vehicle batteries directly to the end consumer because of the specialization of the vehicle battery. Some manufacturers already have their e-commerce market for some category batteries with skipping the retail sales channel. This strategy saves lots of cost on ordering and shipping. However, it is not suitable for many other categories battery to have direct sales to end customers, and automotive battery manufacturers still need to supply batteries to different chain stores, workshops, original equipment manufacturers (OEMs), or even local garages through logistic transportation companies. The larger maintenance chain stores or workshops might have batteries with their private label made by various automobile battery manufacturers depending on the location to reduce shipping costs or to provide more different types or sized of batteries. Therefore, when a vehicle needs to replace its battery, people usually go to maintenance stores, workshops, or chain stores and have their battery replacement service.

2.1.2. Automotive Battery Technology Improvement

As we all know, a car is made up of thousands of parts with complex structures. It is not easy for an original equipment manufacturer (OEM) to produce all parts by itself. Hence, the supplier of auto parts is often the lifeblood of the auto industry. With growing energy transitions and environmental protection, numerous automotive battery suppliers delve deeper into battery technology innovation for vehicle electrification to keep winning a position in the market. For example, with the rapid growth of electric vehicles, the power battery, one of electric vehicle's core technology, has been paid more attention. Power battery is the power source that provides energy for electric cars, electric trains, electric bicycles, or even golf cars. Electric vehicles use

Lithium-ion batteries to store energy and offer stable working voltage with high power and energy density. A lifetime of a battery will directly impact on the cost of an electric vehicle, and a power battery technology can limit the development of electric vehicles (J. Zhao 2015.) Thus, many automotive battery suppliers have focused on developing battery technology, such as increasing power density and energy density, on ensuring battery stability and also maintain market share.

The hybrid electric vehicles (HEVs) a new option for improving vehicle efficiency and lower toxic gas emission (M.A. Hannan 2012.) A small battery has been used for micro-hybrid cars to start or stop the system, and a more solar battery been used for a full hybrid car to supply the whole electric system. A power battery is one important energy storage device with lightweight, high specific power and energy density (Z. Rao 2011.) Therefore, with the technology development trend of new energy vehicles, automotive battery technology has naturally become one of the critical links in the automobile industry.

2.1.3. Partnerships

In fact, in recent years, cooperation between automakers and battery suppliers is accelerating. Automotive battery suppliers are looking for partnerships with many other industries to expand their footprint. To bring more new technology and innovation to the market, automotive battery suppliers cooperate with OEMs to work together and improve brand awareness. General Motors, for example, disclosed in a recent filing that it would seek a joint venture with LG Chem in power batteries ("US: LG Chem's Holland plant to supply more batteries to GM," 2015). Toyota and Ningde Times New Energy Technology (CATL), the largest vehicle battery manufacturer in China, jointly announced the establishment of a comprehensive partnership in the stable supply and development on evolution of new energy vehicle (NEV) power batteries (CORPORATION, n.d.).

On the one hand, constant cooperation activities between automotive battery suppliers and carmakers improve the automotive battery supply chain system.

On the other hand, with more and more OEMs trying to develop battery technology and integrated supply chain system, battery cost would decrease in the nearly future. Therefore, like an automotive battery manufacturer, it is time for automotive battery manufacturers to explore other cooperation opportunities in other areas.

2.2.Automotive Battery Lifespan

On average, a vehicle battery will last three to four years, ideally with regular use and maintenance ("How to Make Your Battery Last," n.d.). However, several factors may impact a battery lifetime. The driving habits, vehicle exposure time to extreme elements, vehicle conditions, and road conditions are all possible variables that impact on battery utilization and lifespan. For example, numerous people who live in an area with extreme temperatures will usually use an AGM battery (maintenance-free battery) for their vehicle since this kind of battery is highly spill-resistant and better able to handle repeated discharging and recharging under hot or cold weather. According to the AAA reports, about 1.8 million battery-related service calls in the summer of 2018. Another example could be the taxi's battery. Since a vehicle battery needs to be replaced at about 30,000 to 50,000 miles, a taxi's battery usually has a higher battery replacement frequency than a standard use car.

With the development of science and technology, people are having a variety of choices of transportation. According to car sales in recent years, we can see the possible development trend of sharing instead of owning in the future. On the other hand, automobile battery suppliers are gradually upgrading and enhancing battery technology to extend battery life. According to the

research of "Batteries for Electric Cars" from Boston Consulting Group (BCG), it indicates that many automotive manufacturers are planning for a ten-year battery life span vehicle to meet electric cars' energy-storage needs.

With the combination of increasing annual vehicle mileage and the future trend of shared mobility, the most critical driven factor of battery replacement would be the increasing of "sharing mileage" and vehicle utilization. Therefore, if battery manufacturers sustain only focusing on cooperation with the automaker and automotive aftermarket, they would miss massive business opportunities under the growing shared mobility trend.

