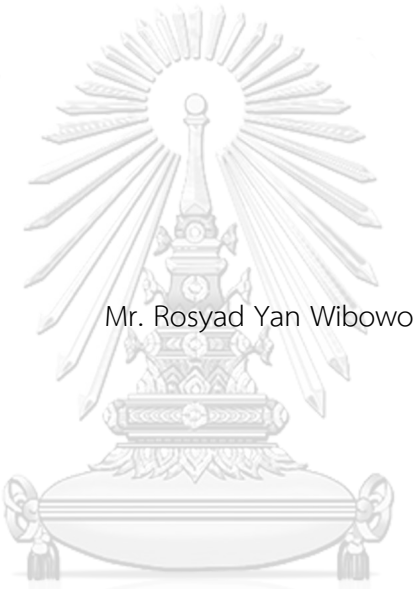
Assessing the Potential of Developing an Ecosystem for Electric Scooters in Bangkok, Thailand

Mr. Rosyad Yan Wibowo



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อุปสงค์ของการสัญจรที่เพิ่มมากขึ้นได้ชักนำความท้าทายในการให้บริการรูปแบบการเดินทางที่ยั่งยืน การที่การขนส่งสาธารณะไม่สามารถส่งผู้โดยสารถึงหน้าประตูที่หมายได้โดยตรงได้มอบโอกาสแก่ยานพาหนะขนาดเล็กให้มีบทบาทในระบบการสัญจร และเนื่องด้วยผู้คนจำนวนหลายล้านต้องเดินทางไปมาในทุก ๆ วัน เมืองหลวงของประเทศไทยจึงต้องการตัวเลือกในการเดินทางมากกว่านี้ และสกูตเตอร์ไฟฟ้าก็เป็นหนึ่งในตัวเลือกดังกล่าว สกูตเตอร์ไฟฟ้าสามารถเดินทางได้ในระยะทางสั้น ๆ โดยไม่ได้รับผลกระทบจากการสภาพจราจรบนท้องถนน แต่อย่างไรก็ตาม ภายใต้กฎหมายในปัจจุบัน สกูตเตอร์ไฟฟ้ายังไม่ได้รับการรับรองว่าเป็นหนึ่งในรูปแบบของยานพาหนะในกรุงเทพฯ ด้วยเหตุนี้จึงเกิดคำถามเกี่ยวกับการดำรงอยู่ของระบบนิเวศสำหรับสกูตเตอร์ไฟฟ้าในเมือง เพื่อตอบคำถามดังกล่าว งานวิจัยเล่มนี้จึงเจาะจงไปที่การค้นหาศักยภาพในการพัฒนาระบบนิเวศของสกูตเตอร์ไฟฟ้าในกรุงเทพมหานคร ประเทศไทย งานวิจัยนี้ใช้วิธีการสัมภาษณ์แบบกึ่งโครงสร้าง (Semi-structured Interview) ด้วยการสุ่มตัวอย่างแบบเจาะจง (Purposive Sampling) ในการดำเนินการสัมภาษณ์กับผู้ใช้สกูตเตอร์ไฟฟ้า (n=6) ผู้ให้บริการ (n=1) และซัพพลายเออร์ (n=1) ในเชิงโครงสร้างพื้นฐาน จะใช้วิธีการสัมภาษณ์ผู้ใช้งานและการสังเกตภาคสนามควบคู่กันไป จากนั้นจะใช้การวิเคราะห์แก่นสาระ (Thematic Analysis) และสถิติอย่างง่ายในการวิเคราะห์ข้อมูล

ในภาพรวม ระบบนิเวศของสกูตเตอร์ไฟฟ้าในกรุงเทพฯยังคงอยู่ระหว่างการพัฒนา ความสามารถของอุปทานต้องมีการจัดเตรียมเลนจักรยานให้เพียงพอเพื่อให้ตอบสนองการขับขี่อย่างปลอดภัยในสภาพแวดล้อมที่เหมาะสม และในโครงสร้างที่ต้องการ จะต้องมีความรู้ความเข้าใจเกี่ยวกับการใช้สกูตเตอร์ไฟฟ้าที่มากขึ้น เฉกเช่นเดียวกัน สถาบันหรือฝ่ายบริหารส่วนกลางก็ต้องจัดตั้งกฎเกณฑ์ต่าง ๆ เพื่อวางมาตรฐานในการใช้งานสกูตเตอร์ไฟฟ้าในกรุงเทพฯ เพื่อให้เกิดความปลอดภัยในการสัญจรโดยสกูตเตอร์ไฟฟ้าอย่างครอบคลุมในทุก ๆ ด้าน ความท้าทายดังที่กล่าวไปเมื่อตอนต้นนั้นเกี่ยวข้องกับการวางมาตรฐาน การจัดตั้งโครงสร้างพื้นฐาน การขับขี่ที่ไม่ปลอดภัยและความรู้ความเข้าใจเกี่ยวกับสกูตเตอร์ไฟฟ้า ศักยภาพในการพัฒนาระบบนิเวศสำหรับการใช้งานสกูตเตอร์ไฟฟ้าในกรุงเทพฯ ได้แก่ การใช้งานเฉพาะพื้นที่ เช่น มหาวิทยาลัย และพื้นที่ส่วนบุคคลอื่นๆ ยานพาหนะที่สามารถสัญจรในระยะสั้นบนถนนในพื้นที่ การวางมาตรฐานของภาคเอกชน และการขยายความร่วมมือกับหน่วยงานที่เกี่ยวข้องมากขึ้น กลยุทธ์ที่มุ่งเน้นไปที่การสร้างมาตรฐาน ความร่วมมือกับระบบขนส่งมวลชน และการเพิ่มพูนความรู้ของสกูตเตอร์ไฟฟ้าต่อมวลชนนั้นเป็นที่แนะนำ

