Design Guidelines for Shared Micromobility in Town and City Tourist Destinations

by

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Abstract

Tourism that grows the regional economy relies on an adequate transportation system. Tourists usually visit multiple spots within a destination. Those who take public transit have less flexibility due to fixed routes and time schedules. On the other hand, driving personal or rental cars comes with traffic and parking problems and higher expenses. These hassles lower the tourist experience. Moreover, heavy use of vehicles negatively impacts the environment and the locals. Thus, there is a need to develop solutions that address the problem of transportation in tourist destinations. Shared micromobility seems a good solution, decreasing car use and pollution and enabling people to move easily. But shared micromobility programs could easily fail with inappropriate decision-making and service/product design. As a result, this study aims to formulate design guidelines for shared micromobility programs in city and town destinations. The study proposes the design flow and the recommendation checklist using the findings from the literature review, case studies, and survey research, helping organizations and government authorities develop tourism-focused shared micromobility programs that promote local tourism, tourist experience, and environmental benefits.

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War Eagle!

Table of Contents

List of Tables

List of Figures

Chapter 1 Introduction

1.1 Problem Statement

Tourism development usually gives a boost to the economic growth of a country. It grows regional prosperity, employment opportunities, international reputation, and sums of foreign exchange. However, tourism development significantly relies on a well-designed transportation system (Davenport, & Davenport, 2006). Tourists visit multiple attractions within a town/city destination, but most of them have a common problem: mobility. For tourists taking public transit, routes and timetables might limit travel flexibility. And if they rent a car, pickup/return time and locations could still be a hindrance. Tourists driving their own car would encounter parking difficulties and traffic. These hassles and extra time/energy consumptions in a trip may considerably lower the tourist experience and make them give negative reviews toward the destination. In addition, heavy use of vehicles in a tourist destination increases air pollution, greenhouse gas pollution, and traffic congestion, negatively impacting the environment and bothering the residents.

Over the last few years, shared mobility has become a popular business trend. One of the shared mobility modalities, shared micromobility, quickly grew in size worldwide. Many major cities like New York, San Francisco, and Chicago provide shared micromobility services, complementing the existing transportation system (Inturri et al.,

2019) and allowing residents and visitors to move within the area freely. Shared micromobility refers to the shared use of light vehicles, such as scooters, bikes, and mopeds. People can use either station-based or free-floating shared micro-vehicles anywhere and anytime for short-distance travel (Heineke et al., 2019). Shared micro-vehicles not only decrease the use of motor vehicles and environmental pollution but also enable people to move fast and easily instead of walking, saving time and physical energy. Therefore, shared micromobility seems to be an ideal solution for tourism transportation. It makes it easier for tourists to explore a destination and get to the attractions. Tourists who depend on public transit can visit anywhere they want instead of being bound by fixed routes and timetables. Those who drive rental or personal cars can enjoy the journey without annoying traffic and parking problems. Shared micromobility creates a friendly tourism transportation system, delivering a better tourist experience, and promoting a more eco-friendly sightseeing style.

Shared micromobility changes the mobility landscape in cities and towns throughout the world and positively contributes to tourism development and the environment. Nevertheless, a viable shared micromobility program requires comprehensive planning and management (Transportation for America, 2019), and service design and industrial design play important roles in the process (Frog Design, 2020). Currently, there are insufficient studies to guide authorities and companies on designing promising shared micromobility services and products for tourists from a design perspective. Thus, a lack of study on developing design guidelines for shared micromobility in town and city tourist destinations has been identified.

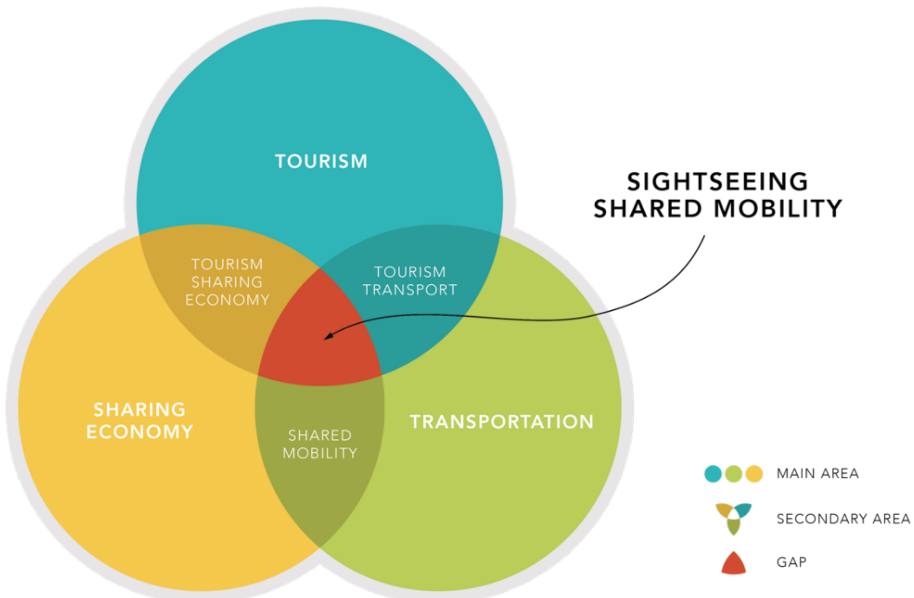


Figure 1: The Research Gap

1.2 Need for Study

Tourism creates revenue, jobs, advanced infrastructures, and international visibility in a region. It is important for these benefits it brings. It was indicated that there is a correlation between transportation and tourist experience and the tourism industry. The better movability tourists have in a city or town, the more appealing and satisfying the tourist destination is for travelers (Davenport & Davenport, 2006; Vetter, 1985). However, tourism transportation activities are regarded as one of the major sources of environmental pollution owing to heavy energy and fossil fuel consumption. The world faces a dilemma over the development of tourism transportation. And it is necessary and valuable to find out an effective solution for the dilemma.

As people today pay more attention to eco-friendly lifestyles, there is an opportunity to evolve a new look of tourism transportation. In recent years, shared micromobility has drawn interest all over the world since its business potential and benefits of environmental sustainability. It seems to fit in the subject of tourism transportation to solve the problem. Nevertheless, it is not easy to plan and run a shared micromobility program. Over the last few years, many shared micromobility startups failed because of wrong decision-making and inappropriate service/product design. Not to mention that developing sightseeing shared micromobility services and products requires adequate considerations toward tourists' needs and preferences. Therefore, there is a need to draw up design guidelines as a tool for startups, companies, and governments that desire to operate a successful shared micromobility program.

Additionally, design plays a crucial role in the shared micromobility industry. For example, operators can see the bigger picture and create pleasant and efficient operations through service design; designers can generate innovative and micro-vehicle and relevant accessory concepts through industrial design. Hence, it is essential to explore further possibilities and opportunities for design studies in the field of shared micromobility.

1.3 Objectives of Study

This study aims to formulate the design guidelines that assist relevant personnel in planning, developing, and improving a shared micromobility program in city and town tourist destinations. Towns and cities are primary and popular types of tourist destinations because they are easy to access and suitable for all (Stainton, 2020). And the road condition in cities and towns is an ideal destination to offer shared micromobility services. The study involves a literature review, case studies, and survey research, establishing the framework of the design flow, carrying out business analysis, and investigating tourists' needs, preferences, and opinions. The findings throughout the research will be the ingredients to form the design guidelines, which provide the design flow for developing sightseeing shared micromobility and recommendations in aspects of service design, product design and business. Government authorities, companies, and startups can apply the tool to develop a sightseeing shared micromobility program that enhances tourist experience and promotes local tourism and environmental benefits in the long term.

1.4 Definition of Terms

1. **Micro-vehicles:** a range of compact and lightweight vehicles driven by users personally with speeds up to 15-30 mph and weight below 500 lb. (ITDP, 2020; SAE

International, 2019). The term “micro-vehicles” and “micromobility” are often interchangeable.

2. **Shared Micromobility:** a transportation resource and strategy that enables users to gain short-term access to shared micro-vehicles on an as-needed basis (Shaheen, 2016; Transportation for America, 2019).

3. **Tourist Destination:** a region that is marketed or markets itself as a place for tourists to visit and is significantly dependent on revenues from tourism (IGI Global, 2017).

4. **Tourist Experience:** a psychological process of tourists during the interaction with destinations, creating memories, emotions, perceptions, and impressions related to places (Noy, 2008).

1.5 Assumptions

For the study, there is the main assumption that shared micromobility services in tourist destinations have a positive impact on sightseeing activities and experiences for tourists. The proposed design guidelines will help personnel develop successful sightseeing shared micromobility in town and city destinations. Due to the different environmental characteristics, tourists are assumed to have different needs and preferences for shared micro-vehicles between city and town destinations. Furthermore, it is assumed that the literature indicating existing findings, frameworks, the problem of tourism transportation, and the potentiality of shared micromobility is true and correct and that the sightseeing shared micromobility is a feasible and effective solution in the real world.

1.6 Scope and Limitations

The study is focused on developing sightseeing shared micromobility, which is the overlapped domain of tourism, transportation, and sharing economy. Since shared micromobility includes service and vehicles, service design and product design are emphasized in the study. The study aims to formulate the design guidelines for shared micromobility in town and city tourist destinations. Even though there are various types of tourist destinations (e.g., beach areas, mountain areas, resorts, etc.), the primary focus is narrowed down to the most common type – city and town -- due to the limited duration of the study. The majority of shared micromobility programs launch and operate in cities and towns. Besides, visiting a city/town as a tourist is an experience that most people have. Therefore, the city/town setting makes the study more practical and easier to undertake.

1.7 Procedure and Methodology

1. **Literature Review:** establish a comprehensive understanding of topics related to the study by reading relevant journal articles, papers, books, and other sources; collect useful information for further research stages.

2. **Case Study:** investigate successful and failed examples in the shared micromobility industry, and identify factors contributing to the success and failure.

3. **Survey Research:** draw up a questionnaire in reference to relevant literature; obtain approval from the Institutional Review Board (IRB); distribute the anonymous questionnaire online and conduct statistical analyses.

4. **Design Guidelines:** formulate the design guidelines for shared micromobility in town and city tourist destinations based on the results received from literature review, case study, and survey research.

5. **Application:** carry out a project to demonstrate the usage of the design guidelines.

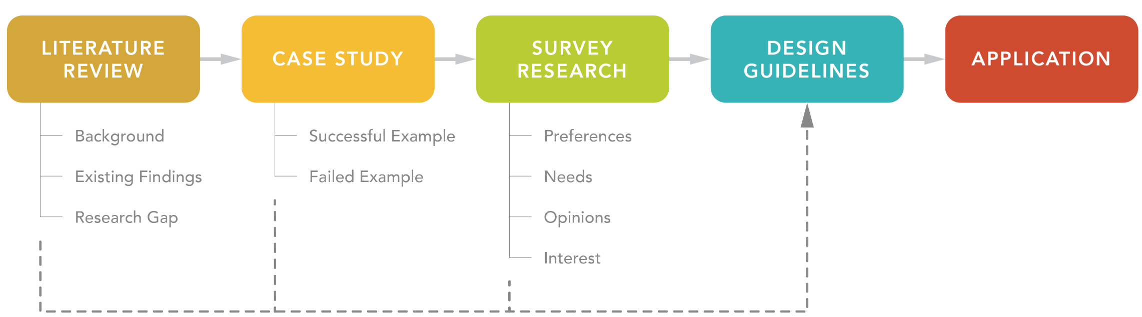


Figure 2: Procedure of the Study

1.8 Anticipated Outcomes

It is anticipated that the outcome of the study will provide the design guidelines for shared micromobility in town and city tourist destinations. The presented design guidelines include the design flow and recommendation checklist toward business, service, and product design. The design guidelines can be applied as a tool for varying cases, helping personnel develop sustainable sightseeing shared micromobility in towns and cities, elevating tourist experience, and promoting eco-friendly tourism transportation.

Chapter 2 Literature Review

2.1 Sharing Economy

2.1.1 The Original Sharing

Sharing is an ancient social concept. It was a basic social norm back then (Bowles & Choi, 2013). For example, the mobile hunter-gatherers in the late Pleistocene would share their food, which was considered public property within the tribe. According to the book *Debt: The First 5,000 Years*, written by the anthropologist David Graeber (2012), the Iroquois would stock goods in longhouses, and councils would assign who was able to use what. In many prehistoric villages were found evidence of having collective storage spaces and the behavior of sharing. However, around 11,000 years ago, private property started forming when people shifted from hunting and gathering to settled agriculture. Farmers would individually occupy a piece of land, sow and reap crops independently, and not share the harvest they have paid through time and physical energy with others (Strauss, 2017). In medieval England, common land became a widespread concept. Each lord of the manor under feudalism rented out land holdings to farmers for mutual benefits. Farmers were allowed to grow crops and raise livestock, creating a self-sufficient and collaborative society (Brooks, 2016).

During the industrial revolution, mechanization transformed society and the economy; workers' living was threatened and resulted in poverty. In the 19th century, the cooperative movement began in Europe in order to relieve the problem. Cooperative societies served the members with shared resources, goods, and welfare, setting free the members from the wealthy and firms' oppression (Kittredge, 2020). The U.S. government encouraged automobile ride-sharing to conserve resources and raise people's morale during World War II. Later on, in 1973, people also participated actively in carpooling in response to the oil crisis (Ferguson, 1997).

People tend to adopt sharing to get through economic or environmental difficulties, leveraging mutual resources to benefit each other. As society changed, shared things were no longer limited to those related to basic survival needs. The emergence of the internet created platforms enabling modern people to share and access digital resources, such as articles, images, music, and videos. Moreover, the internet made it efficient to share ownership of assets. Even though the nature of sharing may be the same, the way and intention behind it were different from the several centuries before (Strauss, 2017).

2.1.2 Development of Sharing Economy

Marcus Felson, Professor of Criminal Justice at Texas State University, and Joe L. Spaeth, Professor of Sociology at the University of Illinois, published a paper entitled

"Community Structure and Collaborative Consumption: A Routine Activity Approach" (1987). They have been credited as the first scholars to bring up the conception of collaborative consumption, becoming the foundation of sharing economic resources. Felson and Spaeth (1978) defined collaborative consumption as the act of one or more persons engaging in joint activities to consume economic goods or services. Collaborative consumption encourages multiple people to share the use of goods and services by bearing costs collectively. The system enables consumers to either provide or obtain resources temporarily or permanently through transfer by peer-to-peer or a mediator. Compared with individual consumption, collaborative consumption optimizes and extends the value of underutilized goods and services by redistributing the right of use among a group of people. It improves benefit, efficiency, and sustainability for the whole society. In the book *What's Mine Is Yours: The Rise of Collaborative Consumption*, British scholars Rachel Botsman and Roo Rogers (2010) described that with collaborative consumption, consumers have alternatives to access ownership by sharing, swapping, trading, or renting. They have divided collaborative consumption into three separate systems: redistribution markets, collaborative lifestyles, and product-service systems.

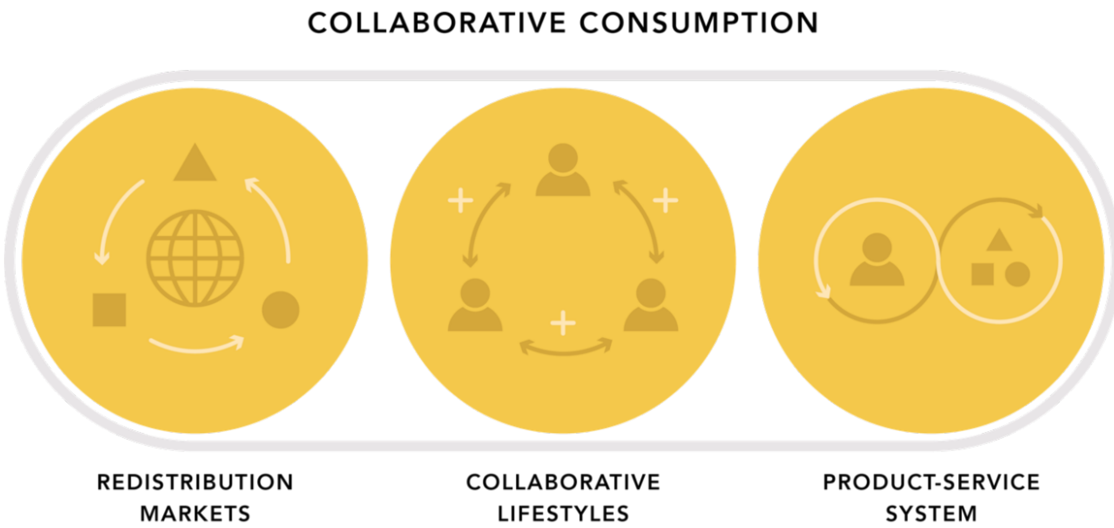


Figure 3: Three Systems of the Collaborative Consumption
Source: Compiled by the author based on Botsman & Rogers (2010)

Redistribution markets refer to where consumers can transfer items that are no longer being used to those who need them, in order to stretch items' lifecycles. The markets advocate the five R's: Reduce, Reuse, Recycle, Repair, and Redistribute (Heyman, 2017). The second system, collaborative lifestyles, are where consumers can share spare resources for free or for profit, such as sharing assets, time, labor, skills, etc. The last, product-service systems, are what provide services to allow consumers to access products without owning them.

The discussion of a sharing economy based on the concept of collaborative consumption arose during the time of the Great Recession. Though the origin of the term "Sharing Economy" was uncertain, Lawrence Lessig, the Professor at Harvard Law School, was possibly first to use the term in 2008. Due to the increasing unemployment rate and declining purchasing power, it was necessary to develop new ways to consume things in response to economic depression. With the impact of the global financial crisis, plus the awareness of the world population explosion, resource depletion, and environmental protection (Bardhi & Eckhardt, 2012), people chose a more economical and sustainable way to use resources.

The sharing economy is considered a platform-based collaborative consumption. It is defined as an economic model involving activities of “acquiring, providing, or sharing access to goods and services," which are "often facilitated by a community-based online platform” (Investopedia, 2014), “an economic activity that involves individuals buying or selling usually temporary access to goods or services especially as arranged through an online company or organization” (Merriam-Webster, 2015). Botsman and Rogers (2010) mentioned that the progress on the internet and new technologies stimulated the evolution of the sharing economy because it created opportunities to make connections among people, even strangers from different places, and provided platforms for sharing to take place.

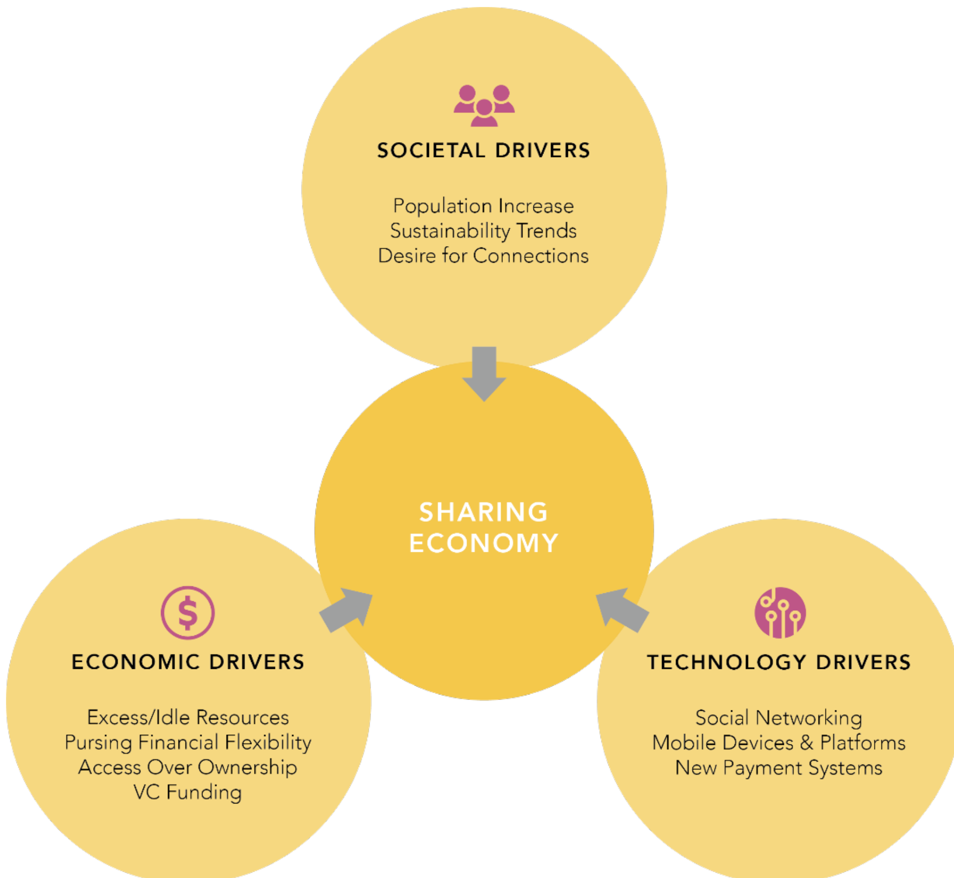


Figure 4: Three Drivers of the Sharing Economy
Source: Compiled by the author based on Owyang et al. (2013)

There are two main business models in sharing economy, distinguished by the structure of participants. One is the peer-to-peer model, also known as consumer-to-consumer (c2c). In this context, there is an intermediary company between a user and an asset/service provider in charge of matching and managing the demand and supply parties via its online platform (e.g., Airbnb, TaskRabbit, Uber). As traditional companies recognized the opportunities in the sharing economy, the other business model came along. That is, the business-to-peer model, also called business-to-consumer (b2c). Business-to-peer companies play two roles in transactions, supplying their assets or services and providing platforms to users (e.g., WeWork, Lime, Zipcar).

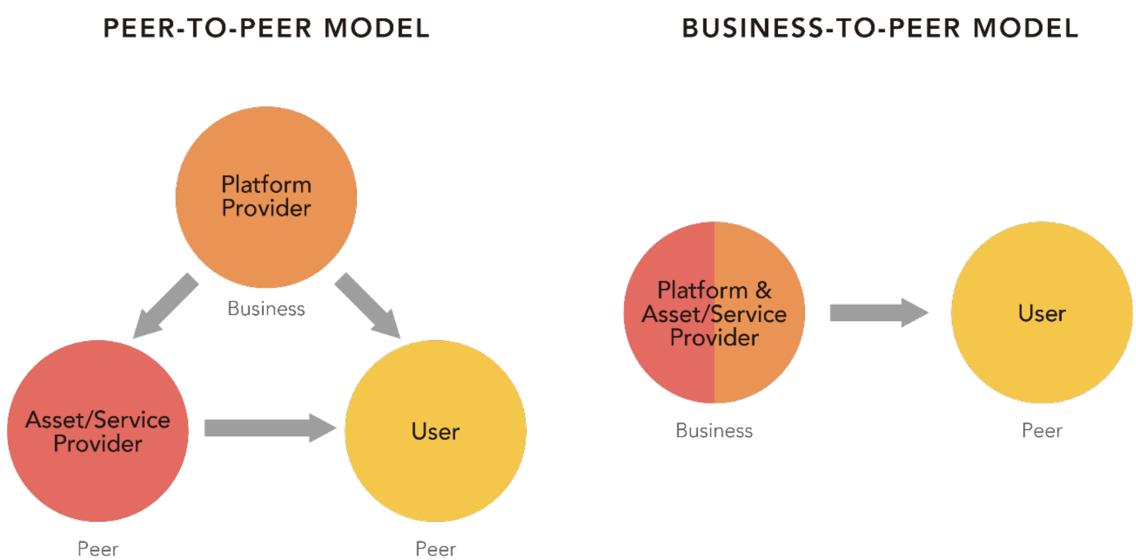


Figure 5: Business Models in Sharing Economy
Source: Redrawn by the author based on PwC (2016)

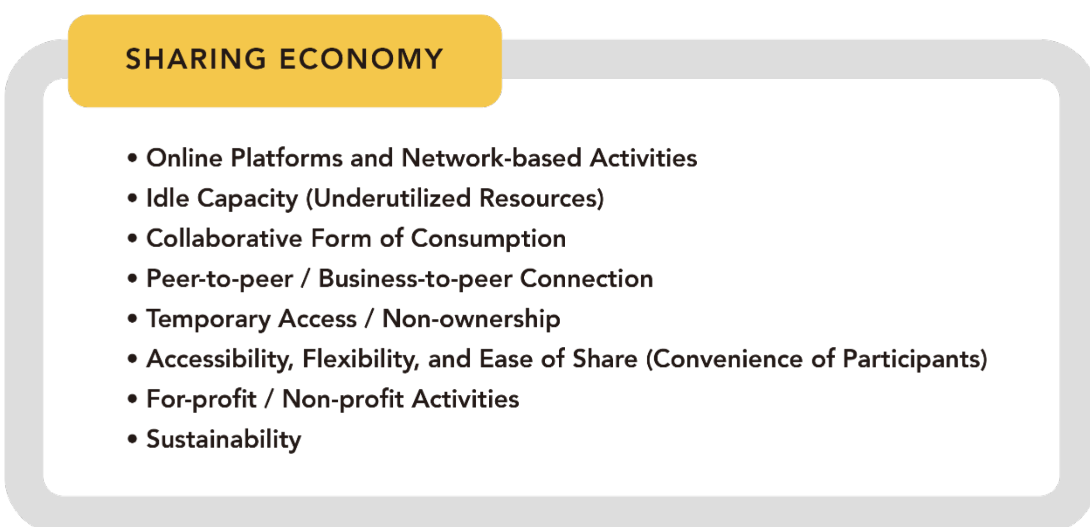


Figure 6: Main Features of Sharing Economy
Source: Redrawn by the author based on Ranjbari et al. (2018)

As Botsman (2012) said in her TED talk: “The real magic and the secret source behind collaborative consumption marketplaces like Airbnb isn't the inventory or the money. It's using the power of technology to build trust between strangers.” The collaboration will fail if any party of the market breaks the trust. Therefore, trust is the crucial cornerstone and is deemed as the main currency in the sharing economy. Anastasia Belyh (2019), an entrepreneur and business blogger, mentioned in her article that mutual trust among companies, stakeholders, and participants contributes to developing a culture of trust and strengthening relationships in the whole society. A sharing economy also contributes to the maximum utilization of resources, exploiting underutilized resources, circulating idled resources, reducing wastage of resources, and slowing down resource depletion. Besides, the new business model changes the role of companies. They were only services or products providers at first. But now, they could also be intermediaries and advisors. Subsequently, role changing has enriched the variety of products or services on the market. However, there are some security risks to the sharing economy since this internet-led process involves data transfer, including personal identity and payment info. In addition, when it comes to disputes, the sharing economy could have accountability issues (Belyh, 2019). Typically, intermediary companies tend to avoid responsibility when disputes occur.