3. Ride-hailing

3.1.Ride-hailing Background and Definition

Ride-hailing, also known as ridesharing, is a platform that involves at least two participants who share a vehicle and coordinate itineraries with smartphones and mobile internet. Ride-hailing is the fastest growing market in the shared mobility service field. More and more people brought ride-hailing into their daily lives in recent years. As early as the beginning of the 20th century, ride-hailing has appeared and popularized. In 1914, there was a brief but popular "Jitney Craze." The ford motor company mass-produced their Model T in 1908, and its popularity been soared and spread. Nevertheless, with the outbreak of World War I and the U.S. economic recession, some Los Angeles car owners started the "Jitney" - offering a ride for only five cents. This idea spread quickly throughout the United States. Due to the rapid popularity of Jitney, trams were losing its competitiveness and facing revenue losses. Therefore, Local governments began regulating Jitney's operations and controlling its growth. This movement resulted in a 90% reduction in Jitney's operations by 1919. During World War II and the 1970s oil crisis, ride-hailing gained

popularity again. The government encouraged people to save energy and use carpooling. However, it ceases to exist with oil prices fell, and incomes rose (Chan & Shaheen, 2011).

In the past few years, ride-hailing has changed the way people traveled and also brought the concept of "Sharing" instead of "Owning." With the rapid development of technology, shared mobility is growing in popularity. Consumer behavior characterizes the mobility of the future, and also the shared mobility directly impacts on consumer transportation manifestations. There are a variety of manifestations of shared mobility. Ride-hailing plays an essential role in shared mobility.

With a mobile application as the leading service platform, ride-hailing service providers provide communication information and guaranteed connection services for their riders with travel needs and drivers with travel service qualifications and capabilities. There are three different types of ride-hailing: Ride-Sharing/Ride-hailing Service, Shared Journey Service, and Online Taxis Service (PricewaterhouseCoopers, n.d.). The Ride-Sharing Service provides online-enabled platforms to connect passengers and local drivers using their vehicles. The Shared Journey Service is a carpooling platform that connects car owners and co-travelers to share journeys. The Online Taxis Service is a company with a fleet of licensed taxi and black cabs. Customers can book a taxi through the application and get when they need to be, quickly and easily. This research concentrates on the type of Ride-Sharing Service.

3.2.Ride-hailing Development

Unlike traditional taxi service, ride-hailing platforms operate by effective technology with matching real-time riders and drivers. In recent years, the ride-hailing market displays its phenomenal growth and development. Uber formally established in 2009, and now it already been developed in many cities around the world. Uber is active in over 700 cities across more than 80

countries around the world. Uber's largest competitor, Lyft, operates in more than 300 cities in the U.S. and completes more than 18.7 million rides per month ("Where the Ride-Sharing Industry in Asia Is Headed," 2017). Other ride-sourcing companies around the world have a significant market presence, as well. Didi, the largest ride-hailing company in China, operates in over 400 cities in China, with over 400 million users ("DiDi," n.d). Grab serves over 30 cities in six counties in Southeast Asia and has over 1 million users (Grab, 2019), and Ola has over 600,000 vehicles across 110 cities, mainly in India. According to Appendix A, the study collects ride-hailing operators in different regions. The listing displays large user volume or fleet size of ride-hailing operators in different countries and their rapid development in recent years. Besides, recent statics regarding Statista Digital Market indicates that the U.S. has about $49,598 million revenues of the ride-hailing market and about 66.1 million ride-hailing user volume ("MIT 'Real-Time' Rideshare Research » Rideshare History & Statistics," n.d.).

3.3.Ride-hailing Business Model and Maintenance Service

Many theoretical types of research present the significant role of the business model of an organization and how it could help with future development projection. For example, according to Chesbrough & Rosenbloom, the method of doing business by which a company can sustain itself through generating revenue (Chesbrough, 2002); The fundamental logic of the business model is finding out the critical value, add resources and capabilities and integrating them with organizational strategy (Ljubomir, 2014); A business model framework assists a company to category capabilities and management practices (Kaj 2011). Many kinds of research indicate the importance of the business model and how it could indicate future development. Therefore, to deep dive into the ride-hailing company's business model could help this research better understand the future development trend of ride-hailing companies. Besides, the fundamental of strategic

collaboration between ride-hailing companies with automotive battery suppliers is that the ride-hailing market keeps its growth in the future. Thus, all correlative factors that impact ride-hailing development need to learn in more detail. Through deep dive into ride-hailing operator's business model, this research points out the reasons correlate to the ride-hailing popularity and also figure out potential parts for automotive battery supplier to build partnerships with ride-hailing companies.