สาขาวิชา	ยุทธศาสตร์เมือง	ลายมือชื่อนิสิต .....
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The rising need for mobility induces challenges to providing a sustainable mode of transportation. The absence in providing door-to-door service by public transportation gives the opportunity for micromobility to take a position. With millions of people commuting every day, Thailand's capital city requires more choices in transportation. E-scooters can travel short distances in a vehicle and are not affected by traffic. However, under the current regulation, e-scooters are not recognized as a mode of transportation in Bangkok which question the existence of the ecosystem of e-scooters in the city. To address the problems, this research focuses on exploring the potential of developing an ecosystem for electric scooters in Bangkok, Thailand. Semi-structured interviews with a purposive sampling method are conducted for e-scooters users (n=6), service providers (n=1), and suppliers (n=1). On the infrastructural side, user interviews and field observation are used in tandem. Subsequently, thematic analysis and simple statistic are used to analyze the data.

Overall, the electric scooter ecosystem in Bangkok is still under development. The supply capability requires adequate bike lane provision to meet safe riding in an ideal environment. The demand structure needs more understanding of e-scooters utilization knowledge so that e-scooters could become a safe transportation mode option for people. Likewise, the institution requires establishing rules and regulations to standardize the use of e-scooters in Bangkok so that safer rides could be achieved. The challenges are related to standardization, infrastructure provision, unsafe riding, and e-scooters' knowledge. The potential of developing an ecosystem for e-scooters utilization in Bangkok are: an area-specific implementation, such as universities, and other private properties; a short-distance mode of transportation around the local road; private sector-led standardization; a partnership expansion within more actors. It is recommended to implement a strategy that focuses on standardization, partnerships with transit systems, and massifying the e-scooters knowledge.

Field of Study:	Urban Strategies	Student's Signature .....
Academic Year:	2022	Advisor's Signature .....

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CHAPTER 1 :INTRODUCTION

1.1. Problem statement and research significance

As a relatively young system in urban mobility, the component that supports the implementation of e-scooters in a city has not been defined well. Describing an ecosystem is beneficial to better understand the situation in such industries. Some scholars used the term business ecosystem which portrays an economic community consisting of many stakeholders from the supply sides, demand sides, and institutions (Ma et al., 2018). Adner and Kapoor (2010) viewed the ecosystem as a way of constructing interdependencies to be more obvious which approach is by understanding coordination between actors. In addition, analyzing ecosystems in a broader scope would be useful to evaluate the capabilities of ecosystem players as well as assess the industry (Shang & Shi, 2013). Knowing and assessing the key components of the ecosystem leads to a guide in deciding which aspect should be improved. Previous studies have explained about ecosystem framework for urban mobilities issues. However, there are barely any authors who focused on describing the electric scooter ecosystem framework in their research.

Some phenomena rose an issue for electric scooter implementation, such as the situation of some countries that do not clearly regulate the ecosystem while not restricting the sales and even the usage. Thailand is one of the countries that remain as the grey areas in electric scooter implementation. In Bangkok, Thailand, e-scooters riders could be found in the city's landscape. According to P&S Intelligence (2021), the micromobility market in Thailand generated over 430 million THB in 2020 and is estimated to grow in the future. While the number of users is growing, there are no clear regulations in Thailand to accommodate the ecosystem and protect both users and non-users from many potential conflicts. To address the problems, one main research question arises, "What is the potential of developing an

ecosystem for electric scooters in Bangkok, Thailand?". To explore the research question, the first stage would explain the ecosystem framework of the electric scooter while the second stage would assess the potential of involving electric scooters in Bangkok's mobility system.

1.2. Purpose of the study

The purposes of the research are:

a. To define the ecosystem framework that can be adapted to assess the mobility system of electric scooters.

b. To assess the potential and obstacles for adopting electric scooters as a micromobility mode in Bangkok, Thailand.

1.3. Scope of the study

This section discusses about the profile of Bangkok and its transportation system, the strategic pathways of e-scooters implementation, and the situation of current e-scooters utilization in Bangkok.

1.3.1. The profile of Bangkok and its transportation mode

The city of Bangkok, which is the capital of Thailand, is a lively and fast-paced metropolis that houses more than 10 million inhabitants[1]. Millions of visitors from across the globe are drawn to the city every year due to its lively urban environment, breathtaking architecture, and rich cultural legacy. Given its high population density, the city has established a diverse range of transportation options to facilitate movement. These options include rail transportation (MRT, BTS, and so on), buses, boats, and taxis, among others, providing many alternatives for traveling

[1] Retrieved from the official website of Population Division, United Nations. https://population.un.org/wpp/

around Bangkok. This section aims to discover the modes of transportation profile in Bangkok.