To avoid this, intermediary companies must supervise any party strictly in the process of transactions.

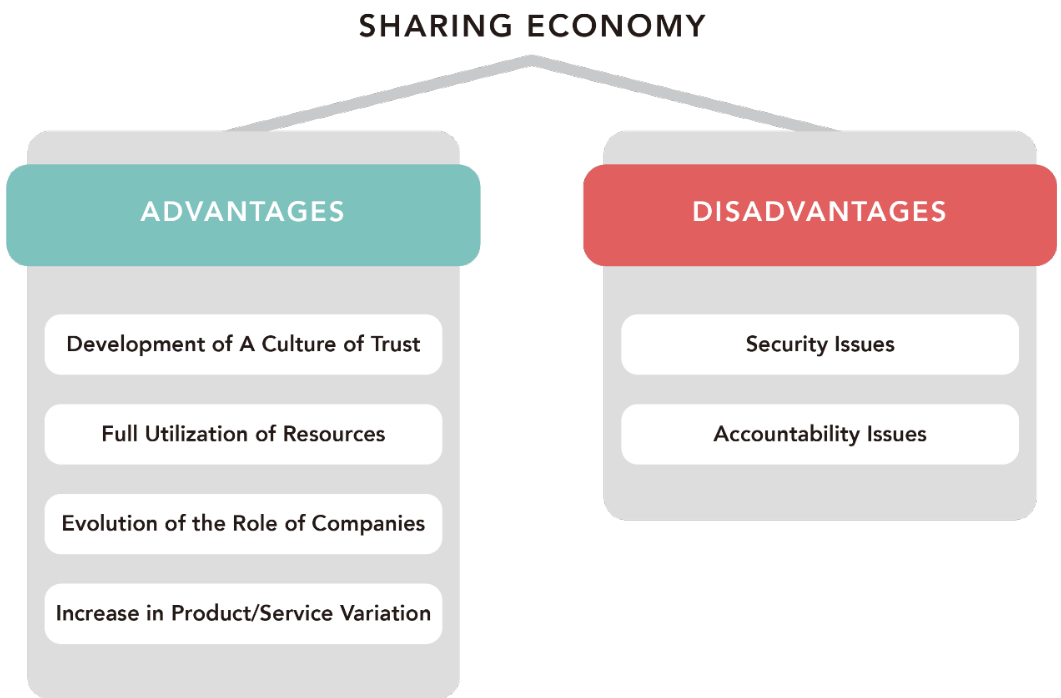


Figure 7: Advantages and Disadvantages of Sharing Economy
Source: Compiled by the author based on Belyh (2019)

As one of the fast-growing business trends (Miller, 2019), the concept of the sharing economy has been applied in a variety of fields. Currently, the sharing economy can be categorized into six different sectors: goods, services, transport, space, food, and money, and each sector is broken down into sub-sectors under similar characteristics or purposes.

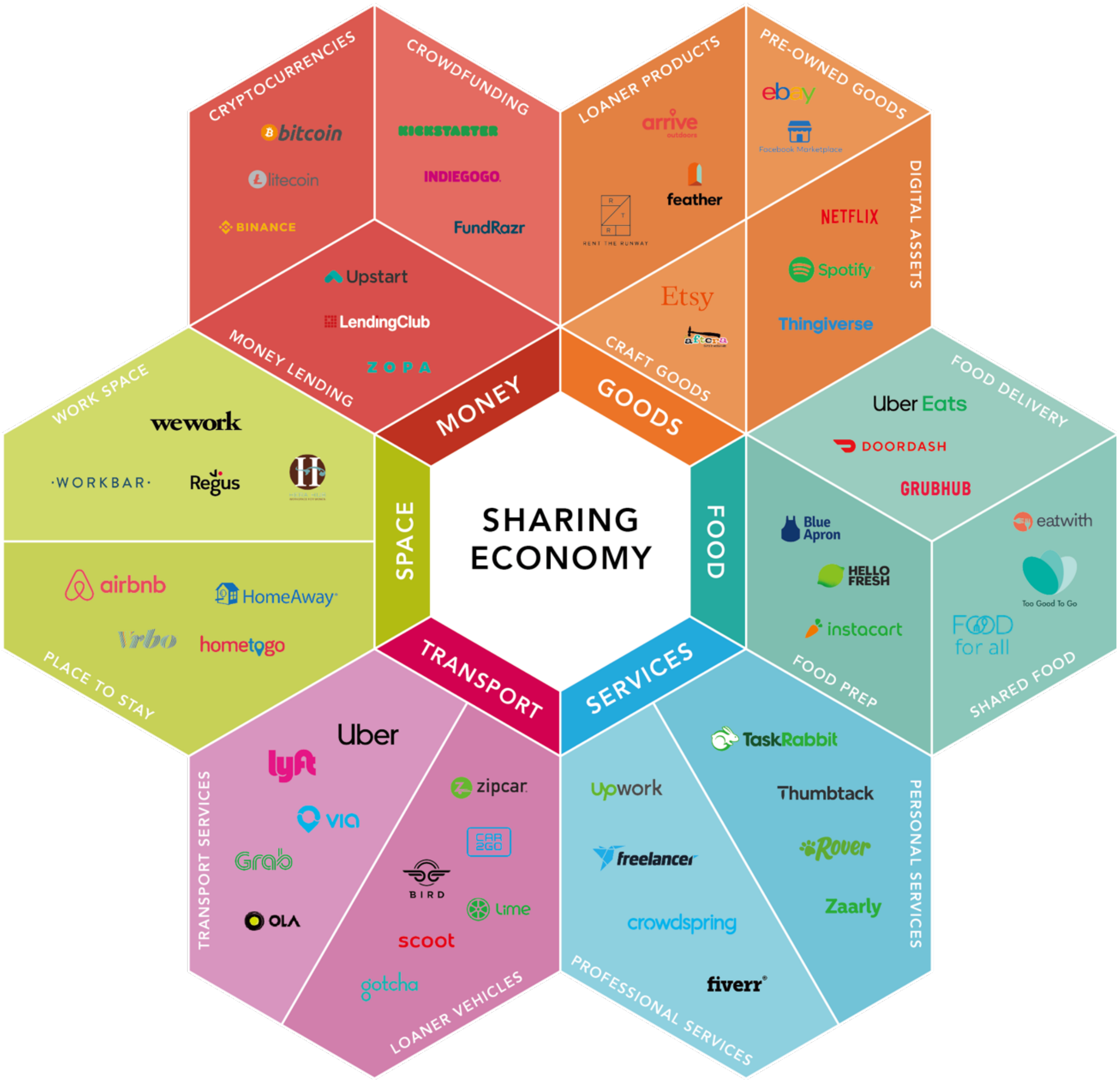


Figure 8: Sharing Economy Sectors and Example Companies

Source: Redrawn by the author based on Owyang (2014)

The sharing economy has been nominated as one of the "10 Ideas that Could Change the World" by Time magazine (2011). It became an "unstoppable and accelerating" trend (Sundararajan, 2017). The realm of the sharing economy will continue expanding and growing as new business ideas come up.

2.2 Shared Mobility

Transport is one of the key sectors in sharing economy. Statistics show that the global value of shared transportation has been estimated up to 350 billion U.S. dollars in 2020 (Statista, 2020). It can be seen that there are great demands and opportunities for shared mobility all over the world. The literature review in terms of shared mobility has been done in the study for a wider understanding of this sector.

As cities grew and extended rapidly, urban planning could not catch up with the speed of population increase, resulting in chaotic traffic and inadequate public transport (Pojani & Stead, 2017). More and more people purchased private vehicles to deal with mobility problems. However, in this way, traffic congestion is getting worse because of an increasing amount of vehicles, which turned out to be a vicious circle and aggravated the problem (Enoch, 2016). Statistics show that 95% of the time that private vehicle stays unused in the garage, and the seat occupancy rate of a four-seater car is below 50% on average (Third United Nations Conference, 2016). Moreover, excessive vehicle ownership and use cause insufficiency of parking spaces, a rising traffic accident rate, and environmental pollution, which lower urban residents' quality of life. As for suburban and rural areas, it seems impractical to establish a proper public transportation system due to low population density and unbalanced urban-rural allocation of resources (Higginbotham, 2000). However, residents in suburban and rural areas have a higher demand for transportation to move around a broader landscape than urban areas. Apparently, there is a transportation problem for both urban and rural areas that needs to be solved.

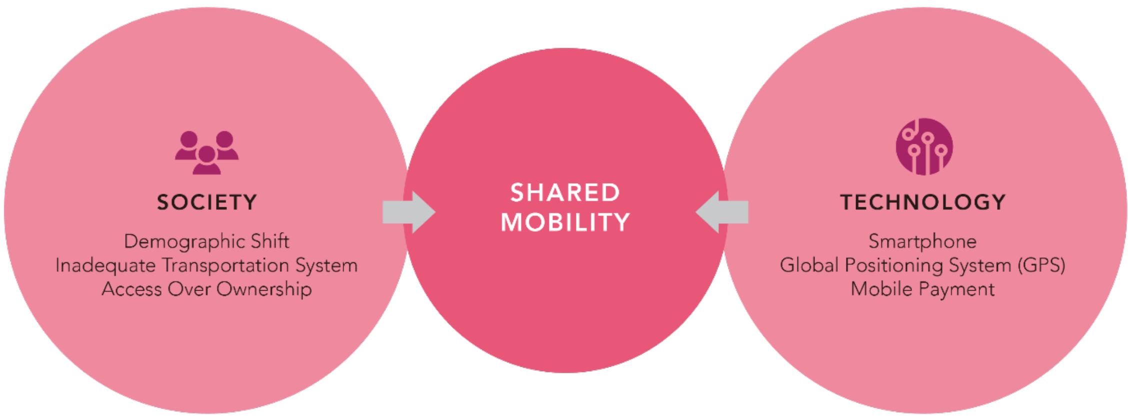


Figure 9: Main Drivers of Shared Mobility

Along with the growing popularity of the sharing economy in recent years, people found valuable to access vehicles and transportation services based on the sharing economy business model, which could be a good solution to solve the transportation problems in urban or rural areas. As demography and social cultures shifted, people have adopted a new attitude, valuing access more over ownership (Cheng, 2016). In addition, internet advancement and the emergence of smartphones, GPS (global positioning systems), and mobile payments have changed the way people live, communicate, and consume dramatically (Shaheen et al., 2017). The current problems in transportation, the common mentality of sharing, and the innovations in technology led to the emergence of shared mobility.

Shared mobility is defined as an innovative transportation strategy about the shared use of transportation devices and services; it enables users to gain short-term access to transportation modes on an as-needed basis (Shaheen, 2016). Even without personal vehicle ownership, people still have the ability to move freely and easily according to their needs and convenience by using shared mobility (Shaheen et al., 2015). Shared mobility satisfies three advantages of private vehicles: flexibility, comfort, and availability (Martinez & Viegas, 2017), making it a more ideal alternative than other mobility options such as taking public transit or walking. Shared mobility appears to be an intermediate mode between private vehicles and mass transit (Machado et al., 2018). Litman (2011) pointed out that an efficient transportation system requires dense networks to serve citizens. Shared mobility is a viable strategy to not only fill the gap of public transit but also become an alternative mobility service. Thus, it is considered a necessary component of an efficient transportation system. Urban planning experts assume that shared mobility makes a significant change in public transportation by alternative services (Le Vine et al., 2014). Some affirm that shared mobility is not a panacea for all transportation issues. It can only serve as a complementary component to existing public transportation systems

(Higginbotham, 2000). For individuals, shared mobility lowers travel expenses and the associated costs of owning a car (Thomson & Granath, 2020), saves time for looking for parking spaces, and increases convenience. Shared mobility reduces the need for driving personal cars and the number of vehicles in operation. Thus, it potentially relieves traffic congestion, crowded public spaces, decreases air pollution and greenhouse gas emissions; furthermore, it improves transportation efficiency, competitiveness, social equity, and quality of life for either urban or rural areas (Machado et al., 2018; Rode et al., 2017).

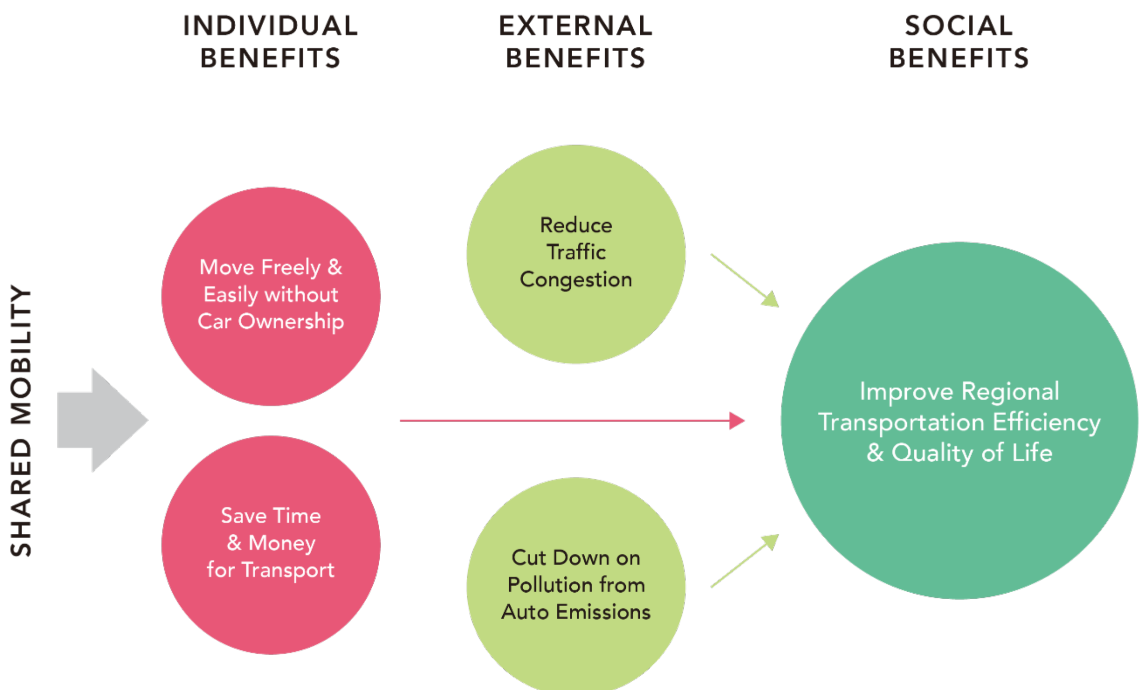


Figure 10: Benefits of Shared Mobility

Shared mobility is an umbrella term that covers a variety of shared transportation modalities, which involve different goals (e.g., getting a ride, obtaining a transportation device), several types of transportation devices (e.g., cars, bicycles, scooters), and various business models (e.g., peer-to-peer model, business-to-peer model) (Unrau & Granath, 2020). And each shared mobility modality has a distinctive range of impacts on travel behavior. Currently, shared mobility includes seven modalities on the market, which are bike sharing, scooter sharing, car sharing, personal vehicle sharing, ridesharing, ride-hailing, and microtransit.

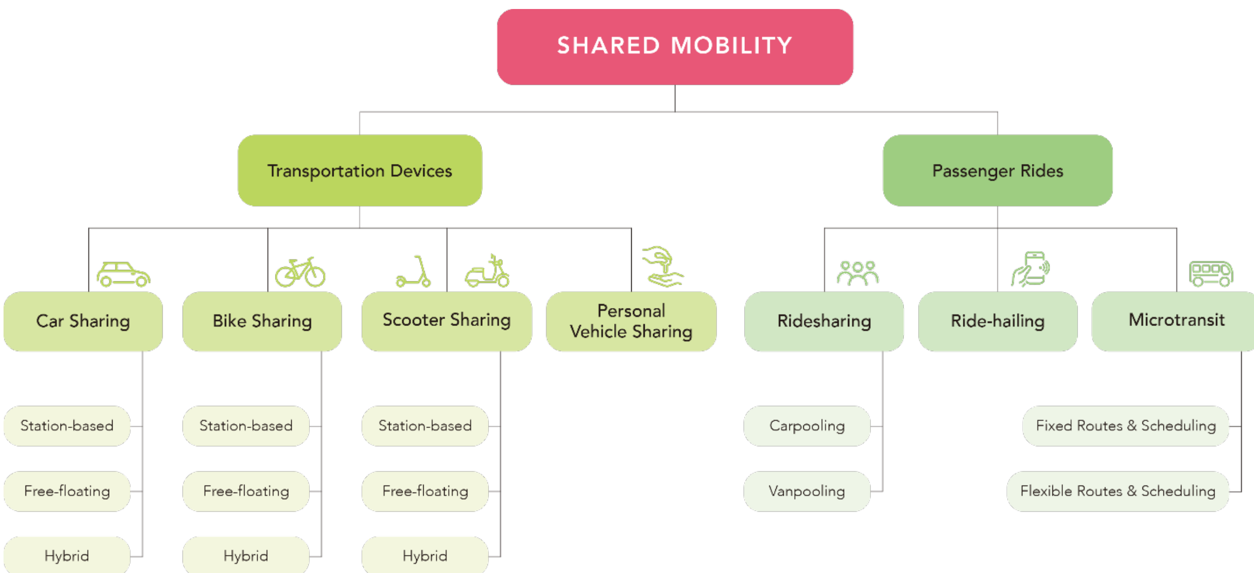


Figure 11: Current Modalities of Shared Mobility
Source: Compiled by the author based on Machado et al. (2018); Shaheen et al. (2020)

According to different trip distances and needs, users will choose the corresponding modality. Bike sharing and scooter sharing would be the most suitable option for short-distance trips since they would not take too much time and physical effort. Bike sharing and scooter sharing modes provide low-cost, flexible, and fun ways to move around

(Nikitas, 2016; Bryce, n.d.). Ride-hailing, microtransit, and ridesharing offer more a comfortable process to pick up and drop off users in medium distances. For relatively long trips, the majority of people tend to drive by themselves because of the flexibility vehicles provide. Users can access vehicles by car sharing programs or private car sharing platforms.

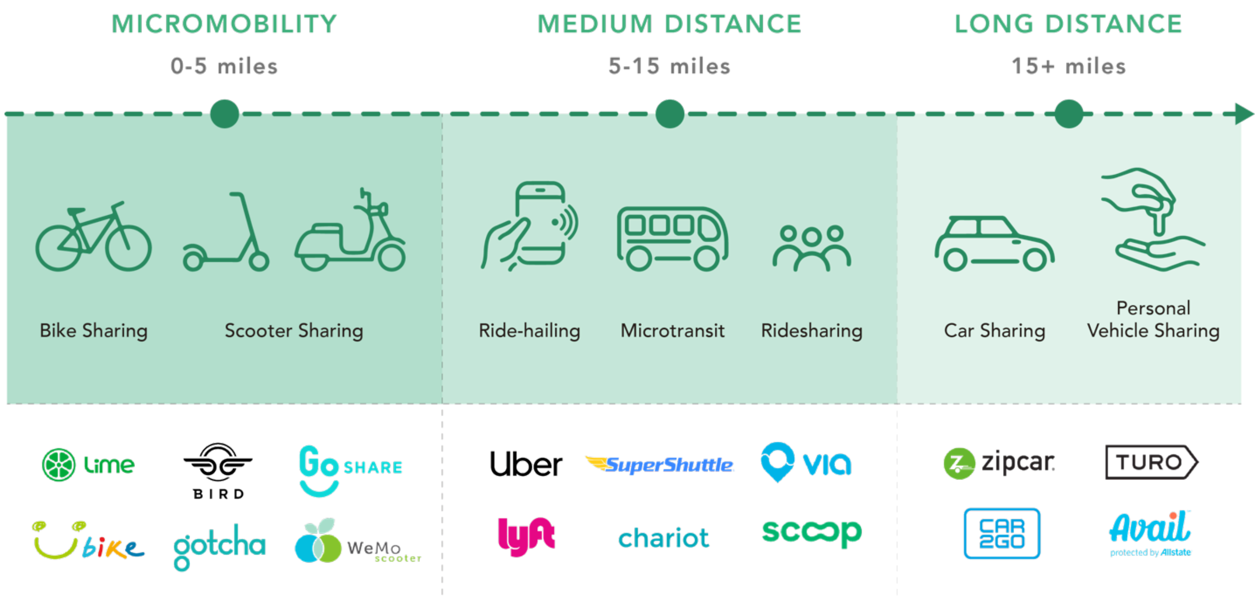


Figure 12: Shared Mobility Modalities by Trip Distance and Example Companies
Source: Redrawn by the author based on CB Insights (2018)

These revolutionary mobility services enhance transportation networks and make it easier to navigate through cities and towns. It is expected that shared mobility will continue providing innovative and viable transportation alternatives, transforming the way people travel.

2.3 Shared Micromobility

Bike sharing and scooter sharing programs are the fastest-growing and most widely-adopted modalities in shared mobility (Parkes et al., 2013; Shaheen & Cohen, 2019). Over the past few years, bike and scooter sharing systems have become almost ubiquitous in cities all over the world. As the figure shows below, the amounts of shared bike and scooter bases in different countries is predicted to considerably increase in 2019 to 2026, indicating the trend and new possibilities of the industry.

Pre-COVID-19 Shared Electric Bikes Installed Base by Region, World Market, Forecast: 2019 to 2026

Region	Installed Base	2019	2020	2021	2022	2023	2024	2025	2026	CAGR 20-26
North America	(Actual)	36,000	66,600	106,560	154,512	200,866	251,082	301,298	346,493	31.6%
Europe	(Actual)	63,000	116,550	198,135	267,482	331,678	391,380	438,346	473,413	26.3%
Latin America	(Actual)	2,090	3,135	3,919	4,703	5,549	6,215	6,712	6,846	13.9%
Asia Pacific	(Actual)	844,800	1,250,304	1,625,395	2,080,506	2,496,607	2,871,098	3,100,786	3,162,802	16.7%
Rest of World	(Actual)	4,945	8,901	14,242	21,362	28,839	36,049	40,375	43,605	30.3%
Total	**(Actual)**	**950,835**	**1,445,490**	**1,948,251**	**2,528,565**	**3,063,539**	**3,555,824**	**3,887,517**	**4,033,159**	**18.7%**

Pre-COVID-19 Shared Electric Scooters Installed Base by Region, World Market, Forecast: 2019 to 2026

Region	Installed Base	2019	2020	2021	2022	2023	2024	2025	2026	CAGR 20-26
North America	(Actual)	272,250	408,375	592,144	817,158	1,021,448	1,225,738	1,348,311	1,415,727	23.0%
Europe	(Actual)	262,500	420,000	609,000	883,050	1,236,270	1,668,965	2,169,654	2,386,619	33.6%
Latin America	(Actual)	162,500	198,250	237,900	275,964	314,599	346,059	373,744	388,693	11.9%
Asia Pacific	(Actual)	24,300	31,590	40,435	50,140	59,165	66,265	70,240	71,645	14.6%
Rest of World	(Actual)	2,500	4,500	6,525	8,809	10,130	10,637	10,956	11,065	16.2%
Total	**(Actual)**	**724,050**	**1,062,715**	**1,486,004**	**2,035,121**	**2,641,612**	**3,317,662**	**3,972,905**	**4,273,750**	**26.1%**

Figure 13: Shared Electric Bikes and Scooters Installed Base Forecast 2019-2026 (Bonte, 2020)

As society pays more attention to environmental protection and is concerned about gasoline shortages, these non-gas-powered micro-vehicles such as bikes, electric bikes, electric scooters, and motorbikes, are considered effective solutions to solve transportation pain points and promote a more sustainable and equitable transportation system (Granath & Richert, 2020). Those micro-vehicles are often included in the term Micromobility, which has drawn attention and discussion worldwide recently.