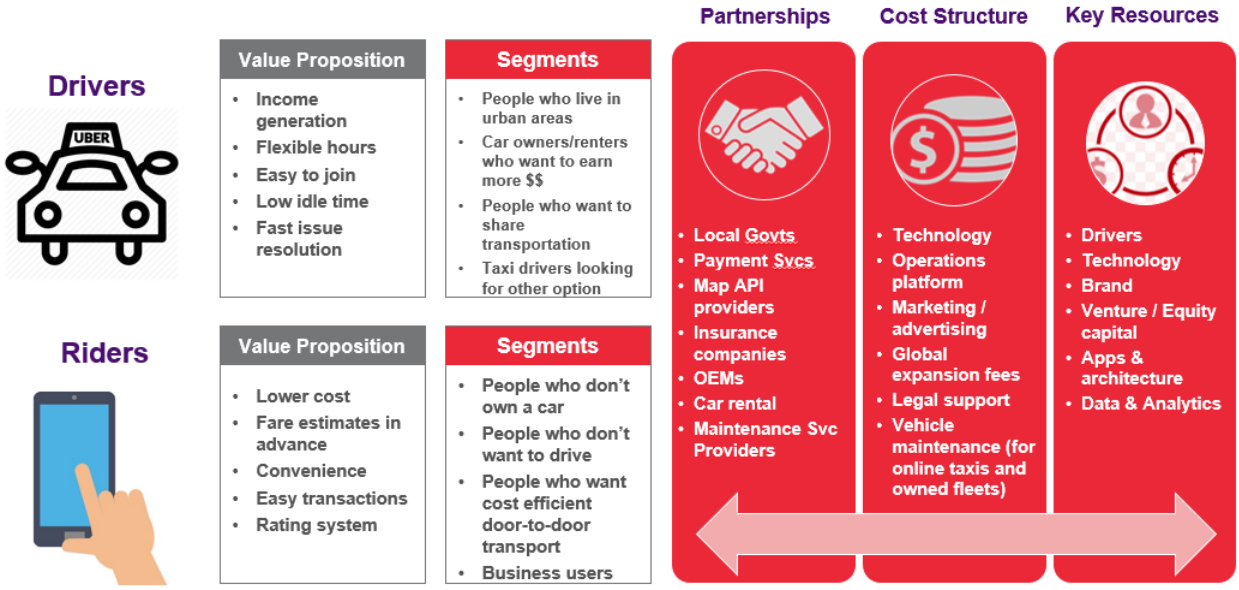

Figure 1. Business Model

The study results based on the ride-hailing business model are elaborated in Figure 1. Firstly, the value proposition of ride-hailing service brought popularity to them. For ride-hailing drivers, they have more income with flexible working hours. For the riders, they spend less on transportation, bring mode convenience. Ride-hailing's customer segment consists of two parts: drivers and riders. For drivers, they own a car and would like to share mobility with people who need a ride, or it could also be taxi drivers look for additional business options. For riders, they could be people who do not own a car but need a ride, or traveler who would like to share a journey with a car

owner. The research of Johnathan and Alan provides the first comprehensive analysis of Uber's driver-partner based on survey data of Uber's driver-partners. This study indicates that Uber's driver-partners are more similar in terms of their age and education to the general workforce than to taxi drivers and chauffeurs. By contrast, Uber's drivers are substantially younger, with 19% under age 30, and 30% are under 40. Nearly half of Uber's driver has a college degree or higher. Also, Uber driver-partners are particularly prevalent in large urban areas (Lee & Savelsbergh, 2015). The analysis carried out with PwC also brings the critical insight that millennials and urban consumers are two large portions of ride-hailing users. According to its survey analysis, about 43% of respondents are likely to have used ride-hailing, and they lived in urban areas; about 60% millennials respondents saying they have used ride-hailing service (PricewaterhouseCoopers, n.d.).

Secondly, some evidence under categories partnerships, cost structure, and critical resources suggest an interesting correlation to the automotive battery business. According to the cost structure, most ride-hailing companies do not have responsibility for vehicle maintenance service since drivers own vehicles by themselves. However, many operators concentrate on the concept of Mobility-as-a-Service (MaaS), a more user-centered mobility paradigm, and try their best to provide integrated service to their customers. Therefore, based on information under category partnerships, many ride-hailing operators have their strategic collaboration with other automobile operators, such as maintenance providers, OEMs, and car rental companies. For example, Uber and Lyft, two large ride-hailing companies in the North America market, they have similar customer segments and business development models. Along with their partnerships, Uber and Lyft are expanding their connections with many different types of service providers. Many ride-hailing companies are trying to have more connections with different types of service providers to

improve their integrated service platform. It would be an excellent opportunity for vehicle battery providers to build a relationship with ride-hailing companies and have more vehicle battery sales.

Uber has its partnership with CarAdvise, a car care service provider, to provide the "Driver Reward Program" on car maintenance service. CarAdvise is integrated into tens of thousands of maintenance shops nationwide, include Firestone, Jiffylube, Meineke, et cetera. (CarAdvise, n.d.). Uber drivers may have a 25% discount on CarAdvise with their car maintenance order (Uber, n.d.). Uber provides maintenance service, which includes car battery replacement, to their drivers with access to have a discount on CarAdvise. Similarity, Lyft's drivers have access to dree and discounted auto services at company Pep Boys with any location nationwide, which also includes car battery replacement (Lyft, n.d.).