The railway network in Bangkok has undergone significant development through a series of rail transit master plans, aiming to cover more than 500 km with over 400 stations. Three primary entities own the rail transport business in the city, each hiring separate operators to manage their services. The Bangkok Metropolitan Administration (BMA) entrusted Bangkok Transit System (BTS) with constructing and operating the first metro line, the Green line, in 1999. The Mass Rapid Transit Authority of Thailand (MRTA) was established a year later to supervise the metro network's expansion. The State Railway of Thailand is the third participant in the metro business, having constructed the Airport Rail Link (ARL) to Suvarnabhumi Airport and other lines. While public transportation is a cost-effective method for transporting large groups of people along a specific route, it does not offer the door-to-door service that many individuals desire from private vehicles. (Ayaragarnchanakul et al., 2022; ESCAP, 2021)

During the early days of the industry, private operators ran the bus transportation system in Bangkok. The government issued licenses to private companies and ensured that their bus routes did not overlap with existing streetcar routes. However, due to intense competition and a sharp increase in fuel prices, most operators could not sustain their businesses, and those who remained offered low-quality services. In 1976, the Bangkok Mass Transit Authority (BMTA) was established to consolidate all bus operations under one entity. Today, the BMTA is the sole owner of the city's buses and operates some of them, while also granting licenses to private companies. (ESCAP, 2021)

Due to Bangkok's classified road network, it is difficult to offer feeder access to all regions using simply public transit. As a result, hired transportation is critical in connecting individuals to transit stations and stops. Taxis and motorbike taxis are the

most common modes of hired transportation in Bangkok. Taxis in Bangkok are often employed to complete a journey rather than connecting to transport stations or stops. During the peak hours, taxis are in great demand and difficult to hail. However, after the new technology of ride-hailing applications has made them more accessible. With increased competition, many taxi drivers have chosen to partner with these application providers who regulate their services and ensure good quality. As a result, taxis now offer complete door-to-door access, making them a reliable and cost-effective competition to high-priced mass transit. (ESCAP, 2021)

In Bangkok, motorcycle taxis have become a vital component of the transportation system for more than three decades ago (Chalermpong et al., 2023), offering a cost-effective and time-efficient means of getting around for both locals and tourists. Motorcycle taxis function as an informal transportation system that bring passengers to public transports and fill the gap of accessibility that is unable to be achieved with public transportations (Ratanawaraha & Chalermpong, 2015). The presence of motorcycle taxis in Bangkok is attributable to several factors, such as persistent traffic congestion, local roads, inadequate pedestrian and cycling facilities, the hot climate, also the expansion of rail transit network (Chalermpong et al., 2023). Despite being an informal mode of transportation, there have been several attempts by national and local governments to formalize and legalize motorcycle taxis in Bangkok, such as standardization of the services and regulation of the fares, safety, and operators (Ratanawaraha & Chalermpong, 2015).

Bangkok has been going through changes in the adoption of cycling as a transportation mode. However, the current provision of safe and proper cycling facilities is deemed insufficient. The city has made efforts to construct dedicated bike lanes in different parts of the city, including the Rattanakosin area. Unfortunately, these lanes were removed in 2016 due to the local community's lack of acceptance, indicating the failure of bicycle implementation on Bangkok's roads (Ratanaburi et al.,

2021). Several factors have contributed to the unsuccessful implementation, such as the locals' disregard for bike lanes, the hot and humid climate, and unsafe shared roads (Mateo-Babiano, 2015). Nevertheless, it is found that bicycle sharing has gained popularity in Bangkok among university students and people seeking a less congested mode of transportation in urban areas (Sangveraphunsiri et al., 2022).

1.3.2. Two strategic pathways for e-scooters ecosystem

Cities are regarded as complex systems, wherein to comprehend cities as a whole, it is not enough to only understand a certain entity (Rybski & Gonzalez, 2022). Despite being a complex system, cities could also be defined as both open and closed system. According to Sennet (2017), a city that is closed is characterized by boundaries and walls, whereas an open city has more borders and membranes. The closed city can be planned and controlled in a top-down manner, making it the city of the rulers, while the open city is a bottom-up space, making it the city of the people (Sennett, 2017). The closed system tend to excessively predict and control the future development of areas that have predetermined boundaries (Porqueddu, 2018).

The logic of open and closed city applies on the situation of e-scooters implementation pathways among cities across the world. The implementation of e-scooters in the open system refers to the use of e-scooters in an open environment that has many borders and membranes. While the implementation of e-scooters in the closed system refers to the use of e-scooters supported by a system in a controlled environment which is rather isolated to the open environment. It means that the open system has more challenges compared to the closed system. The open system interacts more close with other modes of transportation in the open environment where the modal competition occur. The situation of e-scooters implementation from other countries are further explained in Chapter 2.

1.3.3. E-scooters under the open and closed system in Bangkok

In Thailand, e-scooters are classified as motorcycles according to Motor Vehicle Act B.E. 2522, which definition is “a vehicle driven by a motor or electric power with not more than two wheels…”. In other words, e-scooters are treated like a motorcycle that requires the riders to obtain a driving license and the owner to register their vehicle so that it can be operated on the road. However, registration and licensing schemes for e-scooters are currently not yet available. As specified in Section 6 and Section 59 of Motor Vehicle Act B.E. 2522, any person riding an unregistered vehicle is a violation and liable to a fine of no more than 10.000 THB (ten thousand Baht). With this fact, it is very tricky for both service providers and personal users to operate e-scooters on Bangkok’s roads. From the current state of regulation, electric scooters are legally safe to be ridden on private property, private residential areas, and local roads (soi or ซอย). The use of the shared electric scooter involves more elements than a personally operated e-scooters. Coordinately, regulation barriers are more complex beyond the legality of using the vehicle, such as administrative regulations to issue the operator permit (Cao et al., 2021).