2.3.1 Micromobility

The term "Micromobility" was first coined by the business and technology analyst Horace Dediu at the Micromobility Summit in Copenhagen in 2017. Micromobility consists of "micro" and "mobility", which mean "small" and “the ability to move or be moved freely and easily,” implying the ability to move through small vehicles (Chang, 2019). Micromobility is used to describe travel options for short distances using compact and lightweight vehicles less than 1102 lb. (500 kg).

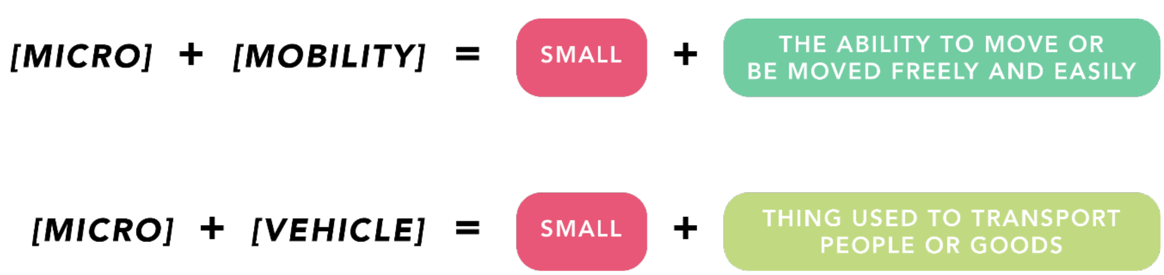


Figure 14: Meanings of Micromobility and Micro-vehicle
Source: Redrawn by the author based on Chang (2019)

The scope of the term "micromobility" is limited to the category of transportation associated with the use of micro-vehicles, such as electric scooters, electric skateboards, shared bicycles, electric pedal-assisted bicycles, and so on (Dediu, 2019; Chang, 2019; Unrau, 2020). According to Horace Dediu, micromobility vehicles can be classified into five categories: Scooter/Bike, E-Bike, Moped, Light Quad, and Heavy Quad. These five categories are mainly differentiated by forms and weight. And the speed performance varies with the size of the engine installed on the vehicle.

Quintile	Category	Addressable Market (Trillion km)	2-sigma Distance (mi)	Median Speed (mi/h)	Max. Weight (lb)	Distance (km)	Speed (km/h)	Speed (m/s)	Max Weight (kg)
1	Scooter/bike	5.4	2	6	55	3.22	10	2.68	25
2	e-bike	5.4	4	12	110	6.44	19	5.37	50
3	Moped	5.4	7	21	220	11.27	34	9.39	100
4	Light Quad	5.4	14	42	440	22.54	68	18.78	200
5	Heavy Quad	5.4	n/a	60	1100	n/a	97	26.83	500

Figure 15: Micromobility Vehicle Categories
(Dediu, 2019)

As the field of micromobility continues to foster innovation, more brand-new micro-vehicle designs emerge. Thus, the previous category system is no longer thorough enough to define new micromobility vehicles. To demarcate clearly and provide details across various micro-vehicles, SAE International (Society of Automotive Engineers International) published the J3194 Standard in 2019, which is the industry's first standard with classification and definition specifically for powered micromobility vehicles.

POWERED MICROMOBILITY VEHICLE

A wheeled vehicle that must:

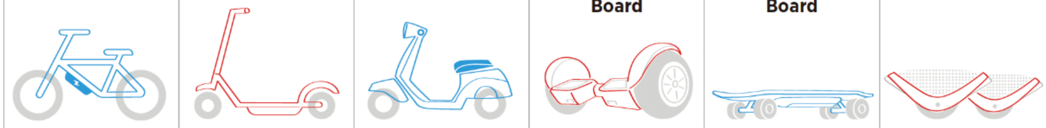
- Be fully or partially powered
- Have a curb weight ≤ 500 lb (227 kg)
- Have a top speed ≤ 30 mph (48 km/h)

Scope of J3194™

- Only includes vehicles that are primarily designed for human transport and to be used on paved roadways and paths
- Excludes solely human-powered vehicles

Figure 16: Definition and Scope in the J3194 Standard
(SAE International, 2019)

There are six types of powered micromobility vehicles in the J3194 Standard, including Powered Bicycle, Powered Standing Scooter, Powered Seated Scooter, Powered Self-Balancing Board, Powered Non-Self-Balancing Board, and Powered Skates. The J3194 Standard (2019) provides detailed descriptions of physical attributes for each type:



	Powered Bicycle	Powered Standing Scooter	Powered Seated Scooter	Powered Self-Balancing Board	Powered Non-Self-Balancing Board	Powered Skates
Center column	Y	Y	Y	Possible	N	N
Seat	Y	N	Y	N	N	N
Operable pedals	Y	N	N	N	N	N
Floorboard / foot pegs	Possible	Y	Y	Y	Y	Y
Self-balancing[2]	N	N	N	Y	N	Possible

Figure 17: Types of Powered Micromobility Vehicles
(SAE International, 2019)

1. **Powered bicycle**

A wheeled vehicle with operable pedals, steerable handlebars, and seat(s). It is composed of two or three wheels held in a frame in the longitudinal direction of movement and could be powered partially or fully by a motor. There are three sub-types of powered bicycles: pedal assist, throttle on demand, and speed pedelec.

a、 **Pedal assist:** equipped with an electric motor, which works only when pedaling and stops working after reaching the speed of 20 mph (32 km/h);

b、 **Throttle on demand:** bicycle is equipped with an electric motor that may be used exclusively to propel the bike with a throttle, and the motor ceases when reaching the speed of 20 mph (32 km/h);

c、 **Speed pedelec:** equipped with a speedometer and an electric motor, which works only when pedaling and ceases after reaching the speed of 28 mph (45 km/h).

2. **Powered standing scooter**

A wheeled vehicle that has a foot platform for the user to stand on, and a operable handlebar on center column with accelerator/throttle and brakes for steering and controlling speed. It is composed of two or three wheels held in a frame in the longitudinal direction of travel, and is powered partially or fully by a motor.

3. **Powered seated scooter**

A wheeled vehicle that has a foot platform(s) and/or footpegs, seat(s), and a operable handlebar on center column with accelerator/throttle and brakes for steering and controlling speed. It is composed of two or three wheels held in a frame in the longitudinal direction of travel and could be powered partially or fully by a motor.

4. **Powered self-balancing board**

A wheeled vehicle that has one wheel or two wheels in parallel, a foot platform or footpegs, and may have a center column with handlebar. The user can control the direction and the speed by manipulating controls on a center column and/or distributing weight to sensors on the foot platform. And it is powered solely by a motor, not statically stable but using a self-balancing mechanism.

5. **Powered non-self-balancing board**

A wheeled vehicle that has neither a handlebar nor a center column. But the user can steer it by shifting body and/or feet position, and control the speed with a handheld device or sensors on the foot platform. It has at least one foot platform and three wheels, and it is statically stable and powered partially or fully by a motor.

6. **Powered skates**

A wheeled vehicle that has two separate units for each foot of the user to stand on. It is powered solely by a motor and the user distributes his/her weight for the control of speed and steering.

Name	Code	Description
Curb weight		
Ultra lightweight	WT1	Curb weight ≤ 50 lb (23 kg)
Lightweight	WT2	50 lb (23 kg) < curb weight ≤ 100 lb (45 kg)
Midweight	WT3	100 lb (45 kg) < curb weight ≤ 200 lb (91 kg)
Midweight Plus	WT4	200 lb (91 kg) < curb weight ≤ 500 lb (227 kg)
Vehicle width		
Standard-width	WD1	Vehicle width ≤ 3 ft (0.9 m)
Wide	WD2	3 ft (0.9 m) < vehicle width ≤ 4 ft (1.2 m)
Extra-Wide	WD3	4 ft (1.2 m) < vehicle width ≤ 5 ft (1.5 m)
Top speed		
Ultra low-speed	SP1	Top speed ≤ 8 mph (13 km/h)
Low-speed	SP2	8 mph (13 km/h) < top speed ≤ 20 mph (32 km/h)
Medium-speed	SP3	20 mph (32 km/h) < top speed ≤ 30 mph (48 km/h)
Power source		
Electric	E	Powered by an electric motor
Combustion	C	Powered by an internal combustion engine

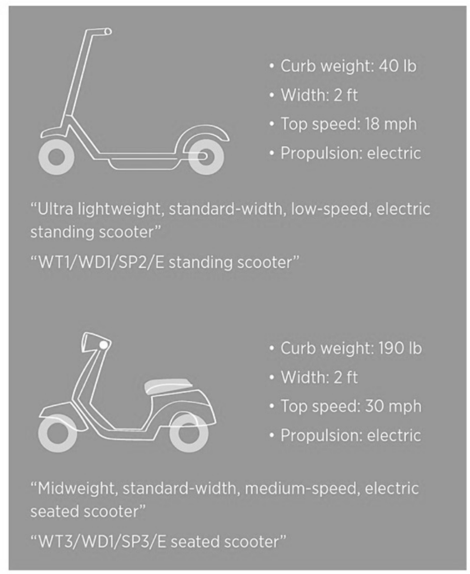


Figure 18: Code System for Powered Micromobility Vehicles and Examples (SAE International, 2019)

The J3194 Standard (2019) also includes the code system in terms of curb weight, vehicle width, top speed, and power source. It has established a common ground among governments, manufacturers, operations, and users for better understanding and effective communication when it comes to powered micromobility vehicles.

	
Giant Escape Disc Bicycle	**Segway** Ninebot E-scooter
	
Momentum Transend E+ E-bike	**Gogoro** 3 GT Moped
	
Bio-Hybrid DUO Pedelec	**Toyota** i-ROAD Microcar

Table 1: Micromobility Vehicle Examples
(Bio-Hybrid, 2021; Giant, 2021; Gogoro, 2020; Japan Bullet, 2014; Momentum, 2021; Segway, 2019)

In the context of a pressing need for solutions for traffic jam and parking spaces, there is a high potential and a huge room for micromobility's development and innovation. In 2019, the world's first micromobility exhibition was held grandly in Hannover, German. Micromobility Expo; the event primarily focused on micromobility in urban areas.

Exhibitors and experts from politics and business started the conversation toward the political and social concerns and the current trends in the field of micromobility. Professor Dr. Stephan Rammler, scientific director of the Institute for Future Studies and Technology Assessment in Berlin has mentioned that “Against the background of a dynamically growing world population, it is necessary to combine sustainability, social justice and economic efficiency. In this sense the Micromobility Expo is the true future fair for the reinvention of 21st century mobility” (Micromobility Expo, 2019).

	
Volkswagen Electric Scooter	**Volkswagen** Cargo E-bike
	
Citkar Loadster Commercial Vehicle	**Micro** Microlino Microcar

Table 2: Exhibitors in Micromobility Expo 2019
(Electrive, 2019; Hitti, N., 2020; Micromobility Expo, 2019)

In the exhibition area of the micro-mobiles, relevant manufacturers, suppliers, importers and service providers of micro-vehicles presented their services and products, such as small, electric light vehicles for the transport of people and goods, ranging from monowheels to pedelecs, e-bikes, cargo bikes, e-scooters, segways, and light commercial vehicles. Micromobility Expo is seen as the platform for knowledge transfer, experience exchange, and the showcase of innovative micro-vehicles (Micromobility Expo, 2021). With these activities stimulating interaction and brainstorming among the professions, we can actively anticipate more new inventions and innovative designs coming out, shaping a bright future of micromobility.

2.3.2 Development of Shared Micro-mobility

Shared Micromobility, such as bike sharing and scooter-sharing, is a transportation resource and strategy by sharing access to any kind of micro-vehicles for multiple users (Transportation for America, 2019). The flexibility, lightness, and compactness of micro-vehicles are considered a cure for transportation inadequacy and crowdedness. Shared Micromobility establishes a better connection between citizens and public transport, reducing reliance on private vehicles, and easing congestion (Khatri, n.d.). And it complements the existing public transit system with external facilities, which is easier to implement than reforming the entire system. As the awareness of environmental protection increased, shared micromobility was adopted widely by companies and governments across the globe.

Shared micromobility is usually used to solve the first and last-mile problems. The "first and last-mile" refer to the beginning and the end of the journey for traveling on public transit, that is, the gap between the station and home, between the station and the final destination, or any other distance that is too close to drive, but too far to walk (Thomson & Granath, 2020; Unrau & Granath, 2020). Shared micromobility makes the existing public transportation networks more complete, and it helps cities and towns establish a truly connected region. It not only bridges the gap with public transportation system but also reduces congestion and parking difficulty caused by four-wheel vehicles (Bonte, 2020).

Figure 19: The First and Last-mile
Source: Redrawn by the author based on King (2016)

Shared micromobility includes different service modes for meeting travelers' needs, such as station-based and free-floating modes. Station-based shared micromobility programs provide micro-vehicles at specific stations or kiosks for pickup and return. And free-floating shared micromobility programs do not have stations or kiosks for micro-vehicles. Rather they allow users to pick up and return shared micro-vehicles to any location. People can use a corresponding mobile app on a smartphone to find, unlock, and use a micro-vehicle, as well as make a payment for the trip, while the free-floating fleet is scattered at random, making it more difficult to manage than the station-based mode. The following technologies are essential to address the challenge: GPS and telematics technologies help locate parked vehicles, track and retrieve stolen ones. AI-based analytics can let the staff identify real-time demands and the patterns, improving the efficiencies of redistribution and recharge or battery swapping practices (Bonte, 2020). Trip rates for both modes usually incorporate an initial flat fee and a charge on a per-minute basis (Transportation for America, 2019). Shared micromobility increases mobility options, reduces greenhouse gas emissions, decreases automobile use, improves economic development and health benefits (Shaheen & Cohen, 2019). Without a doubt, shared micromobility services have been an important part of regional transportation because of the convenience they bring to residents and visitors.

	
Station-based	**Free-floating**

Table 3: Station-based and Free-floating Modes
(News & Observer, 2017; YouBike, 2020)

The first concept of shared micromobility could be traced back to 1975. Luud Schimmelpennink, the Dutch social inventor and industrial designer, collaborated with the group Provo in Amsterdam to begin the first community on-demand bike-sharing program. The program is still active in some places in the Netherlands (Dediu, 2019). In 1995, the first station-based shared bicycles arose in Portsmouth, England. The rack locking technology kept those shared bikes locked, while users need to pay a one-time fee with a smart card for unlocking and using. In the same year, ByCylken, the coin-charged bike-sharing system, was rolled out in Copenhagen, and it was the first large-scale urban bike-sharing program featuring an exclusively designed fleet (Dediu, 2019). With the popularity of smartphone and GPS technology, shared micromobility moved forward to the second stage - the free-floating/dockless era. In 2000, Call a Bike, a dockless bike hire system run by Deutsche Bahn (DB), started operating in several German cities, allowing users to unlock a bike with SMS text messaging. Around 2014, China's bike-sharing companies, Ofo and Mobike, popularized dockless bike-sharing systems based on mobile apps to locate and unlock bikes and mobile payment technology to charge an hourly rate for use. However, the rapidly growing fleet scale caused traffic messes since shared bikes were parked randomly and anywhere, which gave a lesson to other companies in the industry. Broadly speaking, on-demand micromobility began in Europe and was spreading fast throughout China later on. But on-demand electric micromobility began in the US. In 2017, the Bird company started the dockless e-scooter-sharing service in Santa Monica, California. Those shared electric scooters can be found over cities and help people move between downtown and immediate surroundings. E-scooters sharing have drawn business attention because an e-scooter is relatively inexpensive compared to other electric vehicles for it is small and the components were commoditized enough (Dediu, 2019). Electric micro-vehicles became popular worldwide since they are more convenient and physically effortless for users to ride on. More and more shared micromobility companies and startups appearing and running has reflected the astonishing growth and scale of the market.

	
Lime	**Bird**
	
Veo	**Gotcha**

Table 4: The US Shared Micromobility Company Examples
(Bird, 2021; Lime 2nd Street, 2021; Mass Transit, 2019; Veo, 2021)

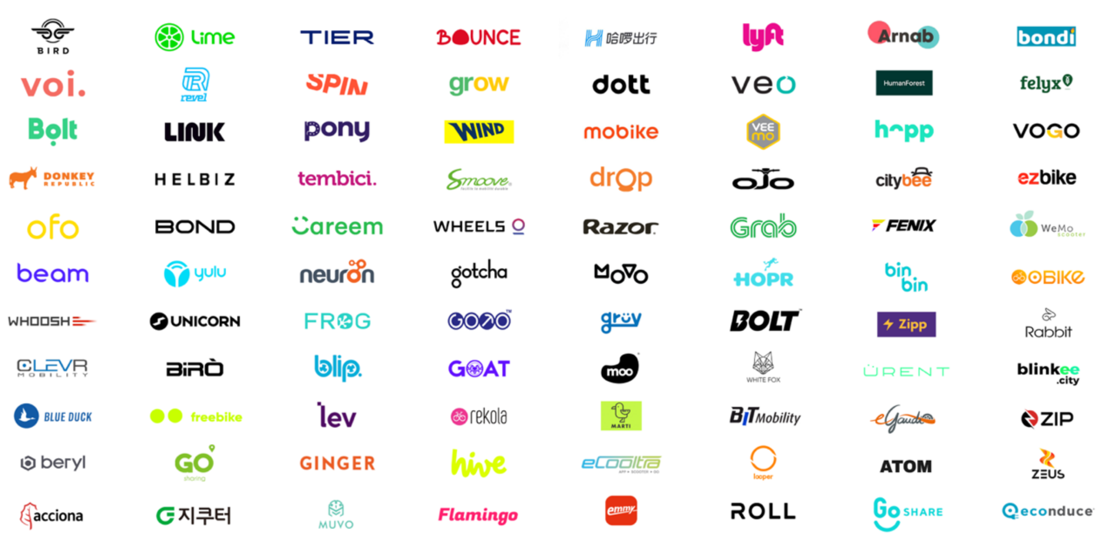


Figure 20: Shared Micromobility Company Examples Over the World
(Micromobility, 2020)

While shared micromobility has rapidly grown worldwide these few years, there are still many challenges hindering its development and adoption, including parking issues, unfavorable regulation, limited infrastructure, safety concerns, poor weather conditions, theft, short hardware lifetime, and profitability.

There have been debates about how to park shared micromobility vehicles. Parking for station-based micro-vehicles is pretty straightforward because users are only allowed to return vehicles at stations. However, many free-floating micro-vehicles are often left in inappropriate places, creating untidy public areas and a hazard to others (Bonte, 2020). Currently, there are six parking ways for shared micromobility: stations, bike racks, demarcated parking areas, geo-fencing, on the sidewalk, and street corrals. T4America has analyzed the pros and cons of these schemes in the *Shared Micromobility Playbook* released in 2019, trying to help companies identify better practices.

Parking Schemes	Pros	Cons
 **Stations**	✓ Easily understood by the general public ✓ Easy to identify locations for parking ✓ Easily manage and charge electric micro-vehicles ✓ Promotes usage by creating dedicated parking spaces and increasing visibility	× Require infrastructure × Relatively expensive × Take staff time and resources to identify where to set up × Limited space in the busiest, most desirable areas × Require maintenance and upkeep for infrastructure × Less flexibility
 **Bike Racks**	✓ Use existing infrastructure ✓ Relatively inexpensive ✓ Quick to install or expand ✓ Easily understood by the general public ✓ Easy to identify areas for parking and no parking	× Overwhelm existing racks with other private micro-vehicles × Take staff time and resources to identify where to install extra racks as needed × Limited space in the busiest, most desirable areas × Require extra work to charge electric micro-vehicles × Less flexibility
 **Demarcated Parking Areas**	✓ Quick to install or expand ✓ Easily understood by the general public ✓ Easy to identify areas for parking and no parking ✓ Address sidewalk blockage issue ✓ Promotes usage by creating dedicated parking spaces and increasing visibility	× Overwhelm spaces on narrow road × Create mess if vehicles aren't parked properly or fall over × Take staff time and resources to identify where to set up × Limited space in the busiest, most desirable areas × Require extra work to charge electric micro-vehicles × Less flexibility

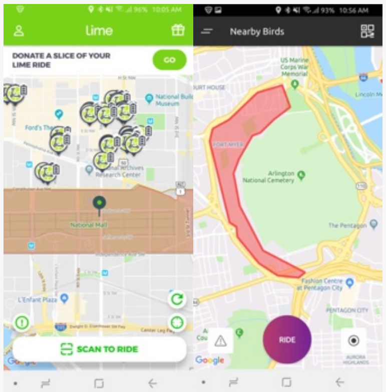
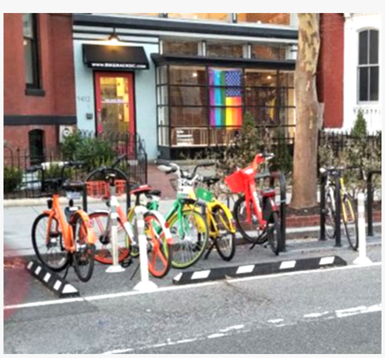
 **Geo-Fencing**	✓ Require no infrastructure ✓ Relatively inexpensive ✓ Offer more flexibility	× Not easy to identify parking areas without the use of the app and accurate GPS × Require education for users to understand and compliance × Create mess if vehicles aren't parked properly or fall over × Take staff time and resources to identify areas for use × Require extra work to charge electric micro-vehicles
 **On The Sidewalk**	✓ Require no infrastructure ✓ Relatively inexpensive ✓ Easily understood by the general public ✓ Offer more flexibility	× Overwhelm spaces on narrow sidewalks × Encourage sidewalk riding × Require education for users to understand and compliance × Create mess if vehicles aren't parked properly or fall over × Require more work to collect and redistribute randomly-scattered micro-vehicles × Require extra work to charge electric micro-vehicles
 **Street Corrals**	✓ Quick to install or expand ✓ Easily understood by the general public ✓ Easy to identify areas for parking and no parking ✓ Addresses sidewalk blockage issue ✓ Promotes usage by creating dedicated parking spaces and increasing visibility	× Take over car parking spaces × Take staff time and resources to identify where to set up × Limited space in the busiest, most desirable areas × Require extra work to charge electric micro-vehicles × Less flexibility

Table 5: Current Parking Schemes for Shared Micromobility
Source: Compiled by the author based on Transportation for America (2019)

Since shared micromobility is a relatively novel industry, most cities and towns haven't introduced proper regulations yet to rule the usage of shared micro-vehicles, which has been a thorny issue for governments to deal with. Fortunately, governments gradually started communicating and working with these shared micromobility companies as they realized the popularity and the social benefits of shared micromobility programs. New laws have been created to improve overall management, for instance, parking shared bikes outside of permitted areas now will be fined in China. Besides, lack of the proper public infrastructure also makes it difficult to adopt shared micromobility program in cities and towns, such as insufficient bike lanes (Granath & Richert, 2020). Most countries (e.g., Paris, England) prohibit electric micro-vehicles from riding on the sidewalk to make sure of safety for pedestrians, while riding on the road could also pose dangers to riders and other road users. There are safety concerns over electric micro-vehicles in terms of speed control and careless riders. It has been reported by UCLA doctors that 40% of the ER visits for head injuries are associated with e-scooter accidents (Youn, 2019).

Weather conditions are also the major challenge for shared micromobility, especially in countries with harsh climate. Few would be willing to ride on a shared bike or scooter in a rainy or snowy day. Rainy seasons and winter are often the off-season for shared micromobility companies, making them lose precious profits. To overcome this problem, some companies will initiate promotion events. For example, the e-scooter sharing company Skip gave away branded winter gloves and hats during the winter in Washington, DC (Granath & Richert, 2020). But, apparently, this was not a long-term solution. In addition, there were many theft and vandalism cases becoming a real problem for shared micromobility companies. The short average lifespan of shared micro-vehicles is not only caused by intentional damages and stealing, but also by the limited endurance for high usage frequency. Shared micromobility companies Bird and Lime have stated that their electric scooters generally last only one to two months because of the above reasons. Those extra expenses are hitting companies of all sizes hard. Even worse, the intense competition forces companies to enlarge the fleet scale as much as possible, but it is hard to fix the broken vehicles in a timely manner, especially for a large fleet. Bad user experiences such as encountering not functioning shared vehicles would easily ruin companies' reputation ultimately. It has been a dilemma of weighing against operating costs and micro-vehicle quality for shared micromobility players (Granath & Richert, 2020). Though several companies have been earning good profits and receiving millions of dollars from investors, many startups struggle to maintain sustainable profitability due to the various challenges mentioned previously. Some shared micromobility programs rely on subsidies and support from local governments since the costs of licenses, stations, vehicles, maintenance, employees are often too high (Dediu, 2019). Highly efficient management of assets and services is required for shared micromobility operators to reach and keep long-term profitability (Bonte, 2020).