Thirdly, based on the primary resources part, ride-hailing operators have their resources such as drivers (car owners), technology, application, data, and analytics. From this point, this study learned that the development of information technology plays a significant role in the ride-hailing market. Ride-hailing services use geospatial mapping technology to collect data and connect riders and available drivers in real-time (Gilibert, Ribas, Maslekar, Rosen, & Siebeneich, 2019). The development of technology enables ride-hailing operators to customize their transportation service by using data and analytics. With the development of information technology, consumer lifestyle, travel behavior, and preferences have been changed. More and more people embraced new mobility options and applications over the last decade ("How automakers can master new mobility | McKinsey," n.d.). Since most ride-hailing business is based on the algorithm, and many activities are data-driven, the innovation battery technology will be an aspect that battery supplier could coordinate with. A cost-effective and practical diagnostic technique for testing vehicle batteries' performance can help ride-hailing companies to better understand the vehicle battery's long-term

durability and performance (Guo, Xin, Barnes, & Li, 2018). Moreover, electric vehicles ride-sharing will play a prime role in the shared mobility market and offer a high level of customer experience in the future (Meng, Ran, Chen & Jiao, 2017). Therefore, the deployment of vehicle battery diagnostic techniques on ride-hailing vehicles, including electric vehicles and also gasoline vehicles, is expected to improve the coordinate relationship between ride-hailing companies and battery suppliers.

Based on the ride-hailing business model, many findings suggest that ride-hailing already been formed as a new industry has caused an enormous wave in the whole world; it not only overturns the traditional taxi industry but also impacts on the mobility trend and the way people traveled to meet the demand their customers. To cooperate with ride-hailing companies, an automotive battery manufacturer could find a way to formalize an agreement on maintenance service with third-party partners, such as maintenance service providers, OEMs, or car rental companies. Besides, there is a potential opportunity for automotive battery supplier to deploy diagnostic technique on ride-hailing vehicles and become a direct maintenance service provider on battery replacement for ride-hailing drivers.

3.4.Ride-hailing Service Impact

3.4.1. Environment

A vital reason that ride-hailing service becomes popular is its powerful impact on the environment. The emergence of online ride-hailing platforms significantly reduced waste in energy and effectively reduced carbon emissions (Martin, Shaheen, & Lidicker, 2010; Chan & Shaheen, 2011).

3.4.2. Auto Ownership

With the higher degree of shared ownership increases, ride-hailing service will directly influence on the mobility trend in the future. Ride-hailing has brought more users with convenient and cost-effective transportation, which makes many people give up their demand for auto ownership. Some studies also point out that car purchase amounts been affected in recent years because of more prevalent ride-hailing service. For example, recent reports display that many Uber users are holding off on vehicle purchases, and more and more people find car ownership is unnecessary with the popularity of ride-hailing service (Guo, Xin, Barnes, & Li, 2018).

3.4.3. Vehicle Miles Traveled (VMT)

According to the data of Uber, the largest ride-hailing operator in the United States accumulated its first 1 billion rides in its six years ("Uber Users Are Waiting to Buy Cars Because of Uber—Vox," n.d.). Furthermore, one of the KPMG reports points out that ride-hailing and ride-sharing services have added about 5.7 billion VMT to major urban areas in the U.S. over the last six years. Several prior studies also indicate their evidence of ride-hailing impact on VMT numbers. With 1.5 million individual rides data, research quantifies the additional miles ride-hailing drivers traveled (Henao & Marshall, 2018). According to an innovate research with Uber's driver and passenger datasets of Alejandro and Wesley (2018), ride-hailing adds a significant amount of VMT (+83.5%) with including dead-heading (without passengers or freight). In terms of increasing vehicle mileage number, higher vehicle utilization has been increased with ride-hailing popularity. Based on previous automotive battery lifetime data, a higher vehicle battery replacement could occur since a ride-hailing vehicle drives more than a standard use vehicle.

The Mckinsey consulting report on mobility services recommends that ride-hailing and car-sharing could account for more than 15 to 20 percent of total passenger vehicle miles globally in 2030 ("How automakers can master new mobility | McKinsey," n.d.). On the one side, all the current

and projection information of the ride-hailing market indicates its remarkable growth. On the other side, all the findings point out the positive impact on vehicle mileage numbers. With the continued development of information technology, substantial potential customer (rider and driver) volume of the ride-hailing market could directly boost total VMT. According to previous information about the automotive battery lifespan, an increasing number of VMT could directly impact on vehicle battery replacement frequency. Therefore, a potential cooperation opportunity between the ride-hailing company and vehicle battery supplier would arise on account of increasing VMT and vehicle utilization.

3.5.Ride-hailing Future Trend

One recent study from UC Berkeley discussed ride-hailing companies' past, present, and future in North America. Future development of ride-hailing is likely influenced and foster growth by three factors: technology interoperability and integration, enhanced casual carpooling, and public policy (Chan & Shaheen, 2011). The information this research has learned from previous studies support us to project on the future development of the ride-hailing market. With a combination of the previous section's information, this study discusses two factors would likely impact on ride-hailing development and also impact on vehicle battery supply.

Firstly, the population. Consumers lead to market development. According to current ride-hailing service user characteristics, many factors, such as age, income, and place of resident influence on people's preference for choosing ride-hailing services. From the previous study, this study learned that millennials and the urbanization population are two significant driven factors of ride-hailing user volume. Therefore, we collected data based on millennials and the urbanization population to project on the potential development trend of ride-hailing. According to the data of the U.S. Census Bureau on population age projection, it discloses that about 74.3 million millennials in 2050 and

about 80.7% of the U.S. Population living within urban areas (Bureau, n.d.). For the global population projection, the Department of Economic and Social Affairs of the United Nations states that about two in three people will live in urban areas by 2050 ("Commission on Population and Development—51st Session," n.d.). Therefore, this research advises that the number of younger population and urbanization population will push the development of shared mobility in the future.