In Bangkok’s landscape situation, there are two implementation pathways of e-scooters implementation: the open and closed system. Electric scooters (open system) are found to be operated personally in several places in Bangkok (see Figure 1). Personally operated electric scooters could thrive in Bangkok as a micromobility option for the users. Electric scooters can be found in both online and offline markets. The online market has sold over 2500 vehicles of standing e-scooters. E-scooters are being sold with the price ranging from 3.500 THB to 34.000 THB depending on the brand and its specifications, such as battery capacity, maximum speed, load capacity, charging time, water resistance, and so on. This wide range of prices gives options for wider user targets to buy the fleets.

Figure 1. Users of personally operated electric scooters around CU Centenary Park (left) and Rajamanggala Stadium (right).

Nevertheless, it is discovered that there were previous companies of e-scooters service providers that tries to operate in Bangkok, such as Neuron, Scoota, Rideleaf, Anywheel, Scootdy, and so on. Some of the service providers chose a controlled environment as their deployment strategy (closed system). However, most of the service providers choose to not operate on Bangkok's roads anymore (see Table 1). Differ from the situation in Phuket, Thailand, wherein e-scooters service providers must stop operating due to the ban from the police (Thaiger, 2022), the reason was able to be analyzed from its high service fee, in particular, due to the impact of COVID-19. Several companies used the scheme of "Unlock Fee + Fares per minute" which results in travel costs higher than local motorcycle taxis for 10 minutes ride. By this logic, people would rather travel with other more efficient mode options. Riding an e-scooters sharing might be able to save the capital cost to buy the fleet, but on the other hand, the long-term spending would be higher than owning the e-scooters themselves. The high fees are mainly to cover the high operation cost as well. In this sense, pricing competition is one of the significant reasons why the service providers could not thrive in Bangkok. In addition, there is a risk of vehicle stealing as the fleet's price is valuable.

Table 1. Service provider's status of the operation in Bangkok.

No	Company	Types of Service	E-scooters Status of Operation
1	Neuron	E-scooters sharing	Dot have operations in Bangkok anymore.
2	Scoota	E-scooters sharing	Do not operate as a e-scooters sharing provider anymore, but offers a vehicle rent (daily, weekly, and monthly).
3	Rideleaf.co	E-scooters sharing	Do not have operations in Bangkok anymore.
4	Anywheel	Bike and e-scooters sharing	Only operates for bike sharing in Bangkok.
5	Scootdy Tour	Tour and Travel	Operates as a feature for tour packages.
6	Beam	E-scooters sharing	Started the operations in a controlled environment (Chulalongkorn University) in September 2022.

1.3.4. Study area

The assessment of the research would focus on Bangkok, in particular around Phayathai Road. The location is being selected because it has significant universities and offices that also connected with the center of BTS Skytrain as well as MRT station. That would be beneficial to assess the users from both workers' and students' perspectives, which is trickier to be conducted in the Core CBD area. Based on the preliminary observation, it is hypothesized that users around Phayathai Road are mainly students. In addition, most users ride e-scooters for short distance travel. However, there are some users that also use e-scooters as a first- and last- mile service and bring e-scooters inside the public transit, since bicycle is allowed to be carried on MRT and BTS Skytrain and there is no prohibition for e-scooters to be carried as well.

Throughout the research design, there are no service providers that operate e-scooter sharing in Bangkok. However, during the data collection, it is found that a

service provider significantly operates in the area of observation. Therefore, this research would include service provider in the data collection. It should be noted that, the focus on this study is about the e-scooters ecosystem which is relatively a helicopter view of e-scooters implementation. Although the observation area is located in a small area and might resemble the closed system, the interview target is predominantly coming from the open system. Therefore, this research would assess the e-scooters ecosystem on both open and closed system which makes the data collection not limited into certain actors in either side.

1.4. Research limitations

This research does not cover all aspects of e-scooters ecosystem in Bangkok, hence it has several limitations:

a. This research assess the potential of developing an ecosystem for electric scooters in Bangkok. However, some of the elements might not fully represent Bangkok because of the study area.

b. This research does not emphasize on the e-scooters users travel behavior, therefore the number of samples in Group A is limited.

c. This research does not provide statistical correlation within some variables due to the small number of sample.

d. This research does not incorporate policy maker in the data collection.

1.5. Benefit of the study

This research is expected to be beneficial in several ways:

a. Provide an ecosystem framework of e-scooters in a developing country context that can become an assessment tool for e-scooters in urban mobility.

b. Stimulate an urban mobility strategy involving e-scooters as a transportation mode option in Bangkok.

c. Present recommendations that are significant for the future regulation design of the e-scooters ecosystem in Bangkok.

CHAPTER 2 : LITERATURE REVIEW

2.1. Micromobility

The idea of micromobility was originated from the new mobilities paradigm by Sheller (2011). In broad-spectrum, micromobility has several key components such as: small size, short distance, light vehicle, two-wheeler (Eccarius & Lu, 2020). According to International Travel Forum, micromobility is defined as the use of micro-vehicle. The proposed definition specify that micro-vehicle is a vehicle that has mass less than 350 kg and speed less than 45 km/h (ITF, 2020). Micromobility could be classified further into several types according to the mass and the speed. By that definition, micromobility includes both un-powered and powered vehicle, such as: bicycles, powered bicycles, kick scooters, powered scooters, skates, one-wheeled balancing boards, etc.