Shared micromobility changed the mobility landscape in cities and towns throughout the world, helping the environment and benefiting people from the convenience and flexibility it brought. Nonetheless, comprehensive planning and management are required to make a shared micromobility program viable (Transportation for America, 2019). Frog Design (2020) pointed out that design plays a significant role when building thorough systems and solve current issues concerning shared micromobility. Companies can plan, review, and upgrade their services and processes in the bigger picture through service design, optimizing the logistics of the whole operation, and delivering an excellent user experience. Industrial design stimulates novel concepts on share micromobility, coming up with safer, smarter, and more enjoyable micro-vehicles and useful accessories (Frog Design, 2020). Therefore, there is a need to engage in the study of shared micromobility from a design perspective.

2.4 Service Design

2.4.1 The Overview of Service Design

In traditional economics, the distinction between goods and services was clear. Goods are tangible and consumable (e.g., furniture, bicycle, home appliances). And services are intangible, instantly exchanged, and not resulting in ownership (e.g., healthcare, public transit, hair styling). However, as new business models keep coming along, the boundary of goods and services is getting vague (Gibbons, 2017). The relationship between goods and services became like a spectrum, and they can be merged and work together. Today, many companies offer combinations of products and services. For instance, Lime, an American shared micromobility company, allows users to use bicycles (which are the goods) for a short period by paying the trip rate via the mobile app (which is the service). Along with the increasing complication of services, there is a need for a more sophisticated approach to review the company ecosystem and internal service process to ensure overall efficiency and positive user perception.

Figure 21: Goods and Services Spectrum

Service design is the activity where designers plan and organize resources for service providers, formulate solutions to improve existing services, deliver pleasant experiences for both employees and customers, and run a sustainable business (Gibbons, 2017; Interaction Design Foundation, 2021). The term “service design” was coined by Lynn Shostack in 1982. She pointed out that “leaving services to individual talent and managing the pieces rather than the whole—makes a company more vulnerable and creates a service that reacts slowly to market needs and opportunities” (Shostack, 1984, p. 139). Practicing service design and building a comprehensive understanding of internal operation and interactions among stakeholders are important for the organization's sake. Most organizations pay attention to customer-facing activities and overlook employee-facing activities. In contrast, service design advocates believed that good services could only be provided if behind-the-scenes systems and processes are smooth fundamentally.

In service design, service is made of three components: people, props, and processes. The component "People" refers to those who give or use a service directly and persons affected indirectly (e.g., staff, customers, fellow customers, partners). Props are the physical or digital artifacts deployed during the service. They can be physical spaces (e.g., shops, teller windows), digital environments (e.g., websites, social media), or objects (e.g., physical products, digital assets). Processes are any workflows, procedures, or rituals involved in a service (e.g., renting a car, hiring a new employee) (Gibbons, 2017). To illustrate the three components, imagine a shared bike program in a city: "People" would be personnel, users, and other road users; "Props" would be shared bikes, stations, and mobile apps. “Processes” would include redistributing bikes, unlocking a bike, and paying for a trip rate.

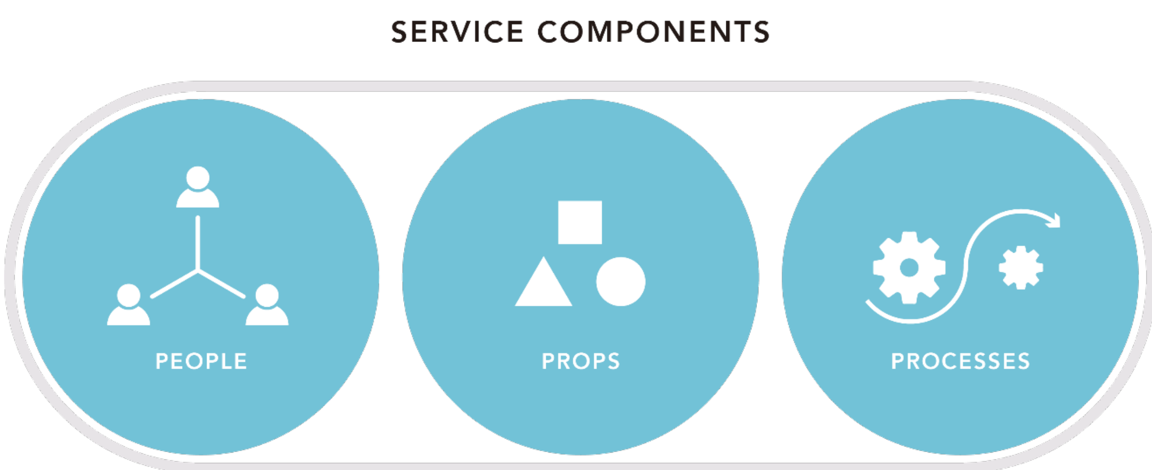


Figure 22: Three Service Components
Source: Compiled by the author based on Gibbons (2017)

In the book *This is Service Design Doing*, authors Marc Stickdorn, Markus Edgar Hormess, Adam Lawrence, and Jakob Schneider (2018) indicated that there are six key principles for service design:

1. **Human-centered:** understand all the relevant people involved in a service through qualitative research focusing on people's attitudes and opinions.
2. **Collaborative:** working in collaboration with various stakeholders makes sure proposed solutions are aligned with any aspects and views.
3. **Iterative:** encourage iteration to ensure that proposed solutions are adaptive.
4. **Sequential:** break down a complex service into independent parts and rethink the most efficient and logical arrangement.
5. **Real:** research and prototype in reality, and visualize intangible values to make users feel real about experiences and trust service providers.
6. **Holistic:** take various contexts and individual difference into service design and ensure proposed solutions are comprehensive overall.

In order to analyze organizational structure, identify pain points, and rearrange a better service process, service designers use a technique called service blueprint to map the whole process related to a service. A service blueprint is used to visualize a customer journey, touchpoints, interactions between personnel and customers, and internal operations and responses (Kalbach, 2016). It shows relationships among three service components (people, props, processes). Service blueprints distinguish frontstage and backstage based on the visibility of service components for customers. Even though practices behind the scenes are invisible to customers, the backstage plays an essential role in performing services and shaping customer experience. Service blueprints help designers and organizations see the big picture of how a service is carried out. After discovering underlying weaknesses, services designers will address flaws, optimize arrangements of resources and processes, bridge cross-department collaborations, reduce redundancies, and therefore, increase strategic benefits for companies and improve the employee and user experience overall (Gibbons, 2017). Thus, service blueprints are a crucial tool in the service design process.

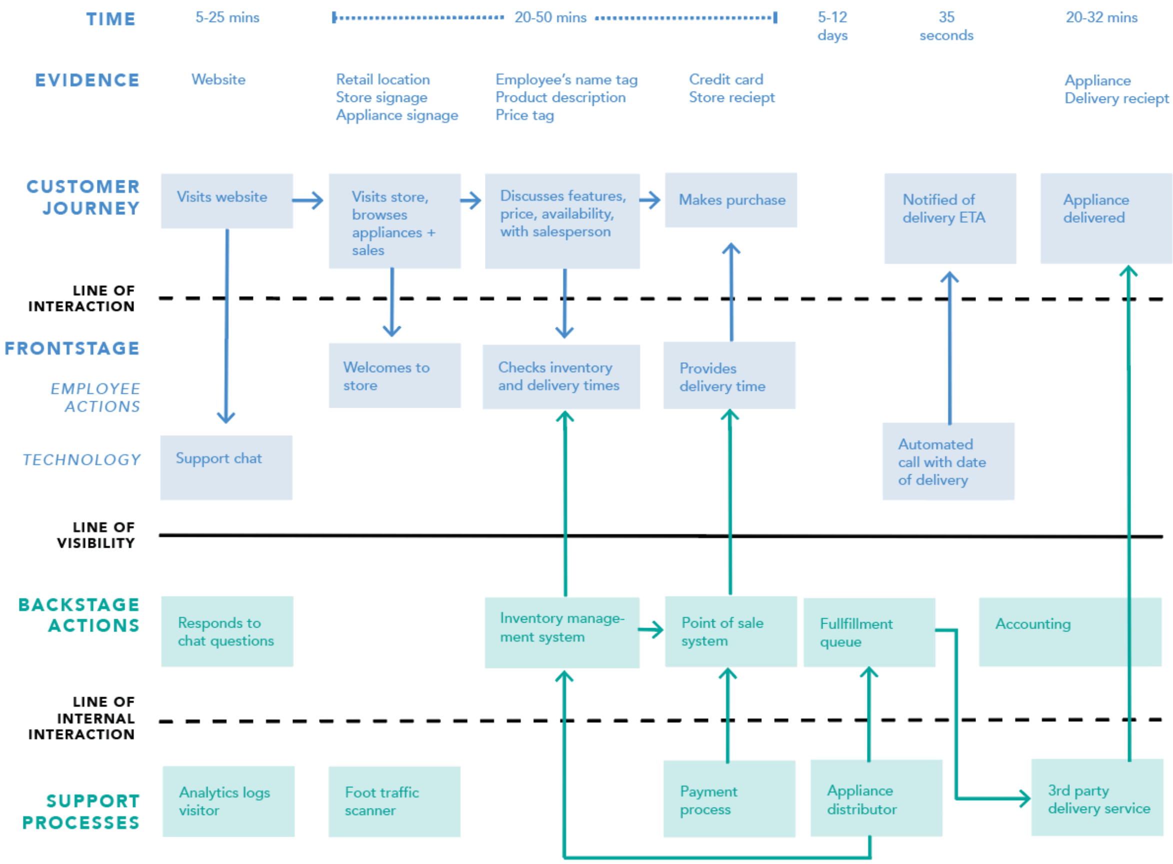


Figure 23: Service Blueprint Example
(Nielsen Norman Group, 2017)

Service design helps companies reveal weak links, inconsistency, and misalignment existing in external and internal service landscapes with a bird's eye view. This allows them to devise and adopt responding solutions, which are eliminating unnecessarily duplicate efforts, wasted resources, and any parts in which frustrations occur; streamlining frontstage and backstage workflows; enhancing efficiency; and reducing costs. With service design, companies can create a better service and deliver an excellent performance and employee/customer experience, consequently increasing business benefits (Gibbons, 2017).

2.4.2 Service Design in Shared Micromobility

Many shared micromobility programs have operated over the world in these last few years, attracting attention from service design professionals and researchers. Shared micromobility is considered a continuum of goods and services and involves various operational models and configurations. This complexity requires further studies on devising a suitable service design process for shared micromobility. Several Italian researchers have provided a four-phase approach for an electric vehicle sharing system meeting the needs and characteristics of target customers (Arena et al., 2014):

1. **Mapping of mobility profiles and service performances**
2. **Competitive analysis**
3. **Development of the service configurations**
4. **Development of the evaluation model**

Mobility profiles expose the segmentation of target users and their specific needs. For example, there are five mobility profiles that have been identified:

Commuter: regular trips between home and workplace/school.

Shopping: recreational travel in the city center, generally characterized by multiple and unpredictable stops.

Neighborhood trips: travel focused in local areas for daily activities such as grocery shopping and taking children to school.

Tourists: recreational travel aimed at visit different attractions.

Moving on campus: travel limited in certain spaces like campus.

Performances refer to the main characteristics of a shared micromobility service. There are ten performance dimensions that have been identified:

Density: number and location of the stations.

Flexibility: lack of constraints in terms of use.

- Space: pickup/return locations.
- Time: reservation and schedule.

Co-modality: collaboration with other public transportation.

- Interoperability: integrated/compatible devices or accessories.
- Multimodality: locations close to other public transport facilities.

Rate: charged prices for usage, including subscription fees, distance-based rates, hourly/minutely rates, and penalties.

Incentives: strategies to promote service use, such as free parking areas.

Availability: number of available vehicles.

Ease of use: simplicity of the procedures and usability of vehicles.

- Access time: time of unlocking a vehicle.
- Operation: lock/unlock system and riding.

Ease of the payment system: simplicity and efficiency of the payment process.

Ease of the reservation system: simplicity and efficiency of the reservation process.

Additional services: complementary features.

The competitive analysis would then be carried out based on mobility profiles and service performances presented in the first phase to propose strategies by understanding competitors and identifying strengths and weaknesses. Later on, device service configurations according to specific needs of mobility profiles are identified. After finishing implementation, establishing an evaluation model is important to examine and refine systems. There are five example indicators for evaluating shared micromobility:

Accessibility: variation of ease of travel within a region.

Congestion: variation of the congestion level on the road network.

Local emissions: quantity of pollutant and greenhouses gas emissions.

Parking places: variation of the public space occupied by private car.

Net present value: economic performance of shared micromobility service.

Alta, an American transportation planning and design company, suggested six steps to design a dockless bike-sharing system (Alta, 2017):

1. **Set program goals**
2. **Learn policies**: governments might have relevant regulations and requirements (e.g., permits/licenses, parking, insurance, operations, data) for shared micromobility programs. It is crucial to understand the above and avoid violations before getting started.
3. **Establish system boundaries**: use local information and data (e.g., bike behavior, topography, weather, demographics) to decide operating range, route planning, and infrastructure investments.
4. **Focus on parking schemes**: it is one of the greatest challenges for dockless shared micromobility.
5. **Integrate programs**: the integration of multiple mobility options and mobile apps will substantially increase convenience and achieve success.
6. **Continuously monitor, improve and innovate**: strategically use data for successful and economical management.

With the TiSDD service design framework introduced in the book *This is Service Design Doing*, the above main points collected from literature reviews were organized and incorporated into the four-phase framework: research, ideation, prototyping, and implementation (Stickdorn et al., 2018).

TiSDD Framework	Main Points for Shared Micromobility Service
Research	• Mapping of mobility profiles and service performances • Competitive analysis • Set program goals • Learn policies
Ideation	• Development of the service configurations • Establish system boundaries • Focus on parking schemes • Integrate programs
Prototyping	• Service processes and experiences • Physical objects and environments • Digital artifacts and software • Business systems
Implementation	• Development of the evaluation model • Continuously monitor, improve and innovate

Table 6: Service Design Framework For Shared Micromobility
Source: Compiled by the author based on Arena et al. (2014); Alta (2017); Stickdorn et al. (2018)

2.5 Transport and Tourism

Tourism is the business of providing services allowing people to pursue recreation, relaxation, and pleasure in places away from home. As an economic activity, tourism strongly relies on transportation to bring tourists to destinations, and transportation itself can also be part of the pleasure during travel. The development of transportation technologies promotes the tourism industry growth (Davenport, & Davenport, 2006). Transportation plays a dual role in tourism: (1) to provide access to a destination and (2) to facilitate mobility within a destination (Dejbakhsh et al., 2011; Lohmann & Duval, 2011; Rhonden & Lumsdon, 2006). The adequacy of a destination's transport system would contribute to its attractiveness for tourists as well as the overall image (Vetter, 1985). According to common empirical evidence, tourists usually visit multiple attractions within their destination (Caldeira & Kastenholz, 2020; Zillinger, 2007). They would take public transit such as buses or the subway, or drive personal or rental vehicles to move between/among tourist attractions. Time is seen to be one of the major limitations for tourists traveling (Bull, 1995). Tourists have limited stay duration in a destination. They need to allocate a suitable length of time for each attraction wisely (Tideswell & Faulkner, 1999; Zillinger, 2007). However, public transit is constrained with its schedule, which means less flexibility, resulting in a compromise between transport and time spent in an attraction (Lew & McKercher, 2006). Besides, fixed routes of public transit prevent tourists from a wider exploration of a destination (Lew & McKercher, 2006). On the other hand, visitors who use a vehicle to reach attractions may have trouble finding parking spaces in a busy and popular area. They have higher travel expenses due to vehicle-related costs such as parking fees and the cost to rent a car. Moreover, when an increasing number of vehicles enter a destination or an attraction area, it may cause air pollution, noise, traffic congestion, and a rising rate of traffic accidents (Williams, 2019; Serrano-Bernardo et al., 2015). Therefore, there is a need to develop solutions that address the problem of tourists' mobility.

2.5.1 Transport and Tourist Experience

Transportation is an indispensable component of the tourism system, and it is one of the most important factors for tourists in destination decision-making (Thao, von Arx & Frölicher, 2020). Tourists would consider the transit route between the departure and the destination as well as the transportation services provided within the destination (Hyde & Laesser, 2009). The local transportation system becomes one of the major considerations for tourists, even an appealing factor to tourists (Zakrisson & Zillinger, 2012).

In the past decades, many tourism-industry-related studies focused on tourists' experiences. Experiences are generated on an emotional, physical, spiritual, or intellectual level when individuals are doing, seeing, or feeling things (Pine et al., 1999), leaving individuals with memorable impressions (Gram, 2005). It is an intangible, continuous, subjective phenomenon (O'dell, 2007). The tourist experience is a psychological process of tourists during the interaction with destinations, creating memories, emotions, perceptions, and impressions related to places (Noy, 2008). It has shown that transportation has a significant influence on the travel experience (Leiper, 1990; Cutler & Carmichael, 2010). The ease of finding and reaching places within a destination is considered an important factor for visitors to assess the tourist experience quality (Haywood & Muller, 1988). Adequate transportation services in a destination would lead to an overall good tourist experience, which explains transportation's importance to the travel experience. Moreover, studies have shown that the tourist experience will positively influence tourist satisfaction and ultimately affect destination loyalty (da Costa Mendes et al., 2010), promoting tourists' revisit intention (Thompson & Schofield, 2007). Tourist experiences can be divided into three stages: pre-visit, on-site-visit, and post-visit (Ab Rahman et al., 2014). From this point of view, transportation certainly plays a crucial role in the tourist experience, no matter when deciding on a destination, during the visit, or after the visit.

2.5.2 Environmental Impacts of Tourism Transportation

Tourism provides a considerable contribution to economic development. Many countries' GDP (Gross Domestic Product) relies on tourist spending, which means it is a catalyst for economic growth (Azam, Alam, & Hafeezc, 2018). However, the rapid development of tourism has caused harm to the environment. Previous research pointed out that tourism is an industry with relatively high energy consumption and CO_2 emissions owing to transportation (Azam, Alam, Hafeezc, 2018; Gössling, S., 2013; Perch-Nielsen, Sesartic & Stucki, 2010; Thao, von Arx & Frölicher, 2020). With rising awareness of environmental issues, tourism is recognized as the primary external source of environmental damage (Jones & Munday, 2004; Saenz de Miera & Rosselló, 2014). According to the UN SG policy briefs (2020), 5% of human-produced emissions come from tourism-related transportation. In order to satisfy tourists' needs, the tourism industry offers transportation between and around destinations, directly boosting the demand for fossil fuels and other energy resources, increasing greenhouse emissions and pollutions (Tang et al., 2014; Zha et al., 2020). During the COVID-19 pandemic, the tourism industry was hard hit since most countries implemented lockdown or social isolation policies. Simultaneously, the global CO_2 emission has decreased 17% by early April 2020 because of the decrease in tourist activities (Le Quéré, et al., 2020). As we see, the environmental impacts of tourism transportation are real. Tourism is bound to grow after the world gets back on track. It is important to seize the chance and develop new solutions for tourism transportation before the recovery, bringing a win-win situation of reducing environmental damage and deriving economic benefits of tourism.

2.5.3 Shared Micromobility and Tourism

According to the above literature review, there is a need to develop eco-friendly, convenient, and pleasant transportation for tourists. And shared micromobility is a good solution because of its attributes mentioned in Chapter 2.3 (e.g., increasing flexibility and enjoyment, reducing traffic congestion and environmental impacts). Adopting shared micromobility programs in tourist destinations would give visitors an excellent experience, and, at the same time, solve those challenging external problems.

Rank	City	Trips 0-1 Mile	Trips 1-2 Miles	Trips 2-3 Miles	Combined
1	Honolulu	25%	19%	12%	55%
2	New Orleans	22%	17%	12%	52%
3	Nashville	22%	17%	12%	51%
4	Chicago	22%	17%	12%	51%
5	Charlotte	20%	18%	13%	51%
6	New York	22%	17%	11%	51%
7	Portland	21%	17%	13%	51%
8	Pittsburgh	23%	17%	11%	50%
9	Los Angeles	21%	17%	12%	49%
10	San Francisco	20%	17%	12%	49%

Figure 24: The Top 10 US Cities for Shared Micromobility
(INRIX, 2019)

On the report of the top ten US cities for shared micromobility (INRIX, 2019), these ten cities are all popular choices of tourist destinations for either domestic or international visitors. The city ranked in the top was Honolulu, Hawaii. A report has shown that Honolulu has more potential for micromobility because of the prevalence of short car trips (Finnerty, 2019), which is similar to the pattern of movement between attractions in tourist destinations. Honolulu's government believes that shared micromobility services decrease the use of polluting vehicles and allow for 24/7 mobility in responding to travel demands

(Frysztacki & Ota, 2020). Based on supportive literature, it is affirmed that shared micromobility is a promising, effective, and practical solution for tourism transportation. However, designing and implementing a shared micromobility service could easily end up with failure due to various challenges mentioned in Section 2.3. Therefore, the research aims to develop guidelines for shared micromobility in town and city tourist destinations from the perspective of service design and industrial design.

Chapter 3 Case Study

3.1 Lime

Lime became the biggest micromobility company in the world after Uber transferred operational control of its micromobility arm to Lime in May 2020 (Wilson, 2020). Compared to the other micromobility giant Bird, Lime has been exploring new possibilities in service modalities and vehicle designs, making it stand out on the market. Therefore, the case study of Lime was undertaken during the research to identify factors and patterns of running a viable shared micromobility program.

3.1.1 Introduction

Lime is an American shared micromobility company. It is based in San Francisco, USA and belongs to Neutron Holdings, Inc. Lime provides dockless electric scooters, electric bikes, and electric mopeds sharing services in many cities worldwide. Since GPS trackers are installed on these vehicles, users can locate them with the Lime app and unlock them for use. Lime aims to create smart and eco-friendly transportation systems that are equally distributed and affordable to all communities, solving the first and last-mile problem and reducing automobile use.

Figure 25: Lime's Shared Vehicles
(Lime 2nd Street, 2021)

3.1.2 History

Lime's co-founders, Toby Sun and Brad Bao, were born and raised in China. Both of them have considerable experience in product and business development and marketing. Toby has worked for PepsiCo delivering the brand to a local market. Afterward, he worked for Deloitte Consulting and supervised the Strategy Service Line. Brad has been a general manager in the Tencent US branch and then being promoted to VP of business development for -Tencent Games. They knew each other through the alumni network of the University of California, Berkeley, and they both worked as executives in Kinzon venture capital firm before founding Lime. They recognized the rise of shared mobility and the need for solving the first and last-mile problem. Therefore, they decided to partner up and launched a shared mobility company (NGP Capital, 2020).

Lime was founded in January 2017 and raised a 12 million US dollar VC fund led by Andreessen Horowitz in March 2017. Shortly after, Lime launched the first fleet equipped with 125 bicycles at the University of North Carolina at Greensboro in June 2017. Later on, Lime started expanding the business to various cities such as Key Biscayne, Florida, South Bend, Indiana, South Lake Tahoe, California, and Seattle, Washington, attracting numerous users. The company was valued at $225 million in 2017 and reached $1.1 billion in 2018 (Robinson, 2018). In Consumer Electronics Show (CES) 2018, Lime announced the new service of Lime-E, the shared electric bike. And Lime-S, the shared electric scooter, was announced two months later. However, public criticism gradually increased because of a lack of permission from municipal authorities and the traffic chaos caused by the fleets (Carroll, 2018). Lime declared that they planned to develop self-driving electric transit pods, aiming to be a leading multi-modal transportation company. Later, the company signed a contract with Uber, supplying electric bikes for expanding Uber Bikes' service (Bond, 2018). Lime redesigned its e-scooters with larger wheels and more robust suspension and aluminum frame to extend vehicle lifespan and resist vandalism in October 2018. In December 2018, Lime obtained the permits and began a new car-sharing service that deployed 500 cars named LimePod in Seattle (Soper, 2019).