Secondly, the development of technology is a vital factor impact on ride-hailing future trends. Ride-hailing service is still growing as the continually developed information technology. Based on a recent report of PwC, a combination of autonomous and shared mobility would be the trend in the future. The fleets of autonomous shared mobility will distribute from urban areas and extend to suburban areas (PricewaterhouseCoopers, 2019). Some OEMs already started manufacturing their autonomous vehicles and built strategic collaboration with shared mobility operators. Consequently, many shreds of evidence have been provided in different research to show the emergence of shared autonomous vehicles. For example, prior research illustrates the benefits of ride-hailing with presenting an analysis of a fleet of shared autonomous electric vehicles to provide ride-hailing service in the metropolitan area. A case study has also been showed to explain potential benefits from $1.34 million to $1.52 million through autonomous ride-hailing service (Farhan & Chen, 2018). Although the technology of autonomous still need to be improved, and autonomous ride-hailing has not become a mature market now, vehicle ownership would be optional in an automatic future, and vehicle needs to be selling rides (Anonymous, 2018). Therefore, autonomous and shared mobility will go naturally together in the future and foster ride-hailing growth.

4. Case Study

To accomplish this research with maximum impact, following qualitative process for this case study relies on:

- Discuss research objectives and design
- Share secondary research result with the relative and necessary information
- Conduct interviews with ride-sharing company and automotive battery company, and record data
- Analysis data and brainstorm
- Organized information and feedbacks of the interviews, and then update information back to companies to have more insights or recommendations

On the one side, the largest ride-hailing service provider in China, Didi, has been chosen as the research object because of the following reasons:

- Didi has its large market share in China. It is a typical illustration for us to understand the ride-hailing industry better.
- Several phone interviews have been completed with Didi's purchasing manager. This research gives recommendations based on real-world data of ride-hailing business model and maintenance service.

On the other side, two large global automotive battery suppliers, Johnson Controls and New CarZone, been chosen to guide this research better study cooperation opportunity with ride-hailing company practically. According to Appendix B and Appendix C, this research specifies interview questions. The result of primary research recommends potential partnership opportunities between automotive battery supplier and ride-hailing service provider. Based on communication with Didi, its business model shows the potential opportunity to partner with battery supplier-specific on

maintenance service. Besides, the communication with the automotive battery company suggests potential partner opportunity specific on battery replacement and battery diagnostic technique deployment. The case study result substantiates the information which this research learned from secondary research and also closed the information gap.

4.1.Fleet Size and Business Model of Didi

Didi Chuxing Technology Company is a transportation company in China, and its mission is to become a global leader in the revolution in transportation and automotive technology. Didi devotes itself to become the largest one-stop transportation platform; that is to provide a variety of application-based transportation service options to its customers. Didi began its expansion in 2015 with expanding services around the world. This Chinese largest ride-hailing operator had obtained over 95% market share in private ride-hailing services and over 99% of the taxi market share in China. It is a leading transportation platform that provides application-based various efficient and reliable mobility services to millions of users in China, including Taxi, Express, Premier, Luxe, Bus, Designated Driving, and Enterprise Solutions.

Didi's platform has about 550 million users and over 31 million drivers in total. About 3 million drivers of Didi are full-time drivers for ride-hailing service, and the rest drivers are part-time drivers. Different from Uber or Lyft, Didi employs drivers and owns vehicles (OV). Besides, it has a joint venture fleet and cooperates with third-party partners. Didi owns a vehicle fleet of over 100,000 vehicles now, and it plans to have more OV through its third-party partnerships by the end of 2019. Didi has its fleet expansion in tier-1 and tier-2 cities in China. Tier-1 cities in China represent the most developed areas, such as Beijing, Shanghai, Guangzhou, and Shenzhen. Tier-2 cities in China represent the cities with populations ranging from one to five million (Xu, Zhou & Qiu, 2018).

Another significant difference between Didi and other ride-hailing operators, such as Uber or Lyft, is its business model. To zero in maintenance service of Didi and Uber, their different business model explores a multitude of options for automotive battery suppliers to invest in partnerships. Firstly, Uber does not own any vehicle. For Uber's driver, they have access to scheduled maintenance services from third-party CarAdvise and have discounts if their vehicle needs to be changed batteries. By contrast, Didi owns its large vehicle fleet size. All the vehicles will be scheduled maintenance services directly from the Didi platform. Based on this situation, this research recommends that it would be easier for an automobile battery manufacturer to have a direct battery business with Didi's maintenance model. The potential opportunity attracted this study to have more communication with Didi to close the information gap and identify a proper business strategy for an automobile battery supplier.