Along with the rising urbanization, micromobility vehicle sharing is admired as a way to reduce traffic congestion, carbon footprint (e.g., pollution issue), and first- and last- mile difficulty. In the longer run, it is possible to reduce the emission as well as the road density. Micromobility has the prospective to solve problems of transportation situation of car-centric in the city. The latent environmental advantages of shared micromobility are based mostly on the replacement of automobile journeys (Sun & Ertz, 2022) Some research simulate that if shared micromobilities replace car trips, it would reduce significant amount of Green House Gasses (GHG) emission produced by the automobiles (Qiu & He, 2018; Kou et al., 2020). The research used high rates of car trips substitution, around 75% to 80%. Although it reduces GHGs significantly, nevertheless, some evidences supposed that approximations of the environmental advantages of shared micro-vehicle are too optimistic (Sun & Ertz, 2022). In fact, the actual car replacement rate of sharing

micromobility in several global cities is only about 10–30% (de Bortoli & Christoforou, 2020; Sun & Ertz, 2022; Zhu, 2021).

However, the idea of small-sized limits micromobilities to relatively short distance capacity in transporting people. It is often been suggested that micromobility be integrated to the public transportation (Oeschger et al., 2020), which in the other words would upsurge access to public services as well. As a short trip for the first- and last-mile, the trips of micromobility occurs in an environment exposed to other road users (e.g., cars and motorcycle). The interaction could both trigger conflict with other road users, and disclose air pollution to riders which risks the public health (Xu et al., 2022). According to Dons et al. (2019), it is found that riders, especially bicycle users, were tending to face peak exposure to bad air quality while having micromobility trips. This situation is contradictory to the fact that cycling is beneficial to people's health.

2.2. Electric scooters

Electric scooters (e-scooters) are a part of powered micromobility. E-scooters can be categorized as personal electric vehicle that transports a single passenger at a distance of no more than 10km and contains electricity as the energy source to run the motor (Ulrich, 2005). However, some literature defines e-scooters as powered two-wheelers that can also be called mopeds and are characterized by their maximum speed of 30 mph or 45 km/h (Hardt & Bogenberger, 2019). This research adopts the e-scooters definition that refers to a vehicle designed to transport users for a short distance with a small electric motor and a deck where a single rider stands (Hollingsworth et al., 2019).

2.3. Mobility ecosystem framework

In any field of studies, there has been significant research about defining ecosystem framework. The approach varies from adapting the ecosystem in related fields or defining the ecosystem from some theories. The ecosystem depends on the authors' analysis to include some elements in the framework. In this literature review, the author tries to define the electric scooter ecosystem by consolidating books and papers.

2.3.1. Key players as an ecosystem

Meyer and Shaheen (2017) define the mobility ecosystem from the previous finding that focuses on future mobility planning and comprehensively discusses sustainable elements related to urban planning. It is important to adapt the mobility paradigm through people-oriented public policies to be beneficial for the quality of life of citizens (Meyer & Shaheen, 2017). Interaction of key actors in mobility-as-a-service and e-bikes sharing could also be identified as an ecosystem framework. Interactions could be both cooperation and competition among the stakeholders from the public or private sectors (Polydoropoulou et al., 2020). The key actors are from the demand side (users), supply-side (supplier/service provider), and institutional side to usually back up the ecosystem with standards and regulations (Karlsson et al., 2020; Polydoropoulou et al., 2020; Ruohomaa et al., 2019).

2.3.2. Digital mobility ecosystem

Another way to view the mobility ecosystem is through the megatrends of digitalization. Loos et al. (2020) developed the Mobility Digital Ecosystem that is formed by five elements "mobility practices, digital data, digital networks, material geographies, also digital devices and services". The concept was urged by the megatrends in urbanization, digitalization, and aging society. One of the ways in

improving social inclusivity for older people is to make them stay mobile by letting them get access to digital elements in the future (Loos et al., 2020). In digital mobility, paying attention to groups of people is important so that it does not make older people a trade-off for younger generations.

2.3.3. The ecosystem of electric vehicle

As electric mobility evolves over time, several papers have discussed about the ecosystem that covers electric vehicles. Curiel-Ramirez et al. (2020) classifies the smart electro-mobility ecosystem by the main actors, main components, and infrastructure. The components and infrastructures refer to the technologies, spare parts, charging stations, and the fleets themselves. The paper explores more on the main actors. The academy as the first actor plays role in growing the ideas and findings from research, development, and innovation. Obviously, the regulations, incentives, taxes, and policies are taken care of by the government as the second actor. The third actor is the industry itself which can be the suppliers and/or the service provider and the manufacturers. Curiel-Ramirez et al. (2020) suggested placing investors and entrepreneurs in the ecosystem to generate new business models for further development. Investors and entrepreneurs must create an innovative environment and platform that enables the optimal development of the other stakeholders (Dondofema & Grobbelaar, 2019).

2.3.4. Business Ecosystem

In defining the mobility ecosystem, several authors on this literature review adopted the business ecosystem concept by Moore (1997) as shown in Figure 2. Business ecosystem is “an extended system of mutually supportive organizations; communities of customers, suppliers, lead producers, and other stakeholders, financing, trade associations, standard bodies, labor unions, governmental institutions,

and other interested parties". The term ecosystem seems that the businesses are large in size. However, business ecosystem can signify to smaller business. The framework of business ecosystem is applicable to the urban mobility context.