In May 2019, the co-founder Toby Sun renounced from the position of CEO and focused on R&D, and the other co-founder Brad Bao took his place (Clark, 2019). Lime was acknowledged as one of the 2019 top startups by LinkedIn for the first time, ranked No.12 out of 50 startups, whereas the company reported the predicted loss of $300 million in the same year (Brown, 2019). At the beginning of 2020, Lime laid off nearly a hundred employees and ended its services in several cities such as Atlanta, Phoenix, San Diego, and San Antonio. Subsequently, the COVID-19 pandemic was declared all over the world. Lime suspended 99% of global operations in response to social distancing policy and decreased travel demand, which hit Lime hard and led to further layoffs in April 2020 (Browne, 2020). Soon after that, Lime acquired assets of electric skateboard startup Boosted, including core patents and the remnant inventory of skateboards, scooters, and relevant parts. To receive an Uber-led $170 million funding round, Lime accepted the transfer of shared e-bike and scooter business Jump from Uber. Simultaneously, Brad Bao stepped down from his role, and Wayne Ting became the new Lime CEO (Carson, 2020).

In 2021, as vaccination rates increase and people begin to return to work, school, and social activities, Lime gradually resumes operations in several cities such as Miami, Florida, Spokane, Washington, Milwaukee, Wisconsin. Lime e-scooters returned to the streets of Edmonton in March, becoming Lime's first reoperated city in Canada (Intelligent Transport, 2021). In April 2021, Lime was selected and granted a permit during New York City's first e-scooter pilot program, and 1,000 e-scooters are expected to begin operation by early summer. NYC DOT stated that more bicycle lanes will be built for pilot zones in two years, enhancing mobility and safety. Lime first introduced Lime mopeds in Washington D.C., where all three Lime modes, e-bikes, e-scooters, and e-mopeds, are offered. According to the survey results, Lime affirmed that people changed their transportation preferences throughout the pandemic, and it makes micromobility an ideal travel option while remaining physical distanced. And the company is slated to return to more cities in the near future (Lime 2nd Street, 2021).

3.1.3 Operations

- **Equipment**

Currently, Lime has three types of vehicles in operation: electric scooter, electric bike, and electric moped. Lime has redesigned its vehicles based on user feedback and testing, showing the determination to deliver a great riding experience for users. As Figure 26 shows, Lime's vehicles are getting sturdier as new models came up. They are designed and manufactured for shared use in rough conditions, from larger wheels, specialized brakes to waterproof and road ruggedness features. In 2021, Lime first introduced their electric mopeds, meeting needs for diverse trip types, vehicle preferences, and distances (Lime 2nd Street, 2021).

Figure 26: Lime Design Evolution
(Lime 2nd Street, 2020)

Figure 27: Lime Electric Scooter Features
(Lime, 2021)

1. **Swept Handlebars**
   A first for shared scooters, the swept-back handlebars create comfortable handling.
2. **Dual Handbrake**
   Just like riding a bike, this brake system is more intuitive for riders.
3. **Firmware**
   Instant geo-fence technology for safer streets and sidewalks.
4. **Swappable Battery**
   New batteries can be swapped out for more sustainable operations and will be compatible with next-generation e-bikes.
5. **Powerful Motor**
   Updated motor enhancements help riders tackle hills like never before.
6. **Bigger Wheels**
   Solid honeycomb tires tackle the toughest road conditions.
7. **Lower Deck**
   A lower center of gravity means a sturdier ride.

Figure 28: Lime Electric Bike Features
(Lime, 2021)

1. **Swappable Battery**
   Long-range lithium-ion batteries with 25-mile range.
2. **Basket for Belongings**
   Conveniently stores bags and groceries.
3. **Adjustable Seat**
   Find the needed height for a comfortable ride.
4. **Lights and Reflectors**
   Front and rear LED lights to improve visibility and safety.
5. **Smart Lock**
   Integrated, retractable cable lock for both lock-to and free-standing options.
6. **Aluminum Frame**
   Highly visible, fortified aluminum frame.
7. **Puncture-resistant Wheels**
   26 inch wheels to tackle anything city streets can throw at you.
8. **Dual Braking**
   Reliable front disc brake and rear drum brake.

Figure 29: Lime Electric Moped Features
(Lime, 2021)

1. **Harmony Between Moped & Rider**
   Lower seat height and oversized wheels provide a low center of gravity.
2. **Designed for User**
   Simple and user-friendly controls and dashboard for safe and effortless riding.
3. **Extend Users' Urban Range**
   Travels up to 87 miles (140 km) on a single charge.
4. **Stow and Go**
   Secure storage making it easy to stow your belongings when you are on the go.
5. **Safety Comes Standard**
   Two helmets make sure one fits, leaving a spare for a passenger plus robust safety training to make you comfortable on the road.
6. **Twice As Fast**
   Top speed of 28 mph (45 km/h).

Moreover, Lime introduced a charitable program called Lime Able and developed a series of adaptive vehicles for riders with special mobility needs. Lime Able members can rent an adaptive vehicle whenever they need it, and Lime will deliver the vehicle to their homes for free. Currently, the program is only available in San Francisco, CA (Lime, 2021).

Figure 30: Lime’s Adaptive Vehicles
(Lime, 2021)

- **How It Works**

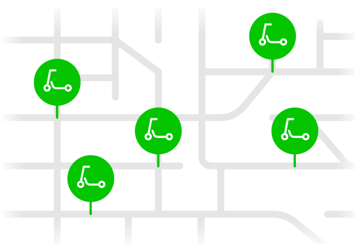
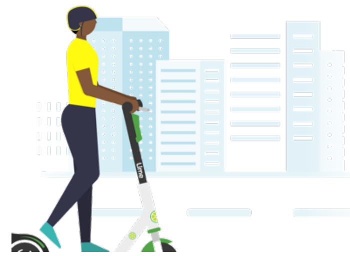
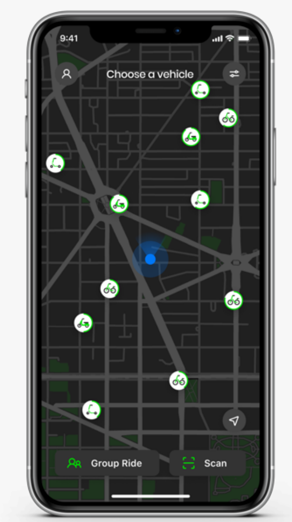
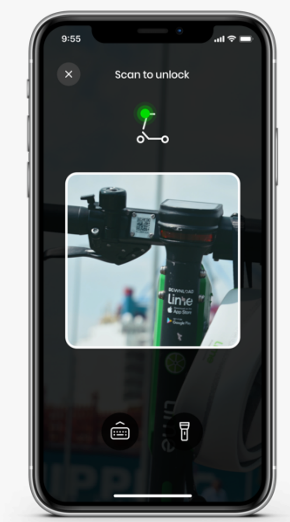
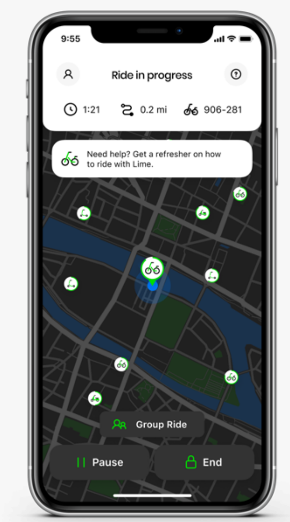
		
Locate	**Scan**	**Ride**
• Download the Lime app. • Use the Lime app to find the nearest available vehicle.	• Scan the QR code located on the vehicle via the app. • Unlock it. • Learn how to enjoy a safe ride in the app.	• Follow all traffic rules and safety policies. • Enjoy your ride. • Park in a proper place. • Take a photo to end ride. • Pay on the app.
		

Table 7: Steps to Use Lime
(Lime, 2021)

- **Fare**

Lime charges a fixed start fee to unlock a vehicle and a per-minute counted fee to ride. If a user reserves a vehicle, he/she will be charged a reservation fee per minute until he/she unlocks the vehicle or cancels the reservation. The average charge to use a Lime e-scooter includes a $1 start fee and 35 cents per minute, but rates and promotions may vary in different locations and periods of time. Users can check the current rate on the Lime app before they rent simply by tapping the vehicle icon on the map, scanning the vehicle's QR code or entering the plate number in the app. Total riding charges will be rounded up to the nearest minute and paid by users' payment method on the app.

Figure 31: Checking Rates on the Lime App
(Lime, 2020)

For those who participate in a public benefits program and have no smartphones or credit cards, Lime launched a program called Lime Access to eliminate the barrier for them. Qualified users can pay in cash at any PayNearMe partner stores (e.g., CVS, 7-Eleven) and unlock vehicles via text. Also, Lime Access offers them a discount of 70% or more on Lime vehicles.

- **Hours of Availability**

Technically, Lime e-scooters and e-bikes are available on a 24/7 basis. Lime's operations team will be responsible for replacing swappable batteries for low-battery vehicles, ensuring sufficient vehicles for rental all day. However, it might be difficult to find some e-scooters from 9 PM to 4 AM since former-generation e-scooters without swappable battery design are removed from the streets by the operations team and juicer team for recharging, and these e-scooters will be redeployed before the following morning comes. As for Lime e-mopeds, hours of operation may differ from locations. Lime e-mopeds are available from 5 AM to midnight in Washington, DC, while they are 24-hour operational in Paris.

- **Staffing Plan**

Operations Team	Morning Shift	3AM - 11AM	• Reposition and deploy e-bikes and e-scooters on streets based on the analysis of previous and real-time traffic data. • Deploy fleets at LimeHubs where local businesses agree to host vehicles on their property. • Monitor and adjust scooter deployments arranged by juicers.
	Mid-day Shift	11AM - 7PM	• Patrol and focus on the overall maintenance of fleets, including identifying low-battery vehicles, replacing batteries, or picking them up to recharge. • Address issues either reported in the app, customer calls, or emails. • Rebalance fleets and repark vehicles parked improperly.
	Night Shift	7PM - 3AM	• Carry out maintenance and testing checks for each vehicle. • Collect low-battery and broken vehicles to recharge and repair them at Lime's warehouse.
Contractors	Juicers	9PM - 4AM	• Juicers refer to contract employees who sign up on Lime's website to take on charging tasks. • Identify and reserve low-battery e-scooters via the juicer mode of the Lime app. • Retrieve and recharge them at home or other places (at least 95% charged). • Inspect and report any necessary repairs. • Drop off the e-scooters to designated locations.

Table 8: Lime’s Staffing Plan
(Gridwise, 2021; Lime, 2018)

- **Maintenance**

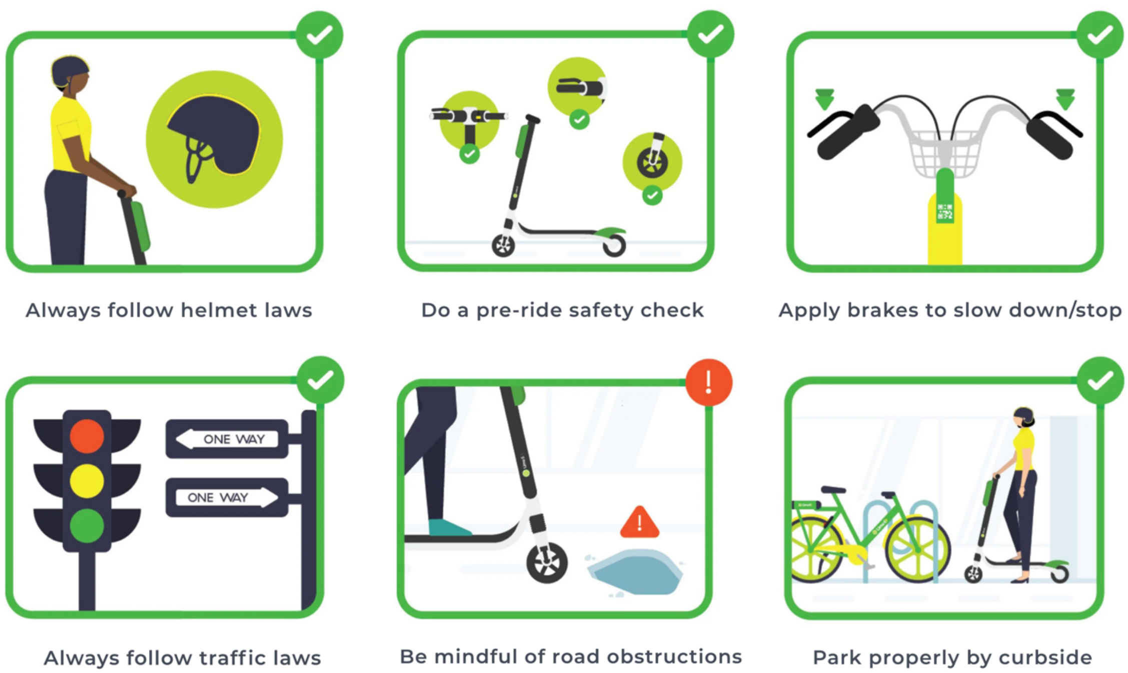
Lime's operations team is responsible for maintenance, cleaning, and repair. Basic maintenance tasks will be done before each deployment and ensure every vehicle is in good condition to serve. Routine checks will extend vehicles' lifespan for as long as possible. The team will know when an e-bike, e-scooter, or e-moped has something wrong through several ways. The team will identify any maintenance needs when the team patrols around during the daytime and when e-scooters are taken to the warehouse for recharging each night. Users can also report issues via the Lime app, customer service calls, and emails, informing the team to offer corresponding maintenance support. Moreover, when a vehicle has received a low user rating twice, it will be automatically put into a watch list by the system and wait upon an upcoming inspection.

- **Safety & Parking Policies**

Lime has been dedicated to keeping users safe. Users can find the "Safety Center" tab on the Lime app and learn relevant rules and regulations anytime. Furthermore, there is a "Safety 101" page on the Lime website, providing users with videos and directions on how to ride and park properly. The following table shows suggestions Lime has given to its users on the app and the website.

Riding Guidelines

- Check the brakes, frame, handlebars, wheels, throttle, pedals, lock, or seat before starting a ride.
- Ensure the front and rear lights on the vehicle are turned on and visible at night.
- Wear a helmet when riding.
- Be 18+ years old to ride.
- Ride one person per e-scooter/e-bike.
- No drunk riding. Do not text and ride.
- Ride on a bike lane. Do not ride on the sidewalk.
- Follow local traffic laws. Yield to pedestrians.



Parking Guidelines

- Do not block sidewalks, crosswalks, bus stops, driveways, service ramps, any entrances and paths.
- Park away from private property.
- Parking near a bike rack is preferred.
- Park e-scooters, e-bikes upright.

Table 9: Lime’s Riding and Parking Guidelines
(Lime, 2021)

Once users have watched tutorials on the app/website and have fully understood, they can take a short quiz on the website to earn a free ride as an incentive or to claim a free helmet in participating cities. Lime also offers discounts for users to buy collaborating brands' helmets and safety gear, promoting the act of cautious riding. Users can sign up for the First Ride Academy lesson taught by Lime's team members if they still have questions.

3.1.4 Keys to Success

According to the case study, the following summary indicates the five main factors for Lime's success.

1. **Clear company culture and consistent branding showing core values.**

Lime spent much time and effort building a strong corporate identity. Their spirit, visual identity and every other detail align with Lime's core value: creating a smart, compelling, and eco-friendly transportation solution. Lime's co-founders have said, "We believe that branding and culture are important ingredients for Lime's success" (NGP Capital, 2020). The distinct company culture has attracted like-minded users, increasing customer loyalty and the company's visibility.

2. **Having teams with professional and practical experiences in relevant industries.**

Lime's co-founders both worked for a venture capital firm before establishing Lime, and their background was beneficial when they were seeking funding. Thus, they understood that human resources are the most crucial assets of an organization. Lime's executive teams have extensive experience in ride-sharing and relevant industries. Their valuable know-how and insights led to Lime's rapid growth.

3. **Focusing on users' needs when developing products and services.**

Lime considers itself as a user-centered company. Lime’s teams always think of what they can do for users rather than what the company can accomplish. Lime tailors products and services based on users' needs. For example, Lime is the first shared micromobility company carrying insurance on their vehicles and providing cash access for those who do not have a credit card.

4. **Comprehensive logistics of operation.**

Moreover, Lime has comprehensive operational networks such as redistributing, charging, repair, and maintenance services, keeping the operation as smooth as possible and delivering a better user experience. As the company's scale expands, Lime pursues vertical integration of its products and services, reducing dependency on suppliers.

5. **Having a strategic partner that supports and complements each other.**

Lime and Uber have been partnering since 2018. Their business models are complementary. And they strengthen each other and share resources, opportunities, and potential customers in the field of first and last-mile transportation. Therefore, finding a mutually beneficial partnership will likely take a business to another level.

3.2 Ofo

As one of the fast-growing bike-sharing companies in China, Ofo once has had a valuation of $3 billion and had over 62 million active users, but ended up in bankruptcy in 2018 (Bloomberg, 2018). The case study attempts to review the rise and fall of Ofo and identifies the reasons why it failed.

3.2.1 Introduction

Ofo was a bicycle-sharing company based in Beijing, China. It was founded in 2014. Ofo provided users with dockless bike services. Users need a deposit to have an account and top up money for use. Users can locate a signature-yellow Ofo bike nearby, use the mobile app to get the password of the bike's padlock and pay an hourly rate from the account's balance for use. Ofo had deployed over 10 million bikes in 20 countries. In 2018, it announced a reduction in operations globally and eventually shut down the business permanently due to a large debt in 2019.

Figure 32: Ofo Dockless Shared Bike
(Paton, 2019)

3.2.2 History

In 2014, Ofo was founded by Dai Wei and his four friends while the cycling club members at Peking University. They aimed to begin a startup with their interest, share the fun of cycling, and solve the first mile/last mile problem for urbanites (Bork, 2019). It was named "Ofo" because the word itself looks like the image of a person riding on a bicycle. In the beginning, Ofo only ran the business on campus. In June 2015, Ofo officially launched and deployed 2,000 bikes in Beijing with funding from Peking University alumni, attracting around 20,000 users (Peking University, 2015). In 2016, Ofo expanded the operation to many cities in China. After obtaining the investment of $130 million from Chinese tech giants Xiaomi and Didi Chuxing and $450 million funding led by Didi Chuxing and Russian investor Digital Sky Technologies, Ofo started expanding internationally to other countries, including Singapore, United Kingdom, United States, and France, and Australia in 2016 to 2017. Soon after, Ofo raised an additional $700 million funding led by Alibaba, Hony Capital, and Citic PE (Lulu, 2017).

Due to the fast-paced business environment in China and the fierce competition with the primary rival Mobike, Ofo adopted a price war strategy and increased the scale of the fleet. It is reported that Ofo ordered 5 million new bikes annually from suppliers. In an attempt to cut down the manufacturing cost of bikes, the quality of Ofo bikes suffered, resulting in a short hardware lifetime and high rates of damage and theft, delivering a negative user experience (Zhou, 2017). Even though Ofo had extensive funding, the company faced a huge amount of maintenance costs that negatively impacted the business's sustainability in the long run. After missing the chance to merge with Mobike or be acquired by Didi, Ofo suffered from tremendous cash-flow pressure. Ofo began reducing their operations domestically and internationally while their competitor Mobike received a US$2.7 billion investment from Meituan-Dianping (Bork, 2019).

In 2018, an internal email about financial issues was leaked. Subsequently, both investors and customers started losing faith in Ofo, aggravating the funding crisis. Other than funding disruption, the overwhelming requests for refunds from users also put Ofo in trouble. Later on, Ofo declared bankruptcy and ceased the operation entirely, leaving a mess to society – massive unpayable debts and a large number of abandoned bikes (Zhong & Zhang, 2018).

Figure 33: Huge Piles of Unused Ofo Bikes
(Hookham, 2017)

3.2.3 Operations

- **Equipment**

Models		Tire	Details
Ofo 2.0		26" Pneumatic Tire	• ofo 2.0 bicycles were equipped with various types of bike locks: push-button/4-digit combination padlock, electronic combination/Bluetooth padlock.
Ofo 3.0		22" Pneumatic Tire	• Had three types of bike locks: 4-digit combination padlock, electronic combination/Bluetooth padlock.
Ofo 3.1		24" Pneumatic Tire /Solid Tire	• Had three types of bike locks: 4-digit combination padlock, electronic combination/Bluetooth padlock.
Ofo 3.2		24" Solid Tire	• Had two types of bike locks: electronic combination padlock and Bluetooth padlock.
Ofo L1		24" Solid Tire	• Z-shaped bicycle frame. • Equipped with the electronic Bluetooth padlock. • The solar panel attached to the bike basket was to supply power for the padlock.

Ofo Curve		24” Pneumatic Tire /Solid Tire	• Curved-pipe bicycle frame. • Equipped with the electronic combination padlock.
Ofo 3.21		24” Solid Tire	• Equipped with a handle behind the seat. • Drum brake for the front wheel. • Some were put ads on wheels for making money. • Equipped with the electronic combination padlock.
unnamed		24” Solid Tire	• V-shaped bicycle frame. • Equipped with electronic Bluetooth padlock. • The solar panel attached to the bike basket was to supply power for the padlock. • Similar to ofo Bicycle US.
Ofo Black		24” Solid Tire	• Five-spoke bicycle wheels and belt drive. • Equipped with the electronic Bluetooth padlock. • Similar to Mobike bicycles.

Table 10: Various Versions of Ofo Bikes
(Ofo Bicycle, 2017)

Although Ofo's teams had iterated vehicle design many times based on user and market feedback, they had a lower budget for equipment. Their strategies were to adopt cheap vehicles and scale up the fleet to gain market share. The low-cost equipment may have caused an unstable quality of product and service and a lack of ability to prevent vandalism and theft, delivering an unpleasant user experience and increasing maintenance costs (Zhou, 2017). Moreover, Ofo did not recall old versions of bikes and standardize its devices. Different bike models on the street with different ways of unlocking caused confusion for users. It was also an extra load for staff to tell apart a variety of bike models to repair, maintain, and address issues correspondingly, making management difficult.

		
Push-button Combination Padlock	4-digit Combination Padlock	Electronic Combination Padlock

	
Electronic Combination Padlock w/ Bluetooth Unlock	Electronic Bluetooth Padlock

Table 11: Five Types of Ofo Bike Locks
(Ofo Bicycle, 2017)

At first, Ofo used mechanical combination padlocks on its bikes, which criminals could easily crack, and people with bad intentions could memorize the password with the same bike to get multiple rides for free. Many Ofo bikes were hacked, making Ofo lose incomes from vehicles. Although Ofo changed mechanical locks for electronic smart locks to prevent dishonest users, it was still too late for a startup with fragile financial conditions.

- **How It Works**

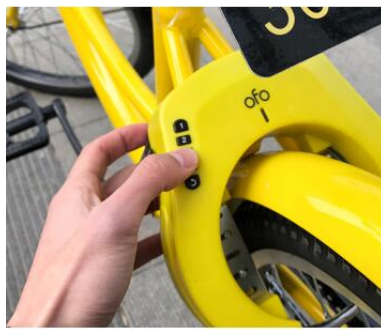
		
Find	**Unlock**	**Ride**
• Download the Ofo app. • Look for a yellow ofo bike on the street.	• Scan the QR code or type in the plate number to get the password. • Unlock it.	• Enjoy your ride. • Park in a proper place. • Lock it. • Pay on the app.

Table 12: Steps to Use an Ofo Shared Bike
(KkNews, 2017; Science China, 2017)

In the early operations, users could not use the mobile app to locate vehicles. They needed to search for bright yellow Ofo bikes on the street with the naked eye. Ofo teams improved the mobile app afterward and enabled users to locate nearby bikes on the app. However, Ofo bikes were not equipped with GPS trackers. Locations of Ofo bikes were based on the previous user's smartphone, which would transmit where the user claimed to finish parking and end the ride. For the latest generation Ofo bike with electronic Bluetooth padlock, users no longer needed to unlock an Ofo bike with a password. They simply had to make one tap in the app and get ready to go.