4.2.Ride-hailing Vehicle Maintenance and Cost

Didi is investing heavily in its automobile services business by upgrading its maintenance solution service platform. Since Didi has its large fleet size and the large volume of active end-users, they launched their brand-new parts and maintenance service platform and workshops, named as Xiaoju Chefu, to serve their vehicles and independent car owners maintenance service, which includes battery replacement. Xiaoju is the auto repair and maintenance service line under Didi and available in many tier-1 and tier-2 cities, such as Shanghai, Hangzhou, Nanjing, Guangzhou, Shenzhen, and Chengdu. Customers of Didi have easy access to Xiaoju maintenance service through Didi driver application and Wechat application.

There are two types of Xiaoju Stores. First of all, the small stores are responsible for the most common maintenance items on vehicles, such as battery replacement, oil change, and tire replacement. The preventive maintenance schedule calls for a battery replacement after one-year

usage or at 100,000 km, whichever comes first. The large stores are responsible for more complicated maintenance items, such as vehicle breakdown and accident repair. Based on the interview with Didi, this study also learned that maintenance cost for the ride-hailing vehicle is about five times more than a standard owned vehicle's maintenance cost. There are two main reasons for the high maintenance cost. One reason is higher accident rates, and another reason is higher vehicle utilization. The average annual vehicle mileage of a typical privately-owned vehicle is 20,000 km. The ride-hailing vehicle has higher utilization with average annual vehicle mileage of 100,000 km to compare with a typical privately-owned vehicle. The interview data confirm secondary information we learned previously; that is, ride-hailing would be brought more travel mileage, utilization, and battery replacement frequency to a vehicle.

4.3.Automotive Battery Supplier Development Strategy and Partnerships

The New CarZone used to be CarZone, is a Chinese company focus on automobile aftermarket business. The CarZone joints venture with B2C e-commerce Tmall automotive division and QCCR.com, a car care platform, to become a new company named as New CarZone. According to our communication with automobile battery company, the automobile aftermarket develops rapidly in China. However, there is not an integrated supply chain system to serve car owners to find their regular maintenance workshops. Therefore, New CarZone develops many cooperation relationships with OEMs, auto parts suppliers, and also transport service providers to central and expand a whole supply chain system to provide reliable vehicle maintenance services for car owners. They expect to expand its supply chain system to cover about 100,000 stores nationwide and also cover about 90% car types. Moreover, during the interview, New CarZone mentioned that they already build a cooperative relationship with the largest ride-hailing company Didi and supply automotive battery to Didi in time of need. Besides, they also have a partnership with an extensive

global automotive battery manufacturer Johnson Controls to supply their battery inventories in many different types. According to the data from automotive battery supplier, this research explored the partnership between ride-hailing company and automotive battery supplier, and the automotive battery suppliers state that an integrated supply chain system does demand further cooperation with many other automobile service provider and automotive product suppliers in the future.

4.4.Ride-hailing Operator Partnerships with Automotive Battery Supplier

Based on our interview with Didi, we learned that Didi initiated its D-alliance Program with more than 31 partners span OEMs, parts and components manufacturing, electric vehicle series, and digital map services. Since the new car sales have declined sharply in China, automobile sales to the ride-hailing company have helped OEM decrease their inventories and also increase the availability of shared mobility. Because Didi performs its maintenance on fleet vehicles, and heavily vehicle utilization drives up annual maintenance costs, Didi is keenly interested in a direct relationship with automotive battery supplier. They build a cooperative relationship with New CarZone in China, and Didi also expressed its interest in cooperating with automotive battery manufacturers and developing more cooperation opportunities with battery suppliers to serve its owned large fleet size better. After this research giving feedback to respondents, the New CarZone indicates that they do have an interest in partnership with the ride-hailing company. New CarZone has its supply chain system covered with more than 80,000 stores across the country, including various parts and accessories, including engine oil, tires, batteries, and quick-wear parts, but it still developing their entire supply chain system with demanding more cooperation. Therefore, to explore the partnership with the ride-hailing company match with its business development strategy now.

In addition, in 2018 November, Uber have partnered with CarAdvise, the leading vehicle repair & maintenance technology platform ("Gale Academic OneFile—Document—CarAdvise Named as Uber Pro's Exclusive Repair & Maintenance Partner," n.d.). The objective of this partnership is to improve customer experience for Uber's driver partners on cost-effective and convenient maintenance service. As an automotive battery supplier, the indirect relationship with ride hailing companies' end customers could also been establish through third-party maintenance service companies. For example, based on the partnership between Uber and CarAdvise, an automotive battery supplier can offer Uber's driver battery discount through CarAdvise platform. When a driver needs to replace the car battery, he/she could go to CarAdvise and offer one online or through retail stores with discounts. Meanwhile, since CarAdvise platform has its existing and potential users, establishing an indirect partnership with Uber through CarAdvise will also promote the battery sales of car battery suppliers. In addition, to establish relationships with more end consumers through CarAdvise platform would help the supplier increase the brand exposure.