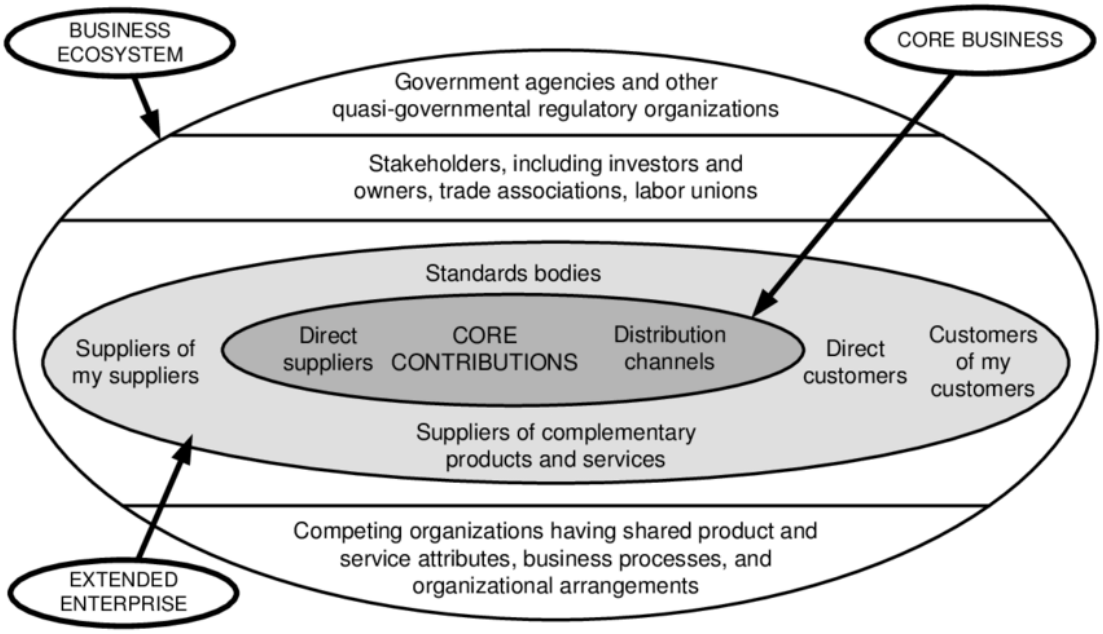


Figure 2. Business ecosystem (Moore, 1997).

Shang & Shi (2013) combines business ecosystem and capabilities theories. Differing from the business ecosystem theory which specifies a broad understanding of a business' surrounding components at the industrial level, capabilities theory tends to investigate the internal features of organizations. Subsequently, Shang & Shi (2013) defines the ecosystem framework consisted of demand capabilities, supply capabilities, interface capabilities, and supporting elements (Table 2). Business ecosystem can also be combined with innovation system theory. In this case, the proposed "dynamic business ecosystem" involves two support activities, industrial transformation and industrial feedback, which are also defined as the interaction mechanisms between the value network and the resource pool (Ma et al., 2018). Meanwhile, Pütz et al. (2019) adopted the business ecosystem model and make the

Original Equipment Manufacturer (OEM) acts as the supplier of the digital data which has interactions with different key actors.

2.3.5. Summary

The ecosystem framework from the literature review was categorized into four types: key actors as an ecosystem; digitalization as an ecosystem; the ecosystem of an electric vehicle; and business ecosystem. Mobility ecosystem is defined as cooperation and competition of actors (Polydoropoulou et al., 2020), which could consist of demand side (users), supply side (supplier/service provider), and governmental side (Karlsson et al., 2020; Polydoropoulou et al., 2020; Ruohomaa et al., 2019). Loos et al. (2020) defines a "Digital Mobility Ecosystem" which aim is to improve social inclusivity to stay mobile. In the electric vehicle side, the significant element to the ecosystem is the infrastructure (e.g., charging station, parking space) along with the main actors and other main components (e.g., investors, entrepreneurs) for the optimal development (Curiel-Ramirez et al., 2020). Lastly, business ecosystem theory by Moore (1997) which idea is an extended entreprises of mutually supportive organizations has evolved and has been adapted by many authors including Shang and Shi (2013) and Ma et al. (2018). The literature review of the ecosystem framework is summarized in Table 2.

Table 2. Summary table of literature review in mobility ecosystem framework

No	Source	Context	Framework
1	Meyer and Shaheen (2017)	Mobility ecosystem for urban planning	Develops basic concepts of mobility ecosystem principles that was adapted from previous finding. There are six key elements of mobility ecosystem, which are: 1) clean and healthy environment; 2) sociability and liveability; 3) smart growth that support mixed-used of land; 4) smart and easy access to the services; 5) safety; and 6) world class sustainable infrastructure.
2	Polydoropoulou et al. (2020)	Mobility-as-a-Service	Defines MaaS ecosystem as cooperation and competition of stakeholders/actor from public and private sectors.
3	Loos et al. (2020)	Urban public transport for elderlies	Introduces the framework of "mobility digital ecosystem" which comprises of mobility practices, digital data, digital network, material geographies, and digital devices & access to service.
4	Ruohomaa et al. (2019)	Electric bicycle digital ecosystem in a small city	Identify a digital ecosystem for electric bicycle in small cities towards a Smart City Concept that includes: Bicycle supplier; University; Companies; City planning; and Inhabitants in the city
5	Karlsson et al. (2020)	The development and implementation of mobility-as-a-service	Develop framework on three analytical levels: - Macro level (national government) - Meso level (regional and local government, public service provider, private service provider) - Micro level (citizens/customers/users)
6	Curiel-Ramirez et al. (2020)	Smart electro-mobility	Categorize the smart electro-mobility framework as the main actors, main components, and infrastructure.
7	Vermesan et al. (2013)	Electric mobility	Sustainable EV's ecosystem: - Original Equipment Manufacturer (OEM) - Norms, regulations, standards - Battery suppliers - Utilities - Governments, local authorities