- **Business Model**

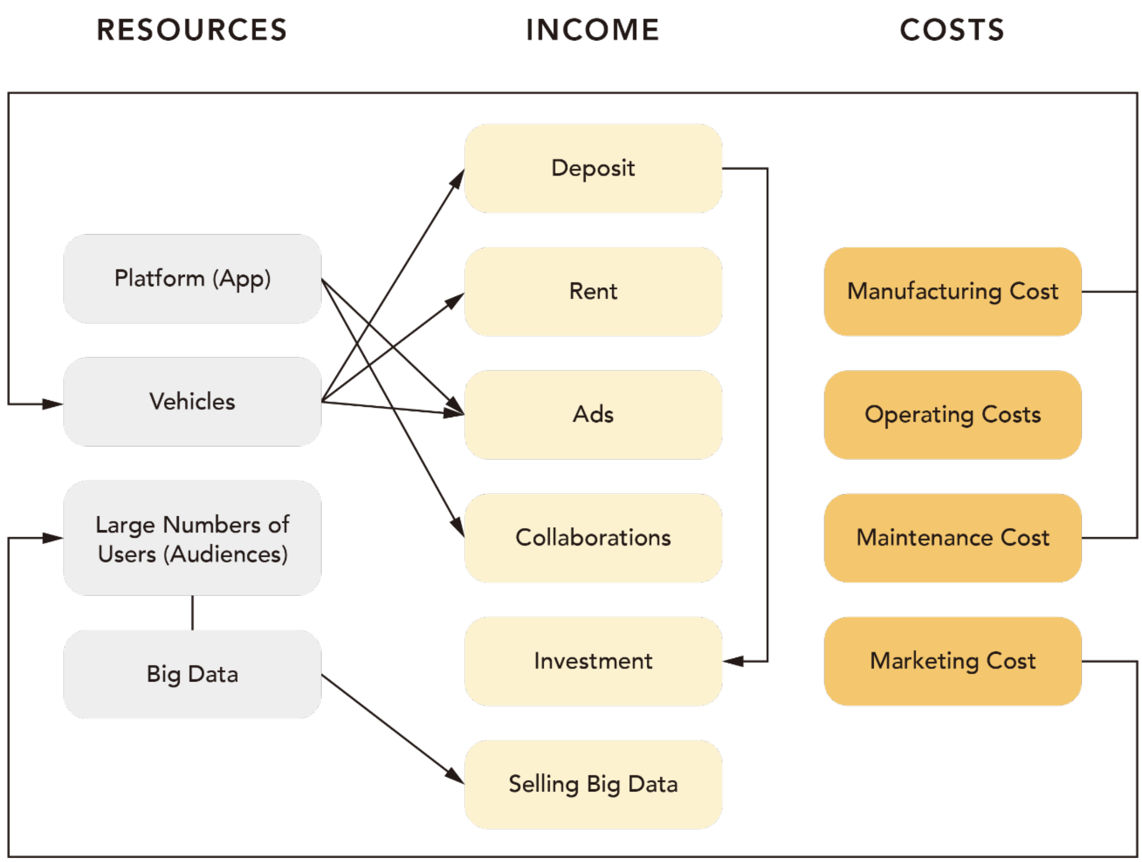


Figure 34: Ofo's Business Model
Source: Compiled by the author based on Forward The Economist (2019)

Due to many unscrupulous free rides, Ofo failed to get the payback on vehicles and recover their costs. In addition, the government's unfavorable regulations were also one of the reasons for making losses. In the beginning, Ofo exploited its resources as much as possible to increase overall income, such as providing advertising services on bikes' wheels, leveraging users' deposits for other investments, selling big data, etc. However, more and more relevant restrictions and prohibitions came up and limited Ofo's income sources. As the maintenance costs rose and income diminished, the operating condition of Ofo became progressively worse.

3.2.4 Reasons for Failure

According to Ofo's case study, three reasons that resulted in failure have been identified as the following:

1. **Careless equipment scheme and management.**

Ofo adopted low-quality equipment to lower the manufacturing cost. However, poor equipment that could not deal with frequent use, vandalism, and theft increased the repair cost and vehicle loss instead. Additionally, Ofo did not standardize its shared vehicles, deploying various bike models with different bike locks on the street that frustrated users in use and management. As Ofo expanded its business, the teams forgot the original intent as a "bike-sharing" company. They spent a fortune on buying a huge amount of deployed bicycles rather than maximizing the operating effectiveness with limited vehicles. Ofo made itself like an old-fashioned rental company that came with high maintenance costs.

Ofo did not take their situation carefully enough and strengthen management in response to rapid expansion, leaving poor corporate governance, financial and accounting system.

2. **Unfavorable policies.**

From the external factor aspect, some policies and requirements issued by local authorities became the reason for the cost increase and the obstacle to Ofo's expansion, such as limitation of the vehicle numbers in operation, weighty responsibility for insurance, and strict privacy policy. For example, Ofo withdrew from the European market eventually because the General Data Protection Regulation (GDPR) was too strict to comply with. Some regions do not allow bike-sharing companies to put advertisements on bike bodies, cutting down one of Ofo's income sources. The uncertain policies and challenges put the industry under pressure.

3. **Short-sighted and half-baked strategies.**

When a new industry is launched in China, many venture-backed startups jump into the competition and spend big on subsidies, referral bonuses, and promotions to win the market. The rest with a small market share will die when it is no longer affordable to fight. It is a common business phenomenon in China called Money Wars (Towson, 2019). Initially, Ofo made it and stood out as one of the market leaders with another competitor

Mobike. However, Ofo did not realize that the game was not over yet and even went on for a long period of time.

In 2017, Ofo started going global before it ensured market dominance in China. Although launching operations internationally would increase valuation and VC funding, it would take considerable time and money to carry out. For Ofo, expanding overseas was not necessary and not worth enough return to take on at the time. In the economic environment of China, large funding could come incredibly fast and easily but would not last for too long. As the income reduced and the costs increased, Ofo failed to break even and ran out of money, becoming a loss-making bike-sharing company.

3.3 Responses to the Pandemic

Due to COVID-19, single-person shared micromobility has drawn more attention. Shared micro-vehicles help people with short-distance travel while social distancing, such as going to work, grocery stores, pharmacies, visiting doctors. However, shared vehicles touched by multiple riders may incur on-surface transmission. Thus, shared micromobility companies have implemented new measures to keep users and employees safe and healthy. As a reference for similar situation in the future, the following table was compiled to present how leading shared micromobility companies Lime and Bird responded to the pandemic, took corresponding actions, and mitigated the risks.

	BIRD	Lime
Vehicles	• Follow a rigorous process to routinely clean and disinfect each scooter. • Increase the daily frequency of cleaning and sanitizing, including the sterilization of the scooters and helmets.	• The staff clean every vehicle in the fleet every time they come in contact with one. • Disinfect all surfaces using approved cleaners. Wipe so that the surface remains visibly wet for five minutes, and let dry. • Focus on frequently touched areas including handlebars, brakes, and throttles.
Users	• Educate users to practice social distancing in a ride, which is at least six feet of space between a rider and other road users.	• Educate users to wear masks in public settings, stay socially distanced while riding, and wash hands or use hand sanitizer before and after use.
Employees	• Provide gloves for field service staff members as well as hand sanitizer for all employees. • Closely monitor the Centers for Disease Control (CDC), the World Health Organization (WHO) and other trusted federal and global agencies to inform hour-by-hour decisions.	• Outfit employees with masks and disposable gloves. • Training courses: Hazard Communication, Preventing the Spread of Transmissible Illness, Cold and Flu Prevention, Personal Protective Equipment (PPE), Social distancing protocols training, Preventing on-surface transmission training, and stopCOVID.co training. • Establish a COVID-19 task force to communicate relevant news and safety protocols.

Table 13: COVID-19 Safety Procedures
(Bird, 2020; Lime, 2021)

3.4 Takeaways

To sum up, crucial factors concerning the success and failure of shared micromobility were found through the case studies. The table below shows the tips for developing a successful shared micromobility company, becoming one of the supporting materials for the further formulation of the design guidelines.

Design	**Service**	• Focusing on users' needs when developing services to deliver a good user experience.
	Product	• Focusing on users' needs when designing vehicles to improve usability. • Sturdy and smart equipment to cope with frequent use, vandalism, and theft. • Striking the balance between vehicle quality and manufacturing cost. • Standardizing vehicle model to avoid confusion.
	Branding	• Distinct and consistent corporate visual identity. • Clear mission, vision, and values statement, cultivating positive company culture to improve employee commitment and attract customers.
Business	**Staff**	• Recruiting employees with know-how and experience in ride-sharing, venture capital, and relevant industries.
	Management	• Thorough operating procedure to ensure smooth routine operations, including vehicle redistributing, charging, repair, and maintenance. • Moderate scale of fleet to operate sustainably. • Build a robust financial and accounting system.
	Strategy	• Expanding business wisely with a thorough assessment at a moderate pace. • Scouting a strategic partner that benefit mutually. • Seeing the bigger picture and avoiding short-sighted strategies during fierce competition.
	Public Relations	• Communicating and negotiating constantly and effectively with authorities to secure the operation and profits.

Table 14: Tips for Developing a Successful Shared Micromobility Company

Chapter 4 Development of Design Guidelines

4.1 Survey Research

The service design framework and crucial factors of shared micromobility business were compiled out of the literature review and case studies. To draw up thorough design guidelines for shared micromobility in tourist destinations, it is necessary to understand how tourists perceive sightseeing shared micromobility service, what they need and prefer regarding sightseeing vehicles, and to see if tourists have different needs and preferences between town and city destinations. Therefore, the survey research was implemented to collect useful information from questionnaire responses as an ingredient for the guidelines, helping adopters develop user-centered services and products for tourists. The survey was approved by the Institutional Review Board (IRB) and was conducted online via the SurveyMonkey platform. The total anonymous respondents are 80 people considered potential tourists in town and city destinations and aged 18 and up.

4.1.1 Questionnaire Design

The questionnaire consisted of 22 questions which can be sorted into five parts: (1) demographic questions, (2) needs and preferences toward in-city sightseeing vehicles, (3) needs and preferences toward in-town sightseeing vehicles, (4) the overall form and appearance preference, and (5) perception of sightseeing shared micromobility services. The framework of the questionnaire was designed based on the Consumer Perceived Value proposed by Jillian Sweeney and Geoffrey Soutar in 2001. It is a notion that the success of a service or product is affected by how customers perceive their values. There are four dimensions to customer perceived value: emotional value, social value, price/value for money, and performance/quality. In the questionnaire, the tourists' preferences concerning types, features, form, and appearance of sightseeing micro-vehicles attribute to the emotional value; popularity and environmental advantages of sightseeing shared micromobility service attribute to social value; and the willingness to pay for tourism attribute to the aspect of price/value for money, one of the functional values.

Emotional value	the utility derived from the feelings or affective states that a product generates
Social value (enhancement of social self-concept)	the utility derived from the product's ability to enhance social self-concept
Functional value (price/value for money)	the utility derived from the product due to the reduction of its perceived short term and longer term costs
Functional value (performance/ quality)	the utility derived from the perceived quality and expected performance of the product

Figure 35: Four Dimensions of Consumer Perceived Value
(Sweeney & Soutar, 2001)

To identify the appropriate vehicle types for tourists in cities and towns, the study proposed the micro-vehicle classification according to SAE International (2019) and ITDP (2020). Micro-vehicles, including human-powered and electric-powered, are divided into twelve types: skateboard, scooter, bicycle, cargo bike, rickshaw, powered skateboard, powered scooter, powered bicycle, powered cargo bike, powered rickshaw, powered self-balancing board, and powered seated scooter. In the questionnaire, respondents can choose what they think are the most suitable micro-vehicle types for tourists in city/town destinations.

					
1	**2**	**3**	**4**	**5**	**6**
Skateboard	Scooter	Bicycle	Cargo Bike	Rickshaw	Powered Skateboard
					
7	**8**	**9**	**10**	**11**	**12**
Powered Scooter	Powered Bicycle	Powered Cargo Bike	Powered Rickshaw	Powered Self-Balancing Board	Powered Seated Scooter

Table 15: Types of Micro-vehicles

Source: Compiled by the author based on ITDP (2020); SAE International (2019)

As for investigation of preference toward sightseeing micro-vehicles' form and appearance, the study adopted the Semantic Differential (SD) method with a 7-point bipolar rating scale to identify generalized preferences. Semantic differential method is widely applied in Kansei engineering, asking where respondents fall upon between two grammatically opposite adjectives, showing their inclination toward a product. In the questionnaire, six pairs of adjectives were selected from the semantic vocabulary of bicycle imagery (Tseng, 2013), which are traditional/innovative, archaic/futuristic, slim/beefy, angular/smooth, static/dynamic, and plain/ornate, put at each end of the scale. Additionally, questions asking about the perceived usefulness of sightseeing shared micromobility are based on the TAM questionnaire (Lewis, 2019).

1	Safety	⟷	Dangerous	10	Dynamic	⟷	Static
2	Young	⟷	Mature	11	Professional	⟷	Amateur
3	Funny	⟷	Monotonous	12	Delicate	⟷	Rough
4	Fast	⟷	Slow	13	Comfortable	⟷	Uncomfortable
5	Avantgarde	⟷	Conservative	14	Ornate	⟷	Simple
6	Soft	⟷	Masculine	15	Lightweight	⟷	Bulky
7	Flow lines	⟷	Non-flow lines	16	Texture	⟷	Ragged
8	Durable	⟷	Vulnerable	17	Unique	⟷	Ordinarylines
9	Fashion	⟷	Tacky	18	Succinct	⟷	Complex

Figure 36: The Semantic Vocabulary of Bicycle Imagery
(Tseng, 2013)

4.1.2 Data Analysis

The data collected from the questionnaire was organized, coded, and analyzed through Microsoft Excel. The analysis results of the questionnaire are shown below.

- **Respondent Demographics**

The male respondents account for 53.75% of the total, and the remaining 45% of respondents are female. The majority of participants are aged 18 to 34-year-old. And a large proportion of respondents' ethnicities are Asian/Pacific Islander and White/Caucasian.

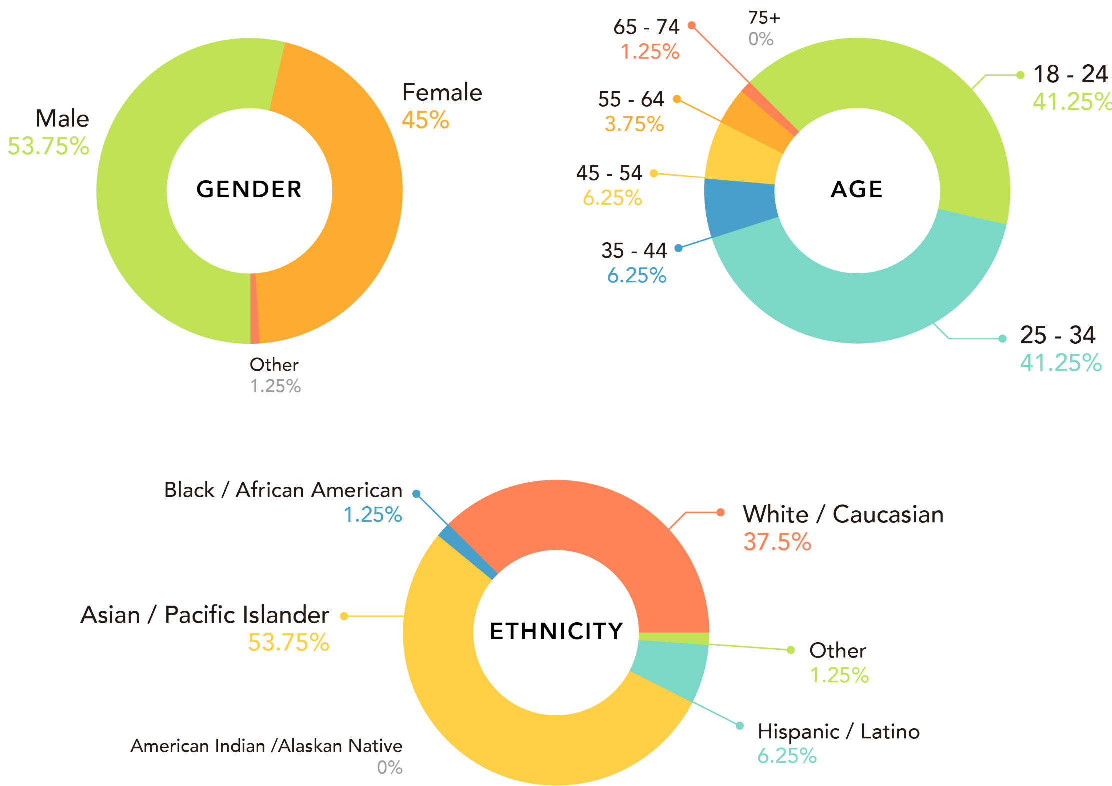


Figure 37: Survey Respondent Demographics

- **Needs and Preferences toward sightseeing micro-vehicles**

According to the survey, the top three preferred micro-vehicles in cities and towns are the same: regular bicycle, powered bicycle, and powered seated scooter. It can be inferred that powered and seated micro-vehicles are preferred.

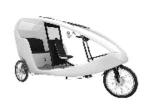
Micro-vehicle		City (%)	Town (%)	Micro-vehicle		City (%)	Town (%)
1		0.4	1.3	7		17.2	14.6
2		2.1	2.5	8		19.7	15.0
3		20.9	20.4	9		2.9	5.8
4		1.7	7.1	10		7.1	8.3
5		1.7	1.3	11		4.2	5.0
6		2.5	2.1	12		19.7	16.7

Table 16: Preferred Micro-vehicles for City/Town Tourist Destinations

Storage space and safety light are considered important features for shared micro-vehicle in both city and town tourist destinations. However, there is a slight difference in tourists' needs between cities and towns. In city destinations, respondents' data indicates that the phone mount holder may be an essential feature for shared micro-vehicles. In contrast, the attached helmet seems more important for tourists in town tourist destinations.

Feature	City (%)	Town (%)	Feature	City (%)	Town (%)
Storage space	20.4	18.9	Phone mount	16.7	12.5
Hanger hook	5.9	4.6	Attached helmet	14.1	14.2
Extra seating	7.0	13.2	Safety light	21.9	19.9
Canopy	2.2	5.0	Horn	11.9	11.7

Table 17: Important Features of Sightseeing Shared Micro-vehicles

The characteristics of sightseeing shared micro-vehicles that respondents considered important are "easy to learn", "easy to use", and "comfortable", which echoed the result of preferred micro-vehicles. People prefer vehicles they are familiar with, requiring little learning. The comfort of micro-vehicles also matters for tourists while sightseeing.

Characteristic	City (%)	Town (%)
Lightweight	8.9	10.2
Compact	7.4	5.2
Easy to learn	17.7	17.5
Easy to use	21.1	19.1
Friendly to any outfits when riding	13.4	12.6
Innovative	3.7	3.1
Exciting	3.7	4.0
Reassuring	6.9	7.7
Comfortable	17.1	20.6

Table 18: Important Characteristics of Sightseeing Shared Micro-vehicles

- **Form and Appearance Preference**

The below figure shows that most respondents tend to admire micro-vehicles with a dynamic and smooth outline, minimalist form, and light volume.

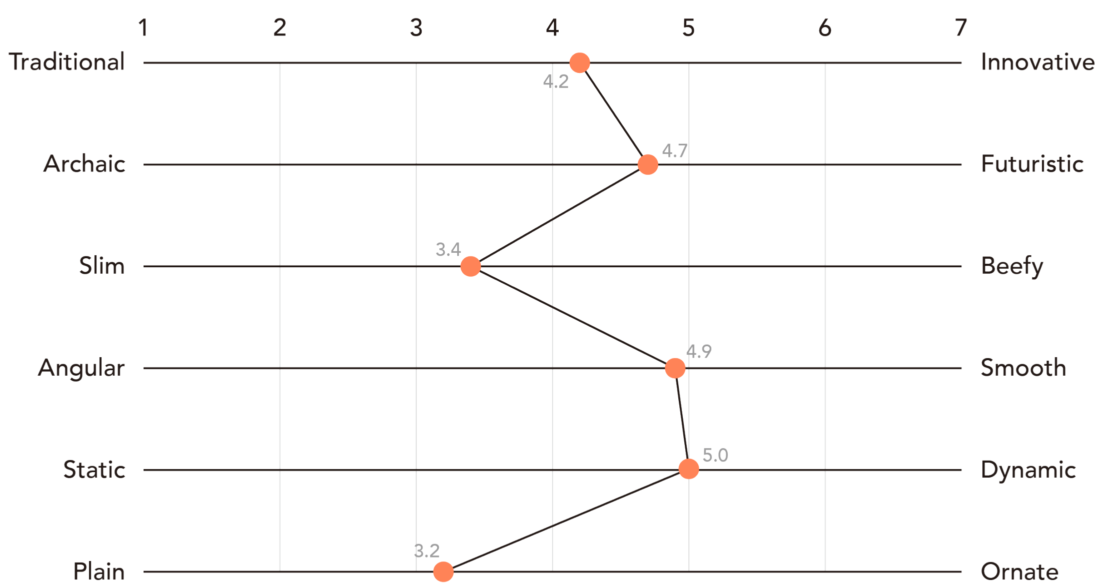


Figure 38: Form and Appearance Preferences for Shared Micro-vehicles

- **Perception of Sightseeing Shared Micromobility**

In the questionnaire, there was a question with a comparison of 78 US dollars car rental fare for a day, asking people how much money they will be willing to pay for one-hour use of sightseeing shared micromobility. The average acceptable price that tourists are willing to pay for shared micromobility is 9.99 US dollars per hour. The reasonable price rate is 12.8%, calculated with numerical values of the car rental fee and the average willingness to pay from responses. The formula below can be used as a reference and help operators determine the price in a range accepted by tourists.

[COST OF RENTING AN ECONOMY CAR FOR A DAY LOCALLY] * 12.8% = [AVERAGE WILLINGNESS TO PAY AN HOURLY RATE FOR SIGHTSEEING SHARED MICROMOBILITY]

Figure 39: The Price Formula of Sightseeing Shared Micromobility

In the questions about perceived usefulness, over half of the respondents expressed that shared micromobility would positively benefit their trip. Over half, 51.25% of respondents agreed that shared micromobility would make their sightseeing activities easier and enhance efficiency. And 50% of people also agreed that it is useful for tourists. Most people's willingness to use would be increased when they acknowledge the popularity and the environmental benefits of the service, which could be a good direction of promoting strategies.

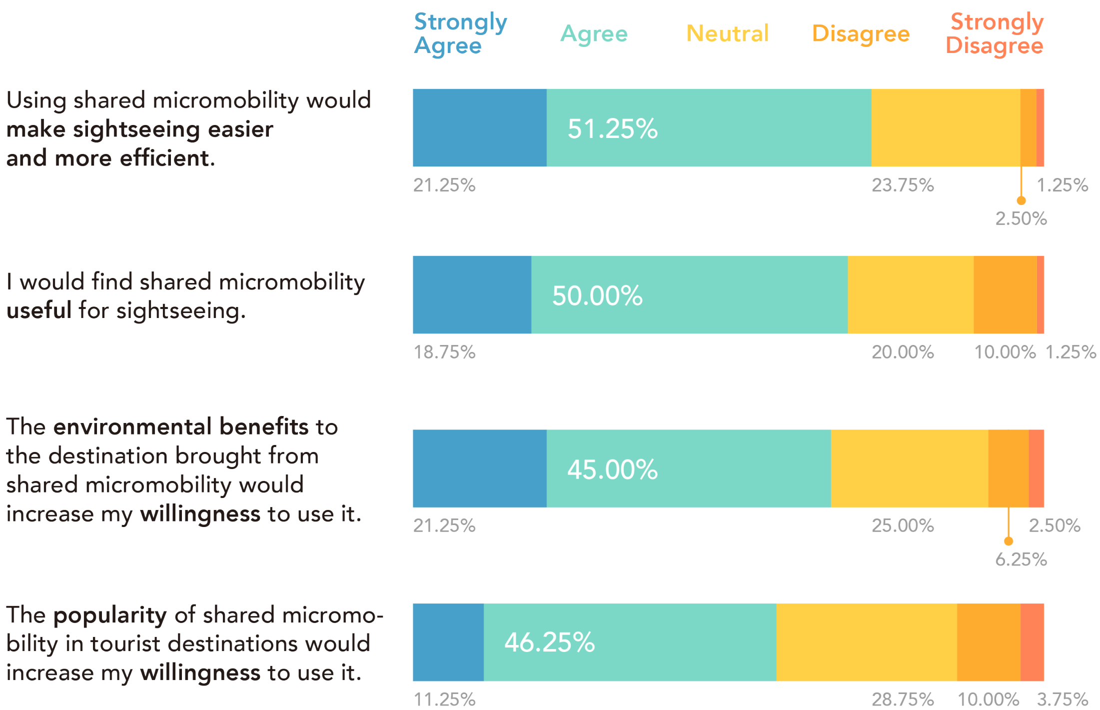


Figure 40: Attitude about Sightseeing Shared Micromobility

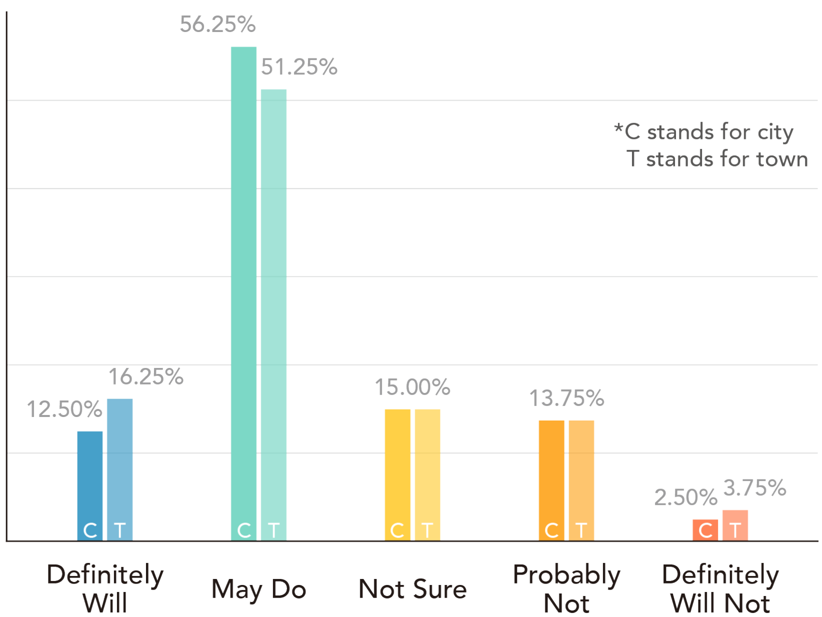


Figure 41: Willingness to Use for Sightseeing Shared Micromobility

The above figure presents the willingness to use based on questionnaire responses. Overall, the willingness to use shared micromobility for sightseeing is relatively high. Furthermore, the tourists' attitudes toward shared micromobility in city and town destinations are similar.