5. Discussion

Through inductive analysis, this research discovers the business development pattern of ride-hailing service providers and automotive battery suppliers and also explores the potential interrelationship between ride-hailing companies and automotive battery manufacturers. Although this study provides findings based on the research questions with a relevant literature review and data collection, this study has limitations and needs further research to discover. First of all, a limitation on a complete similar topic with prior research may impact the result. Many prior pieces of research and studies on relevant topics provide valuable information, but a more effective methodology, including a larger sample size, would result in further research and clarification. Secondly, the sample size of this study is small. There are lots of ride-hailing companies and

automotive battery suppliers around the world. However, it is a challenge to find all pertinent information and make a conclusion. This study provides a limited approach for an automobile battery manufacturer to create a link with different types of ride-hailing companies. However, a larger sample size would ensure better results in qualitative research and address the research problem more effectively. This research illustrates one available method to build a direct partnership with one case study. To link with many other different types of ride-hailing companies, there is a need for further research with more information and data collection to understand better how to approach differently under different scenarios.

6. Conclusion

This research recommends that there are potential cooperation opportunities for automotive battery suppliers and ride-hailing companies to develop their business and also achieve win-win outcomes. With the inductive analysis of primary and secondary research, this study answered three research questions. First of all, this research considered that ride-hailing already changed the mobility trend from "owning a car" to "sharing a car." In the future, with more and more people integrating their daily life with shared mobility, ride-hailing will persevere its development in the shared mobility market.

Secondly, different ride-hailing companies have different maintenance service models. For some ride-hailing companies who own a large fleet service, they develop their maintenance service platform or workshops to take responsibility for their vehicle and battery ownership. To provide more dependable quality and customized service for their vehicles and also for independent car owners, the ride-hailing company with a large amount of fleet and active end users would also be expected to launch their maintenance service platforms or workshops by themselves. Moreover, the owned maintenance service platforms or workshops will also help them to enhance the B2B2C

closed loop. Some ride-hailing companies grow their maintenance service in a different model with a cooperating third-party maintenance platforms or chain stores and provide discounts for their drivers. However, there are still have some ride-hailing companies that have not attained providing maintenance service to their customers. Therefore, there would be potential opportunities for the ride-hailing company to explore further on maintenance service in the future and better serve their customers.

At last, for an automotive battery supplier, the potential opportunity to cooperate with the different business model ride-hailing companies is extraordinarily attractive. For the ride-hailing company which owns a large size of vehicles and demand batteries, the automotive battery company can supply quality products and meet battery needs. For the ride-hailing company which does not own a fleet and cooperates with third party maintenance platforms, the automotive battery suppliers can offer discounts to third party maintenance platform and provide products indirectly to ride-hailing's end-consumers.

The primary research of this study provides the foundation and evidence-based knowledge on studying potential partnership opportunity. Through several one-on-one interviews, this research obtains a set of insights into developing a feasible growth strategy for automotive battery manufacturers and also reconfirms the information of secondary research. Also, a case study examines the proposition that there is a potential opportunity for automotive battery manufacturers to cooperate with ride-hailing companies. Consequently, this research suggests that partnership between automotive battery suppliers and ride-hailing companies is a way to serve customers in a fast-developing, emerging market better.

Acknowledgement

I would like to thank Dr. Jacquelyn Rees Ulmer and Dr. Anthony M. Townsend for their support and guidance. I am grateful to all faculty, friends, and classmates at Iowa State University. I would also like to thank my family. They gave me so much love and guidance. Most importantly, I especially appreciate all respondents who support me and provided extensive and valuable insights for this research.

Appendix

Appendix A. Ride-hailing Service Provider Worldwide

Region	*Country*	*Name*	*Global Driver Volume/Global Fleet Size*	*Ride-hailing Type*
US&CA	***United States***	Uber	3.9 million drivers	Ride-hailing
		Lyft	2 million drivers	Ride-hailing
		Curb Mobility, LLC	100,000 drivers, 50,000 vehicles in network	Online Taxi
	Canada	Uber	3.9 million drivers	Ride-hailing
		Lyft	2 million drivers	Ride-hailing
		Taxify/Bolt	500,000 + drivers	Ride-hailing and Online Taxi
		Kangaride	475,000 members	Shared Journey
		Poparide	41,000 members	Shared Journey
LATAM	***Mexico***	Uber	3.9 million drivers	Ride-hailing
		Cabify	13 million customers globally (15,000 drivers in Chile)	Ride-hailing and Online Taxi
		Easy Taxi	400,000+ Taxi drivers	Online Taxi
		Didi	21 million drivers	Ride-hailing
		Taxify/Bolt	500,000 + drivers	Ridesharing and Taxi
		BlaBlaCar	70 million users	Shared Journey
	Argentina, Chile, Colombia, Ecuador and Peru	Uber	3.9 million drivers	Ride-hailing
		Cabify	13 million customers globally (15,000 drivers Chile)	Ridesharing and Taxi
	Brazil	Uber	3.9 million drivers	Ride-hailing
		Didi (acquired 99)	21 million drivers	Ride-hailing
		Cabify	13 million customers globally (15,000 drivers in Chile)	Ridesharing and Taxi
		Easy Taxi	400,000+ Taxi drivers	Online Taxi