8	Moore (1997)	Business ecosystem	Moore (1997) defines a business ecosystem as "an extended system of mutually supportive organizations" which made up of: suppliers and distribution channels as the **core business**; standard bodies, suppliers of complementary products, and direct customers as the **extended enterprise**; and complimented by government agencies, investors, and labor unions.
9	Shang & Shi (2013)	Electric vehicle industry in China	The paper uses a multiple case study research methodology and explains the conceptual framework in electric vehicle adapted from business ecosystem theory. There are four main elements, which are: - Demand capabilities (service provider, infrastructure provider, end-user) - Supply capabilities (battery, electric motors, control system, EV assembler) - Interface capabilities (dealers/retailers) - Supporting capabilities (governments, universities, industrial association)
10	Ma et al. (2018)	Sharing mobility in China	The author combines two frameworks and formed "Dynamic Business Ecosystem Innovation Framework". It was explored from a static view that comprises two elements, such as a *value network* or core business and *resource pool* or stakeholders with complementary resources.
11	Pütz et al. (2019)	Business ecosystem of connected automated vehicles	Generally, a platform consists of four key actors, such as owners, providers, producers, and consumers. The paper defines a business ecosystem platform based on the Original Equipment Manufacturer (OEM) that acts as the supplier of the digital data. The ecosystem includes: Original Equipment Manufacturer (OEM); Producers (supply of service to customer); Consumers; Vehicle manufacturer; Motor insurance; Parking service; Telematics and connected car service; Vehicle rental/sharing; Breakdown service; and Repair workshop.

2.4. Electric scooters ecosystem in urban mobility

From the literature review, the ecosystem framework is contextualized to electric scooters by choosing the critical elements for the ecosystem. This research adapted the framework from several authors and resulted in an "E-scooters Ecosystem Framework for Urban Mobility" as shown in Figure 1. The main idea came from Shang & Shi (2013) on the adoption of a business ecosystem framework. In general, there are supply capabilities, demand structure, and institution structure. The supply capabilities act as the core business, while the demand structure complements it as the extended enterprises. Combined with institution structure, these form an ecosystem framework.

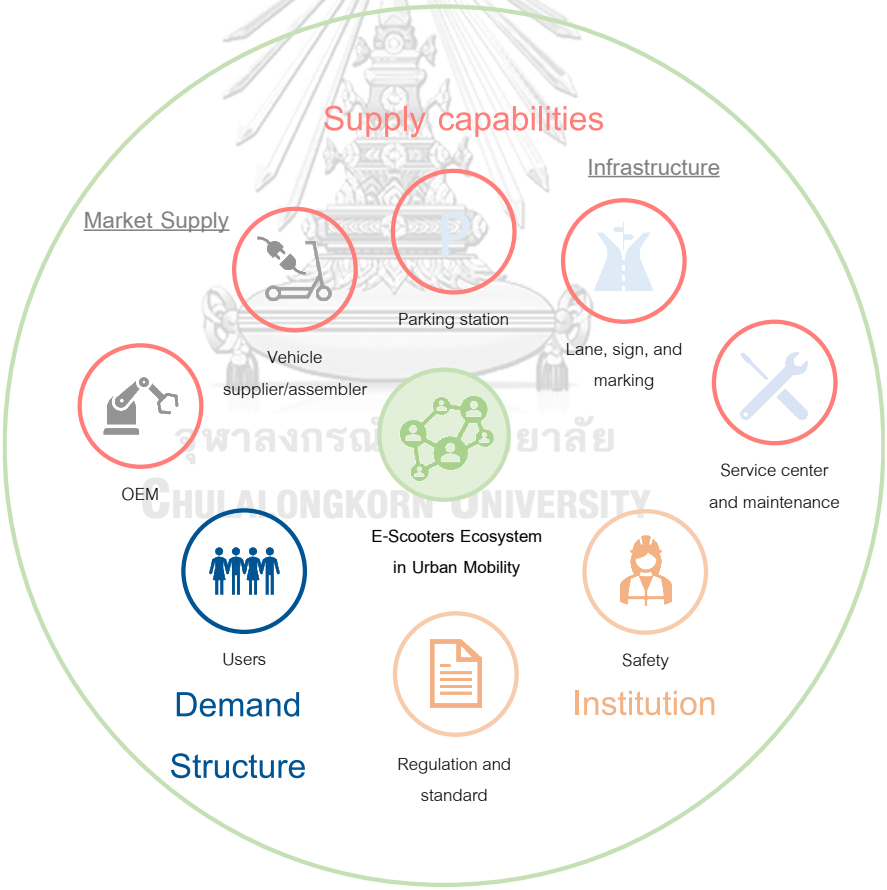


Figure 3. E-Scooters ecosystem in urban mobility. Author's illustration, adapted from (Meyer & Shaheen, 2017; Pütz et al., 2019; Shang & Shi, 2013; Vermesan et al., 2013).

2.4.1. Supply Capabilities

The supply capabilities comprise of market supply and infrastructure supply. Original Equipment Manufacturer (OEM) act as an owner that is in charge of the property rights (Pütz et al., 2019), for example the brand that manufactures the e-scooters. OEM is different from vehicle suppliers and assemblers. Suppliers play roles in delivering the e-scooters to the market beyond who owns the product. While the assembler is the actor in compiling the e-scooters component in a situation where the battery, electric motors, and other spare parts are being delivered unassembled (Shang & Shi, 2013). On the infrastructure side, to achieve the objective of sustainable mobility, there is the need to provide streets, public spaces, and parking space (Meyer & Shaheen, 2017). In the context of e-scooters, the infrastructure refers to parking stations and lanes with signs and marks. Businesses that provide the service to maintain the e-scooters are also significant to the ecosystem (Pütz et al., 2019).