As the survey result revealed, the assumption of significant difference between city and town destinations has been disproved. However, it has been shown that shared micromobility is potentially beneficial for tourists while exploring a city or town. Therefore, sightseeing shared micromobility may be a favorable tourism transportation option to implement in a city/town. Furthermore, the survey data established an understanding of tourists' needs and preferences toward shared micromobility for sightseeing purposes, becoming a crucial component of forming design guidelines.

4.2 Design Guidelines

The main ingredients were obtained and gathered throughout the previous research for formulating design guidelines for tourism-focused shared micromobility in city and town destinations. The design guidelines include the proposed design flow and recommendations in aspects of design and business. The design flow and the recommendation checklist are straightforward. Therefore, any startups, organizations, or authorities can adopt the design guidelines to develop a promising tourism-focused shared micromobility program step by step.

4.2.1 The Design Flow

The framework of the design flow was developed based on the service design framework for shared micromobility (Table 6) presented in the literature review. The following table shows four main phases in the design flow. In each phase, suggested activities and tools are provided based on the literature review and case study findings. Building a holistic understanding of the status quo is an essential step prior to development, helping organizations find business opportunities. The brand, service configurations, platforms, and vehicles are defined and designed in the ideation phase. And generation of concepts will be shaped into tangible forms for evaluating during the third phase. After services launch, operating evaluation ensures a healthy and sustainable business.

Design Flow	Activities	Tools
Research	• Learning policies • Mapping destination travel network • Understanding tourist profiles • Identifying gaps in the market	Persona Journey Maps Competitive analysis
Ideation	• Defining services • Branding • Designing props	REC Checklist Mood Boards Sketching Wireframing
Prototyping	• Visualizing and evaluating: - Service processes and experiences - Physical objects and environments - Digital artifacts and software - Business systems	Service Blueprint Low-fidelity Prototyping Business Model Canvas
Implementation	• Focusing on business goals and strategies • Developing evaluation models for service/product performances	REC Checklist SWOT PESTLE Analysis

Table 19: The Design Flow of Sightseeing Shared Micromobility

Service is a complex and intangible process involving customers, employees, and third-party stakeholders. Therefore, it is necessary to adopt a service blueprint to visualize each step and actor of service and evaluate in a clear way during the prototyping phase. As mentioned in the literature review, a service blueprint is a common tool when designing services. It consists of four key elements and six secondary elements. Key elements are customer journey, frontstage actions, backstage actions, support processes. The customer journey is a series of actions customers have done during a service. Frontstage actions refer to actions that occur in the sight of customers and taken by service personnel who directly interact with customers, while backstage actions are employee actions taken where customers cannot see. Support processes mean additional internal activities that support the service personnel. Secondary elements include time, evidence, arrows, line of interaction, line of visibility, and line of internal interaction. Time indicates an estimated duration for each customer action. Evidence is any physical/digital prop contacted with customers or employees during a service. Arrows are to reveal relationships and dependencies between customer and employee actions. Line of interaction needs to be placed between the customer journey and the frontstage actions, showing their direct interactions; line of visibility divides where actions are visible to customers or not, placed in the middle of the frontstage actions and the backstage actions; line of internal interaction separates internal employees and employees/partners who do not directly support interactions with customers.

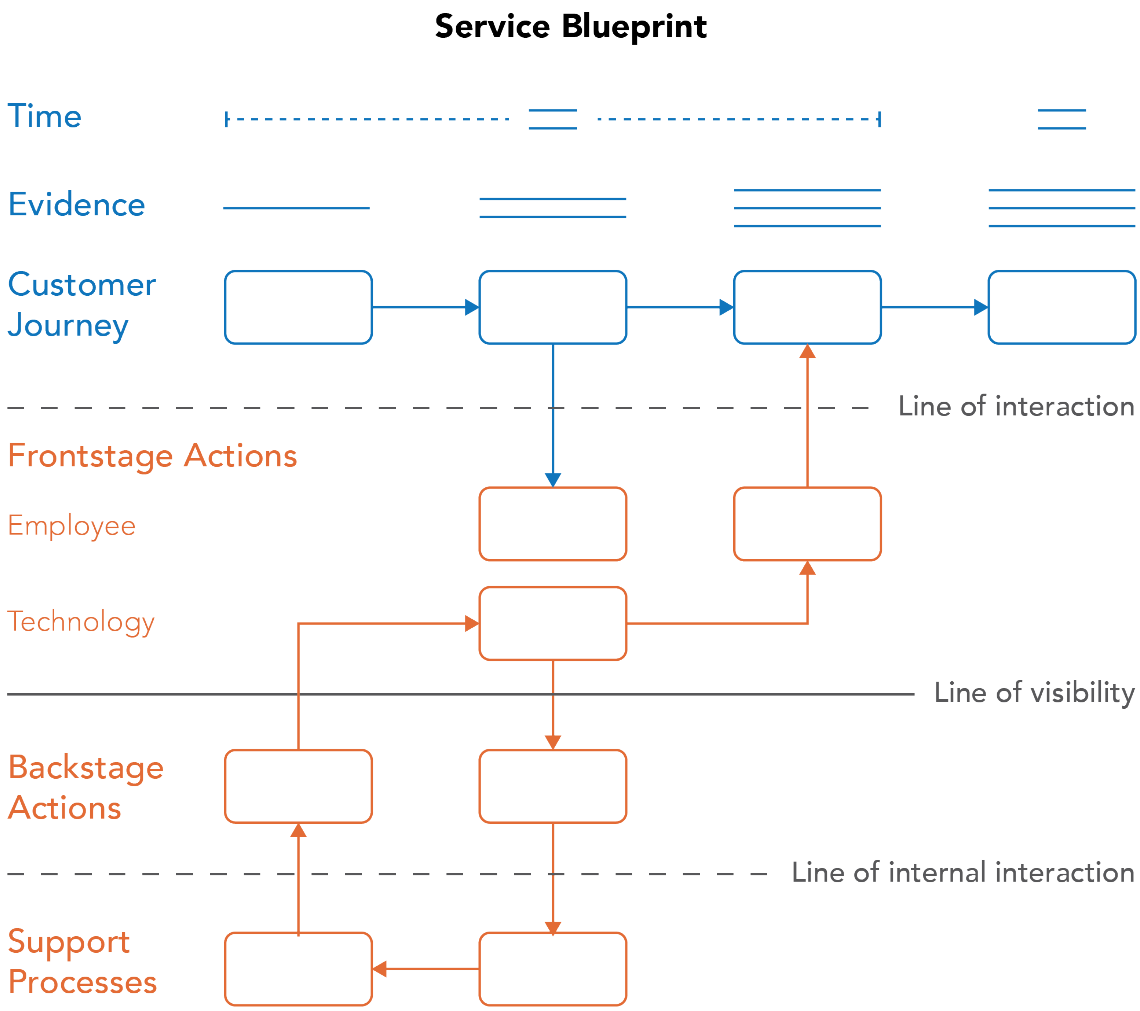


Figure 42: Service Blueprint Template

The flowchart below visualizes the proposed design flow, offering instructional steps for shared micromobility development in city and town tourist destinations, thus helping the guidelines' adopters follow along with the design flow easily and create a tourism-use shared micromobility program.

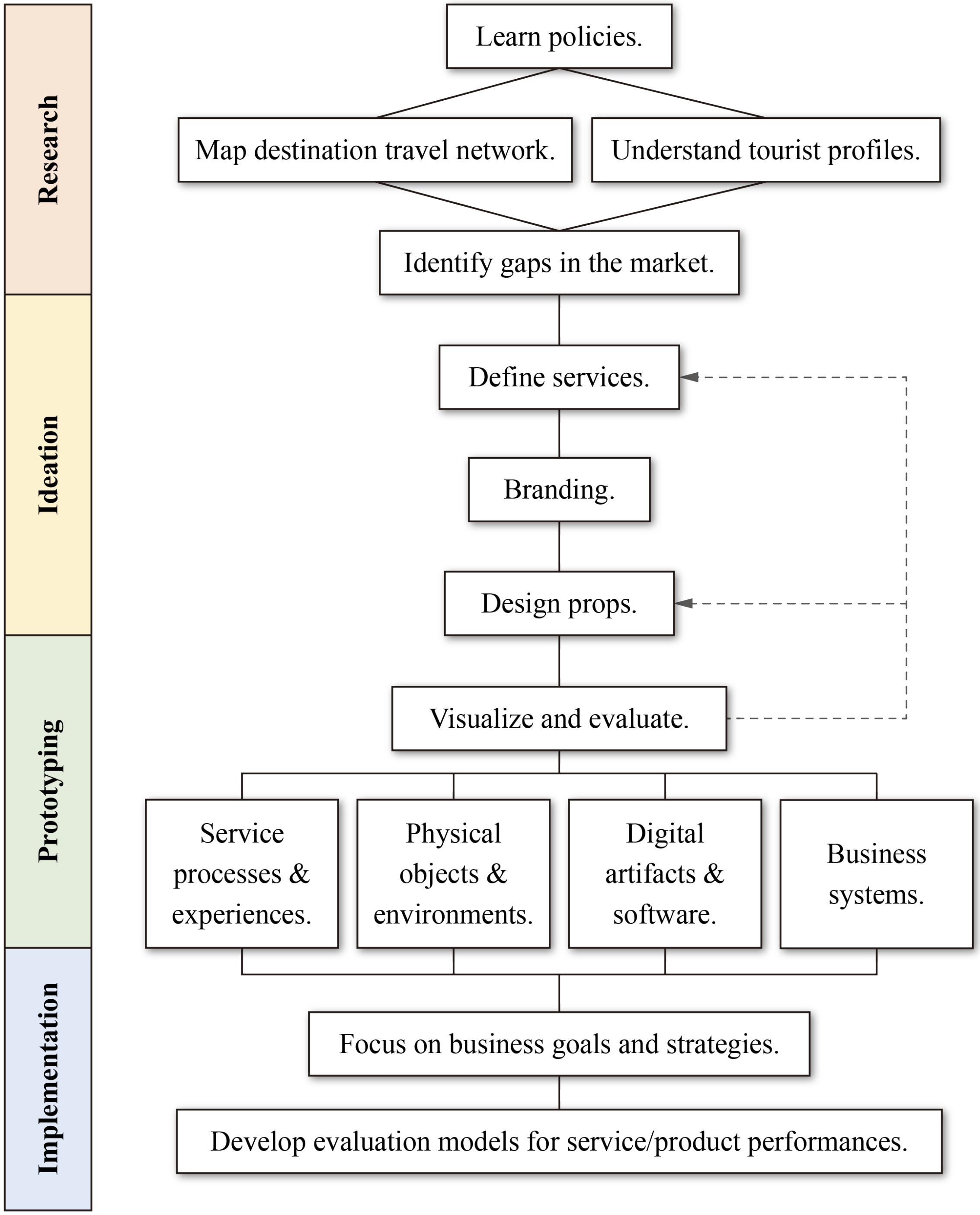


Figure 43: Flowchart of the Design Flow

4.2.2 Recommendation Checklist

Ideation	Service		☐ User-centered design. ☐ Moderate scale of fleet for sustainable operation. ☐ Reasonable price (the price formula as a reference). ☐ Comprehensive logistics of redistribution and maintenance.
	Branding		☐ Distinct and consistent corporate visual identity. ☐ Clear mission, vision, values statement, and company culture to bond with employees and customers.
	Props	Physical Objects & Environments	☐ User-centered design. ☐ Station-based mode. ☐ Connecting to public transport networks and parking lots. ☐ Thoughtful planning of riding lanes and routes. ☐ Streamlined lock/unlock process. ☐ Smart and sturdy equipment against frequent use/vandalism/theft issues, balance between vehicle quality and manufacturing cost. ☐ Standardized vehicle model to avoid confusion. ☐ Preferred vehicles: bicycle and powered seated scooter. ☐ Preferred features: powered, seated, storage space, safety light, phone mount, attached helmet. ☐ Characteristics: easy to learn, easy to use, comfortable. ☐ Dynamic and smooth outline, minimalist form, and light volume.
		Digital Artifacts & Software	☐ User-centered design. ☐ Ease of the payment for foreign tourists. ☐ Reservation system.
Implementation	Business	Internal	☐ Recruiting teams with know-how and experience in ride-sharing, venture capital, and relevant industries. ☐ Expanding business wisely at a moderate pace.
		External	☐ Scouting a strategic partner that benefit mutually. ☐ Avoiding short-sighted strategies during fierce competition. ☐ Public Relations: constant communication and negotiation with authorities for favorable policies.

Table 20: REC Checklist for Sightseeing Shared Micromobility

The suggestions regarding service design, product design, branding, and business discovered and collected during case study and survey research were listed in the checklist below. The checklist was built upon Table 14 presented in the case study. Adopters can take these recommendations into account and incorporate them into the development. For example, tourism-focused shared micromobility stations would be better to be close to public transport stations and parking lots, enhancing the local travel networks and convenience. The station-based mode is suggested because it is easier to manage than the free-floating mode. And it is sufficient to meet visitors' needs based on the pattern that tourists usually move around and among attractions.

Through the provided design guidelines, including the design flow and the recommendation checklist, organizations or authorities are able to develop a promising shared micromobility program in city or town destinations step by step.

Chapter 5 Application of Design Guidelines

In this study, a design project of a tourism-focused shared micromobility program including brand, service, and props design was developed to demonstrate the use of the design guidelines proposed in Chapter 4. Columbus, Georgia, the United States which has been engaging in tourism development and is relatively close to Auburn University, is the chosen city for this design project. The project was carried out by following the design flow and the checklist. The last phase of the design flow, implementation, requires a real business to embark on; thus the project will only present the outcome in the first four phases: research, ideation, and prototyping.

5.1 Development

Based on the design flow, the first phase of developing a sightseeing shared micromobility program is "research", to understand the destination's landscape and conditions before planning and ideation. The main activities in this phase are learning policies, tourist profiles, and mapping destination travel networks.

According to the Georgia Department of Driver Services, a moped is defined as any motor-driven cycle with an engine not exceeding 50 cubic centimeters (3.05 cubic inches). It requires a driver's license to ride on, and the users must be 15-year-old and older. On the other hand, there is no need to have a driver's license to use an electric scooter or electric bicycle based on the regulations in the state of Georgia. Riders must stick to the bike lanes or the roads with a speed limit not over 35 mph. Tourism-focused shared micromobility needs to be easy to access for people. Thus, electric bikes and scooters are considered good micro-vehicle choices in Columbus, Georgia.

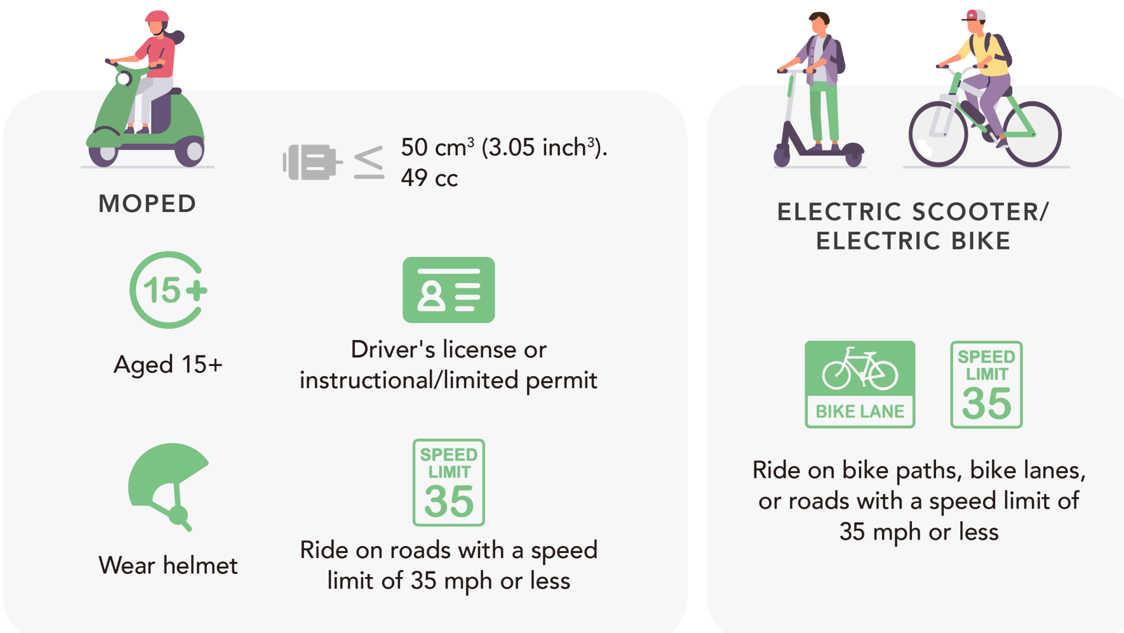


Figure 44: Regulations on Mopeds, Electric Scooters/Bikes in Georgia State

Georgia DDS (2021); Peterson, B. (2020)

In the result of the survey in Chapter 4, bicycles, powered bicycles, and powered seated scooters are voted as preferred micro-vehicles for city and town tourists. The powered seated scooter was ranked second place in the survey. However, it represents a new generation of micromobility with a new look and innovative technologies, which has more possibilities and opportunities for design and business. In addition, most tourists put on casual clothes during their vacation. Compared to bicycles, seated scooters are easier to hop on and friendly to any outfit, especially for skirts and shorts. Therefore, the powered seated scooter is selected as the main type of micro-vehicle in the project.

The tourist profile of Columbus, Georgia has shown in Figure 45 below. The major types of visitors are holidaymakers, family, outdoorsy, and business tourists. Most tourists stay 1-2 nights on average and expect to visit cultural or historical attractions, museums, and outdoor hotspots. When the travel duration is too short to visit multiple attractions, a shared micromobility program for sightseeing purposes seems a good solution for tourists.

Figure 45: Tourists Profile in Columbus, GA
Source: Compiled by the author based on Dean (2019)

Thirdly, developers need to map a destination travel network for further understanding and planning. In the project, the initially drawn map is used to decide the operational range by roughly marking out primary attractions. As shown in Figure 46, the area with the highest density of attractions and highlighted in yellow will be the ground to launch the service.

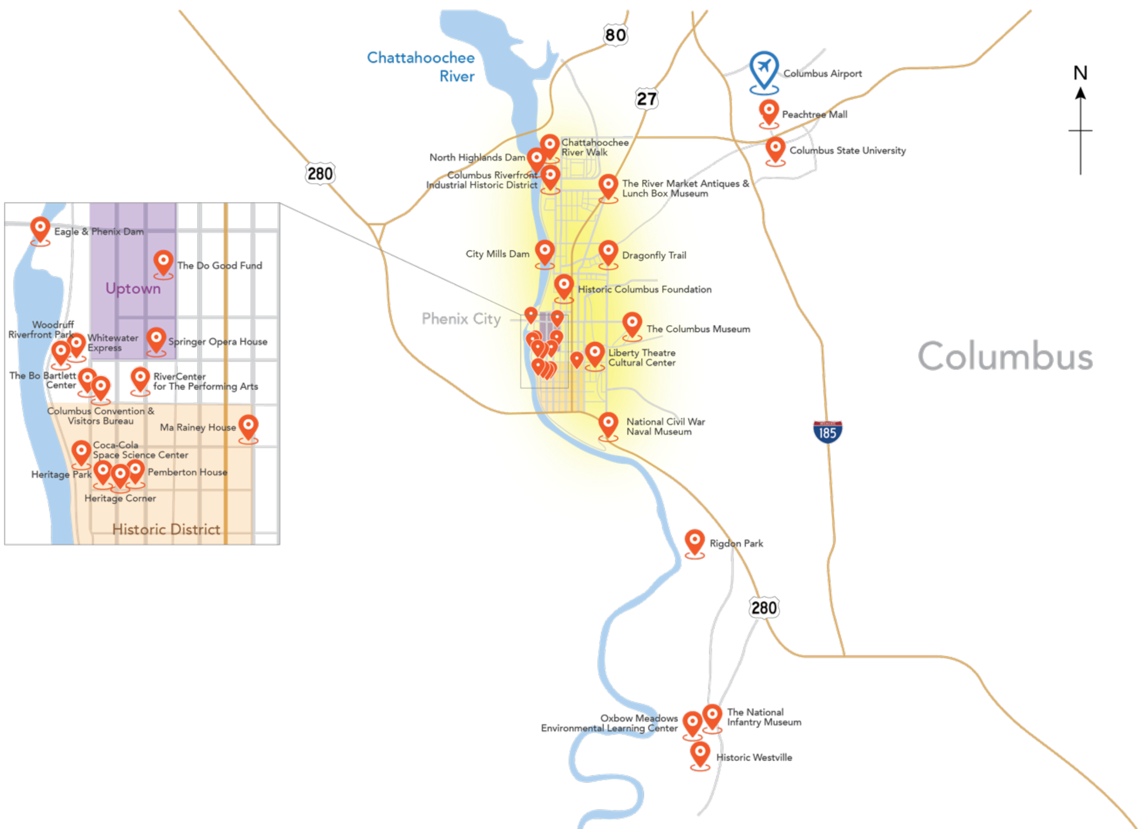


Figure 46: Destination Travel Network Map in Columbus, GA Part 1

After determining the range of operation, developers need to pinpoint more components in the designated area, such as additional hotspots, parking lots, and public transit stations. According to the suggestions from the recommendation checklist, the developed program will adopt the station-based mode which connects to public transport stations and parking lots for better management and maximum convenience. Through mapping out destination travel networks, the locations and number of the shared vehicle stations can be determined wisely as the Travel Network Map, Part Two, illustrates below.

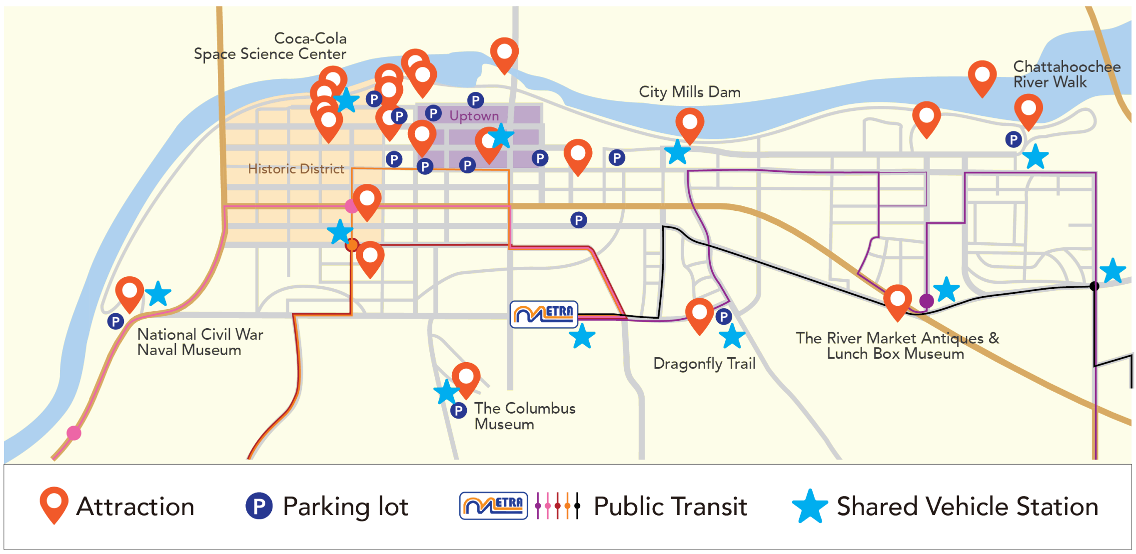


Figure 47: Destination Travel Network Map in Columbus, GA Part 2

After entering the ideation phase in the design flow, several concept sketches for vehicle design are generated through taking the suggestions listed on the recommendation checklist into consideration. And the layout of the mobile app interface was also conceptualized by wireframing. The sketches below helped to generate ideas and finalize the design of the project.