Region	Country	Name	Global Driver Volume/Global Fleet Size	Ride-hailing Type
EMEA	Spain	Cabify (but Spanish taxi drivers continue to strike against ride-hailing companies)	13 million customers globally	Ridesharing and Taxi
		Uber	3.9 million drivers	Ride-hailing
	France	BlaBlaCar	70 million users	Shared Journey
		Uber	3.9 million drivers	Ride-hailing
		Taxify/Bolt	500,000 + drivers	Ridesharing and Taxi
	Germany	Uber (limited service in Berlin)	3.9 million drivers	Ride-hailing
		MyTaxi	45,000 affiliated taxis	Online Taxi
	Russia	Yandex	400,000 + drivers	Online Taxi
		Gett	35,000 drivers (Worldwide), 2000 drivers (NYC)	Ride-hailing
	United Kingdom	Uber	3.9 million drivers	Ride-hailing
		Addison Lee	4,000 vehicles	Online Taxi
		Gett	35,000 drivers (Worldwide), 2000 drivers (NYC)	Ride-hailing
		Ola	9,00,000 vehicles	Ride-hailing
	Nigeria, Kenya, Tanzania, Uganda, South Africa	Uber	3.9 million drivers	Ride-hailing
		Taxify/Bolt	500,000 + drivers	Ridesharing and Taxi
	Egypt	Uber	3.9 million drivers	Ride-hailing
		Careem	planning to have a female driver of 20,000 by the year 2020, 30 million registered users	Ride-hailing
	Turkey	BiTaksi	11,000 drivers	Online Taxi
		Uber	3.9 million drivers	Ride-hailing
		Careem	planning to have a female driver of 20,000 by the year 2020, 30 million registered users	Ride-hailing
	Israel	Gett	35,000 drivers (Worldwide), 2000 (NYC)	Ride-hailing
		Uber	3.9 million drivers	Ride-hailing
	United Arab Emirates/Middle East	Uber	3.9 million drivers	Ride-hailing
		Careem	planning to have a female driver of 20,000 by the year 2020, 30 million registered users	Ride-hailing

Region	*Country*	*Name*	*Global Driver Volume/Global Fleet Size*	*Ride-hailing Type*
APAC	**India**	Ola	9,00,000 vehicles	Ride-hailing
		Uber	3.9 million drivers	Ride-hailing
	South Korea	Kakao T	200,000 drivers	Online Taxi
		Uber (limited)	3.9 million drivers	Ride-hailing
	Indonesia, Malaysia, Philippines, Singapore, Vietnam, Thiland	Grab(27.5% stake Uber)	2.6 million drivers	Ride-hailing and Taxi
		Go-viet/Go-Jek	1,000,000 + drivers	Ride-hailing and Taxi
	Japan	Didi (Didi Mobility Japan)	21 million drivers	Ride-hailing
		Uber (partnering with local taxi companies)	3.9 million	Ride-hailing
	Australia	Uber	3.9 million (60,000 driver-partners in Australia)	Ride-hailing
		Taxify/Bolt	500,000 + drivers	Ridesharing and Taxi
		Ola	9,00,000 vehicles	Ride-hailing
		Didi	21 million drivers	Ride-hailing
	China	Didi (Uber selling its China branch to Didi)	21 million drivers	Ride-hailing
		UCAR (ShenZhou 神州专车)	daily orders for chauffeured 250,000	Ride-hailing
		Yongche - Yidao (易到用车)	daily orders for chauffeured 40,000	Ride-hailing

Appendix B. Interview Question for Ride-hailing Company

Interview Questions
Fleet
How big is your company's fleet size / driver volume? (2019)
How much fleet growth are your company projecting by 2025? 2030?
Will fleet expansion involve geographic expansion to more cities / metro areas? Countries?
Is there a minimum population density or other demographic factors that you consider critical to successfully launching car sharing platform in each location?
How old are the vehicles in your company's fleet?
What is the average miles/trip for ride-hailing users?
How is the average utilization rate on ride-hailing vehicles? What is the long-term target/goal?
How many miles per year does a vehicle in your company's fleet average? What is the long-term target or goal?
Maintenance
How is maintenance done on the ride-hailing cars?
Is car maintenance performed through a local garage? Or through any specific workshop chain?
What are the most prevalent/common maintenance items on your company's vehicles? For example, tire replacement, brakes, battery?
What is the frequency for replacing a battery? Is this more or less often than for a typical privately owned and operated vehicle?
Does your company have a preventive maintenance schedule on vehicles or does your company "run-to-fail" for most wear items?
Would your company consider deploying battery testing tools if they enable early identification of potential battery failure, ensuring minimal unplanned downtime?
Customer's Cost
How would your company maintenance costs for a car-sharing vehicle compare to a standard/privately-owned vehicle? 50% higher per year? Same?
Does your company have any maintenance partners, or replacement parts partners that provide discounts on parts/service for vehicles vs. standard rack rates?
What's typical annual maintenance budget on a car sharing vehicle?
How much unplanned downtime per vehicle does your company experience today?

Appendix C. Interview Question for Automotive Battery Supplier

Interview Questions
What does your company think about the trends in the ride-hailing market?
What does your company think about the opportunities for ride hailing market?
How big is the potential cooperation for automotive battery manufacturer with ride-hailing company?
Where could be the gaps?
What does your company think about the strategy implication based on your company's business model?
What does your company think about the resources for developing this partnerships?

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