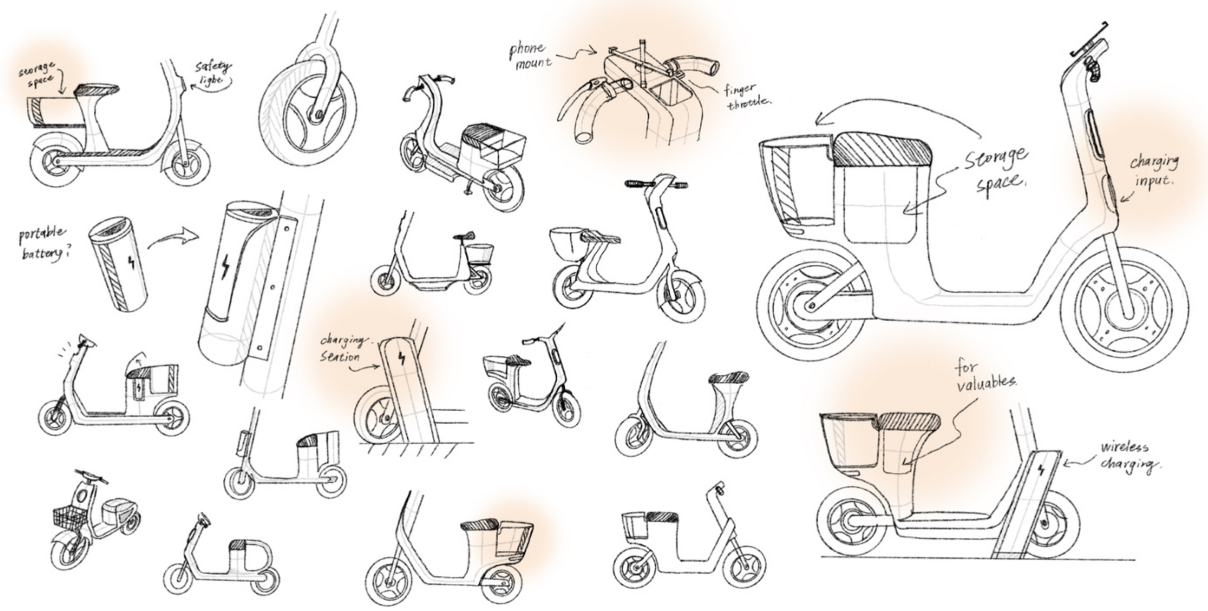


Figure 48: Form Exploration Sketches

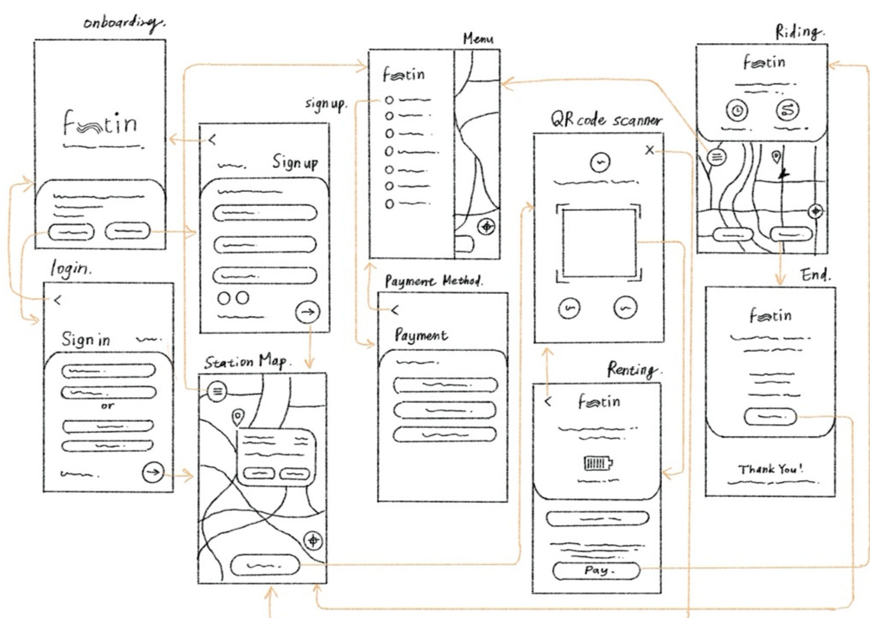


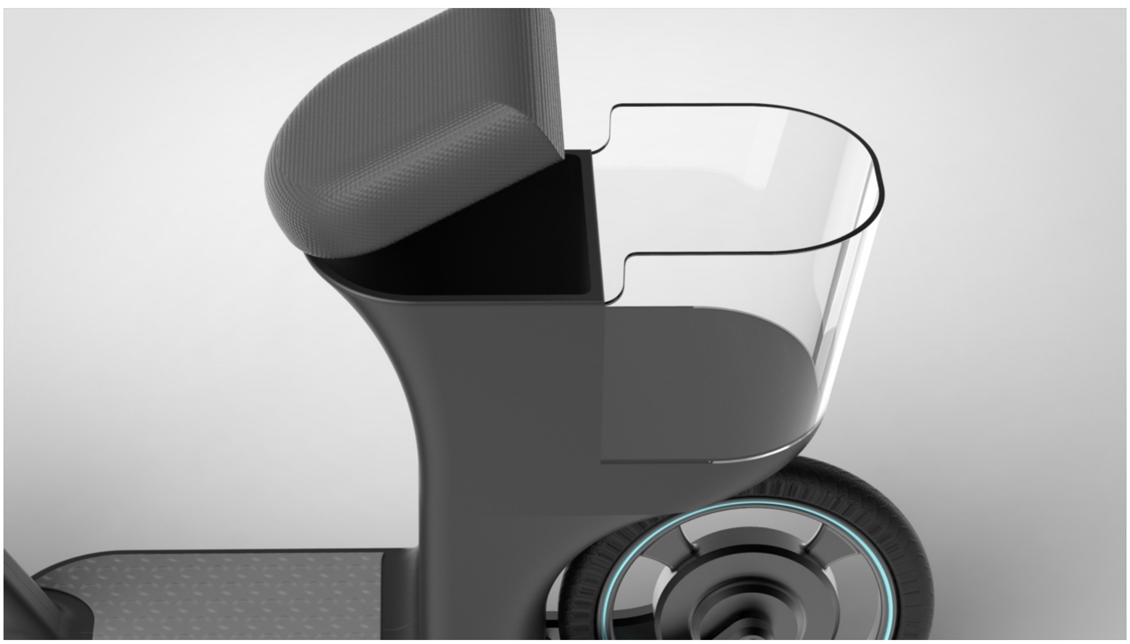
Figure 49: Wireframe Sketches

5.2 The Deliverable

Figure 50: The Tourism-focused Shared Micromobility Program – FUNTIN

In the prototyping phase, the prototype of the tourism-focused shared micromobility program designed for Columbus, Georgia, was generated. Funtin is a program providing powered seated scooter sharing service, enabling tourists to explore Columbus, Georgia, in a more fun and convenient way. The program's name was inspired by the nickname of the city, "The Fountain City." And the logo symbolizes the iconic Chattahoochee River and the well-known whitewater outdoor activities there. The program's mission is to create a smart, enjoyable, affordable, and eco-friendly transportation mode for visitors.

The service props, including the micro-vehicle, stations, and mobile app, were showcased by 3D rendering images and 2D graphics. And the service process and the logistics of the operation were visualized by using the service blueprint technique. In accordance with the suggestions from the recommendation checklist, the form of the Funtin seated scooter tends to be minimalist, smooth, dynamic, and lightweight. And the features include storage space, safety lights, and a phone mount holder.



Storage Space: open-top basket and under-seat storage

Safety Lights: headlight, rear light, and reflective wheel stripes

Phone Mount Holder


Charging Station

Table 21: Features of the FUNTIN Shared Seated Scooter

The design of the charging station aims to reduce the workload for operational teams, allowing them to focus on redistribution and other maintenance jobs, maintaining smooth operation, and delivering an excellent user experience. The shared micro-vehicle with the features above is qualified to meet tourists' needs while sightseeing in city and town destinations.

As the figure presented below, frontstage and backstage actions were listed one by one according to the flow of the customer journey. The service blueprint allows the Funtin operator to see a bigger picture toward the complex service and the logistics of the operation.

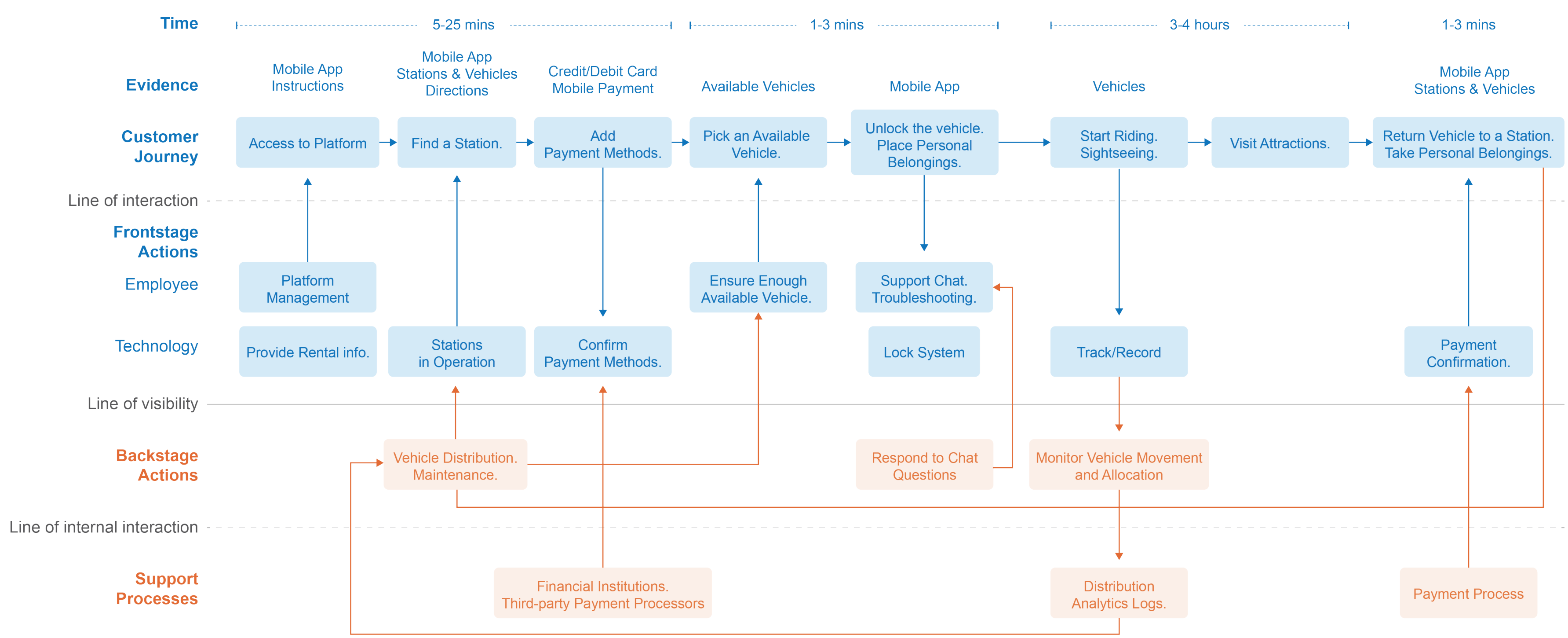
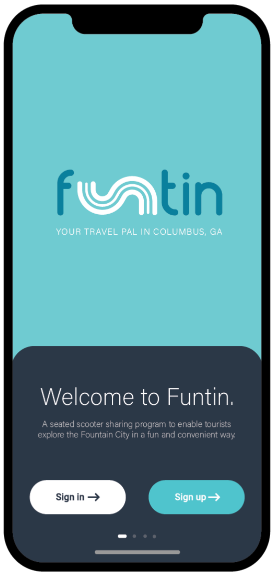
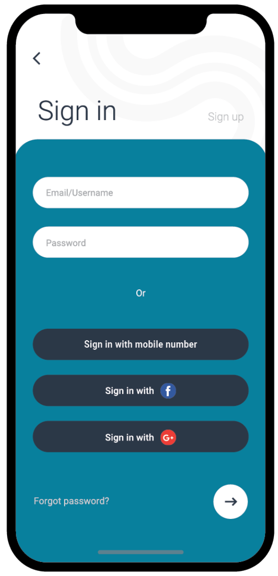
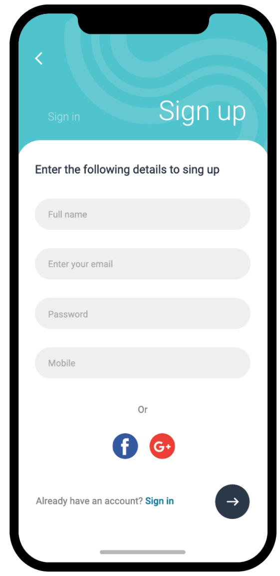
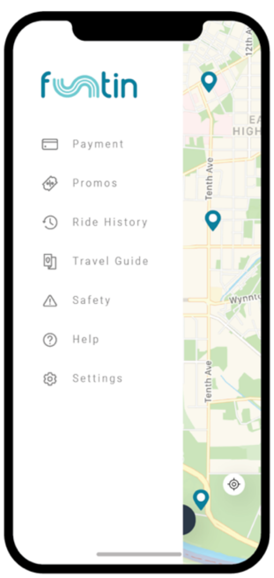
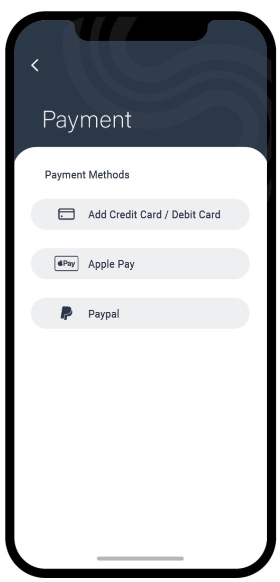
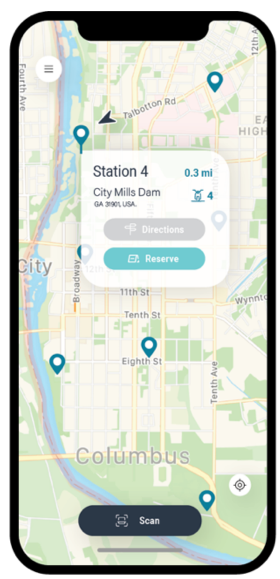
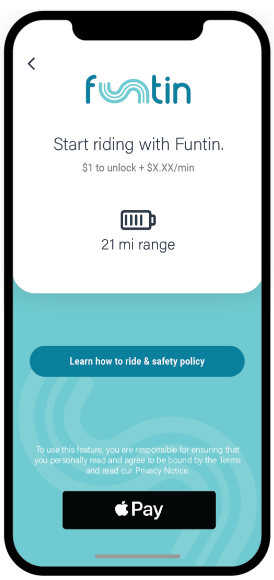
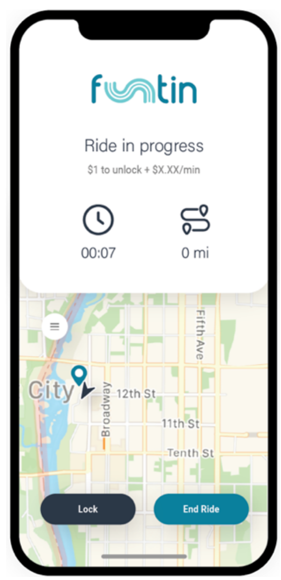


Figure 51: Service Blueprint of FUNTIN

The service process of Funtin can be introduced with the flow of using the mobile app, which can be divided into three stages: login/sign up, pre-ride, on-ride, and end-ride.

<table>
<tr><th colspan="3">Login / Sign up</th></tr>
<tr>
<td>
</td>
<td>
</td>
<td>
</td>
</tr>
<tr><td>Onboarding Page.</td><td>Login.</td><td>Create a new account.</td></tr>
<tr><th colspan="3">Pre-ride</th></tr>
<tr>
<td>
</td>
<td>
</td>
<td>
</td>
</tr>
<tr><td>Menu with tabs.</td><td>Set up payment methods.</td><td>Locate stations, check or reserve available vehicles.</td></tr>
</table>

<table>
<tr><th colspan="2">On-ride</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">Scan the QR code on the vehicle or enter the 4-digit code.</td></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>Rate and battery condition are displayed before renting. Authorize the payment by hitting the button on the app and start riding.</td><td>The app records the time and distance on the go. Users can lock the vehicle when temporary parking, end the ride when returning the vehicle.</td></tr>
</table>

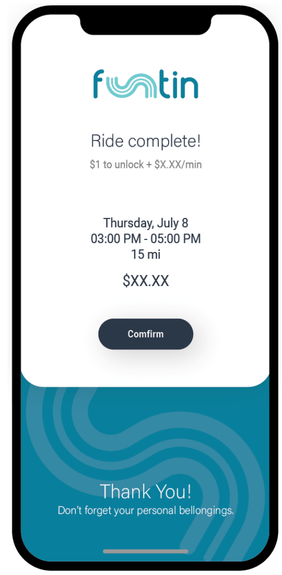
<table>
<tr><th colspan="2">End-ride</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td colspan="2">The system detects the returned vehicle, completes the transaction,
and shows the total price and duration on the app.</td></tr>
</table>

Table 22: The Process of Using the FUNTIN Mobile App

Tourists download the Funtin mobile app and either log in with existing accounts or create a new account. After logging in, the app will navigate users to set up a payment method, and then the users are good to use the service. With the map on the app, the users can find the nearest stations, get directions, check the numbers of available vehicles for each station, and even reserve one in advance. When tourists arrive at a Funtin station, they can rent a powered seated scooter by scanning the QR code on the vehicle and approve to pay with the default payment method. Then, they can ride on Funtin vehicles to explore the city and move among attractions. If the users need temporary parking, they can hit the

"Lock" button on the app and rest assured. If the users want to return vehicles, they get to any Funtin station and dock vehicles to stations, and hit the "End Ride" button. The system completes the transaction after confirming vehicles are being returned.

The design project delivered above is the outcome developed by following the design flow and the recommendation checklist, demonstrating the usage and practicality of the proposed design guidelines.

Chapter 6 Conclusion

6.1 Summary

This thesis was developed to create design guidelines to help a company or a government authority develop a shared micromobility program in city or town tourist destinations for sightseeing purposes. Shared micromobility is beneficial for tourism development for it is an affordable transportation mode enabling tourists to move and explore a destination easily and freely, enhancing the tourist experience. And it has less impact on the local environment compared to driving or taking gas-powered vehicles. However, many shared micromobility startups failed because of wrong decision-making and inappropriate service/product design. Therefore, the study proposed design guidelines through gathering useful findings from the literature and case studies and revealing the tourists' needs and preferences on shared micromobility with the survey. Thus, the thesis acts as a helpful and significant tool to assist organizations/authorities' teams in developing shared micromobility in town and city tourist destinations through the entire design flow of research, ideation, prototyping, and implementation, along with relative suggestions. And the thesis demonstrates such in the design of the Funtin seated scooter sharing program. It is looking forward that more and more promising shared micromobility programs arising in tourist destinations enhance the tourism industry, tourist experience, and environmental benefits.

6.2 Future Research

There are different types of tourist destinations with various geographical characteristics, such as beaches, mountains, and rural areas, etc. However, the study only focused on the town and city tourist destinations. Therefore, it is encouraged to extend the scope toward multiple tourist destination types and make studies concerning tourism-focused shared micromobility more complete in the future.

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Appendix

The Questionnaire

Questionnaire for Shared Micromobility in Town and City Tourist Destinations

You are invited to participate in the survey to collect preferences and expectations towards using shared micromobility in town and city tourist destinations. The study is conducted by YuehTzu Yang for research purposes, affiliated with the Auburn University Department of Industrial Design. If you have any questions, please contact me at yzy0085@auburn.edu or my advisor, Professor Lau, at lautinm@auburn.edu. The participation is completely voluntary, and you may withdraw at any time by closing the browser window. The survey will remain anonymous and will take approximately **7 minutes** of your time. There is no compensation for responding, but your responses are valuable for the study, which may benefit relevant industries and users. Thank you so much in advance for your participation!

"Micromobility refers to a range of compact and lightweight vehicles driven by users personally with speeds up to 15-30 mph and weight below 500 lb."

1. What is your gender?

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Rather not say

2. What is your age?

- ☐ 18 - 24
- ☐ 25 - 34
- ☐ 35 - 44
- ☐ 45 - 54
- ☐ 55 - 64
- ☐ 65 - 74
- ☐ 75 +
- ☐ Rather not say

3. Which race/ethnicity best describes you?

- ☐ White / Caucasian
- ☐ Asian / Pacific Islander
- ☐ Hispanic or Latino
- ☐ Black or African American
- ☐ American Indian or Alaskan Native
- ☐ Other _________________
- ☐ Rather not say

4. How often do you go on a trip?

*before the pandemic

- ☐ Every week
- ☐ Every month

☐ Once in 3 months

☐ Once in 6 months

☐ Once a year

☐ Less often

☐ Never

City Destinations

5. As a tourist, what are the top 3 types of micromobility vehicles you think are suitable to use in city destinations?

☐ Skateboard

☐ Scooter

☐ Bicycle

☐ Rickshaw

☐ Cargo Bike

☐ Powered Skateboard

☐ Powered Scooter

☐ Powered Bicycle

☐ Powered Rickshaw

☐ Powered Cargo Bike

☐ Powered Self-Balancing Board

☐ Powered Seated Scooter

6. **Which of the following features do you think are important for shared micromobility in city destinations?**

   *You may select more than 1 option

   ☐ Phone mount holder

   ☐ Attached helmet

   ☐ Attached safety lights

   ☐ Extra seating

   ☐ Storage space

   ☐ Horn

   ☐ Canopy

   ☐ Hanger hook

   ☐ Other _________________

7. **Which of the following characteristics do you think are important for shared micromobility in city destinations?**

   *You may select more than 1 option

   ☐ Compact

   ☐ Innovative

   ☐ Easy to use

   ☐ Reassuring

   ☐ Comfortable

   ☐ Lightweight

   ☐ Easy learning to operate

   ☐ Friendly to all outfits to ride on

   ☐ Exciting

   ☐ Other ________________

Town Destinations

8. **As a tourist, what are the top 3 types of micromobility vehicles you think are suitable to use in town destinations?**

☐ Skateboard

☐ Scooter

☐ Bicycle

☐ Rickshaw

☐ Cargo Bike

☐ Powered Skateboard

☐ Powered Scooter

☐ Powered Bicycle

☐ Powered Rickshaw

☐ Powered Cargo Bike

☐ Powered Self-Balancing Board

☐ Powered Seated Scooter

9. Which of the following features do you think are important for shared micromobility in town destinations?

*You may select more than 1 option

☐ Phone mount holder

☐ Attached helmet

☐ Attached safety lights

☐ Extra seating

☐ Storage space

☐ Horn

☐ Canopy

☐ Hanger hook

☐ Other _________________

10. Which of the following characteristics do you think are important for shared micromobility in town destinations?

*You may select more than 1 option

☐ Compact

☐ Innovative

☐ Easy to use

☐ Reassuring

☐ Comfortable

☐ Lightweight

☐ Easy learning to operate

☐ Friendly to all outfits to ride on

☐ Exciting

☐ Other _________________

11. What is your expectation for the form and appearance of shared micromobility vehicles?

Traditional	2	3	4	5	6	Innovative
☐	☐	☐	☐	☐	☐	☐

12.

Archaic	2	3	4	5	6	Futuristic
☐	☐	☐	☐	☐	☐	☐

13.

Slim	2	3	4	5	6	Beefy
☐	☐	☐	☐	☐	☐	☐

14.

Angular	2	3	4	5	6	Smooth
☐	☐	☐	☐	☐	☐	☐

15.

Static	2	3	4	5	6	Dynamic
☐	☐	☐	☐	☐	☐	☐

16.

Plain	2	3	4	5	6	Ornate
☐	☐	☐	☐	☐	☐	☐

"Just imagine that you have arrived at the planned destination, and you are going to hop between tourist attractions, get around and explore the town/city."

17. Using shared micromobility would make sightseeing easier and more efficient.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

18. I would find shared micromobility useful for sightseeing.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

19. The environmental benefits to the destination brought from shared micromobility would increase my willingness to use it.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

20. A trend toward using shared micromobility in tourist destinations would increase my willingness to use it.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
☐	☐	☐	☐	☐

21. As a tourist in Miami, if it costs you $78 to rent an economy car for a day (Damage Waiver and taxes are included, but not fuel), how much would you be willing to pay for a shared micromobility per hour?

*US dollar

____

22. Would you use shared micromobility while going sightseeing in a city tourist destination?

Definitely will not	Probably not	Not sure	May do	Definitely will
☐	☐	☐	☐	☐

23. Would you use shared micromobility while going sightseeing in a town tourist destination?

Definitely will not	Probably not	Not sure	May do	Definitely will
☐	☐	☐	☐	☐