2.4.2. Demand Structure

The demand is structured by users that make the business work. The customer becomes the actor that receives the value of goods and services that the business offers (Moore, 1997). Despite being the exchange of value, customers are strongly connected to each element of the ecosystem (Pütz et al., 2019). If the current megatrends of the shift towards service-based mobility work, it would have a significant impact on the customers in a positive way. The infrastructures and regulations are being provided mainly for the users so that the e-scooters can be operated. In addition, the users are the target that generally receives most of the subsidization (Vermesan et al., 2013).

2.4.3. Institutions

The government plays a critical role since it is the one who will give the infrastructures and the boundaries before the development of the technology, such as regulations, incentives, taxes, and new policies, that make up an effective mobility ecosystem (Curiel-Ramirez et al., 2020). Such boundaries are critical to secure the safety each of element. Safety is a big issue in electric scooter usage. The safety conflict could be caused by illegal ridings, such as helmet use violations, unplaced riding, and carrying a passenger (Haworth et al., 2021a). In addition, other important roles of institutions are to generate economic support for the development of technology (Curiel-Ramirez et al., 2020).

2.4.4. The pre-defined actors of e-scooters ecosystem in Bangkok

This section uncovers the possible stakeholders of e-scooters deployment in Bangkok. From the e-scooters ecosystem framework, there are three main groups: Supply, Demand, and Institutions. During the preliminary observation, it is dicovered that there are two market supplies in Bangkok, which are the vehicle supply and the e-scooters sharing supply. The author would like to define both of them as a Supplier and a Service Provider. The infrastructure supply includes the provision of micromobility lanes, parking spaces, and service centers. It is assumed that bike lanes and some of the parking spaces provision are the responsibility of a public sector, Bangkok Metropolitan Administration. There are three departments that might be responsible for those infrastructure in Bangkok: Traffic and Transportation Department, City Planning Department, and Public Works Department (see Figure 4). Department of Traffic and Transportation is responsible for traffic management and provision of transportation modes and networks in the city of Bangkok. Department of City Planning is in charge for designing a master plan in terms of physical planning and development of the city of Bangkok. Meanwhile, Department of Public Works is

responsible for designing and constructing of the city's roads, drainage systems, pedestrian overpasses and tunnels, vehicle flyovers, public buildings, and so on. The provision of bike lanes seems to be the combination of works within those departments in Bangkok Metropolitan Administration.

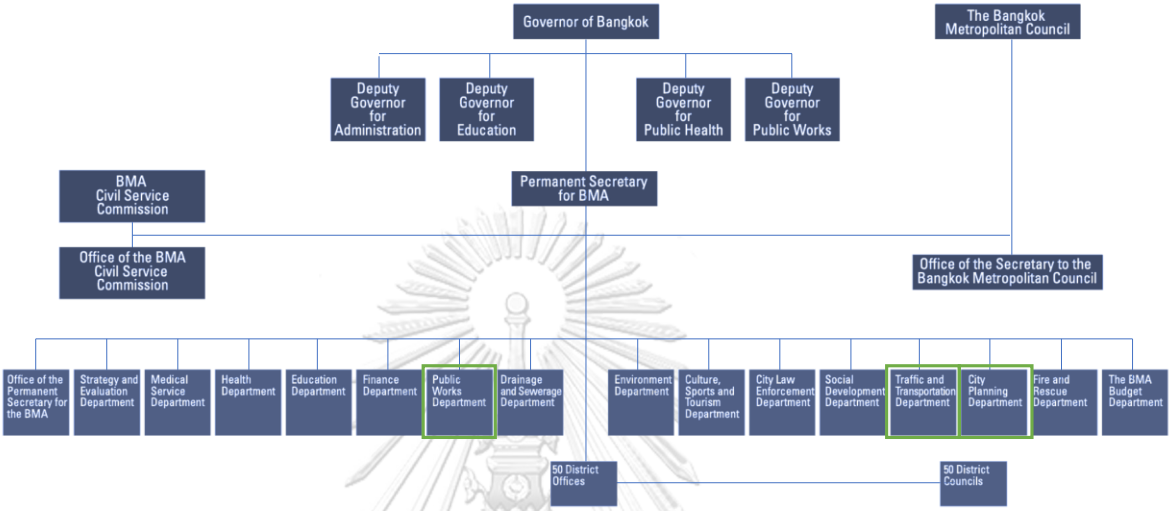


Figure 4. The organization chart of the BMA[2]

In addition, it is worth noting that the public sector does not provide all parking spaces. Some parking spaces might be offered by the management of some buildings in Bangkok. Another infrastructure for e-scooters ecosystem is service centers. The responsibility for providing service centers may come from a particular service company or even the supplier themselves, which are clearly private sector entities. It should be noted that the infrastructure provision in the closed system might be different from the open system depends on the actor who manages the closed environment.

The demand side are viewed as the actors who received the value of goods or services. E-scooters users are the main stakeholder in this group either for the open and closed system. However, the users of e-scooters from the sharing service is defined as a customer. The customers are different from users, because they mainly

[2] Retrieved from the official website of Bangkok Metropolitan Administration. https://official.bangkok.go.th/

receives the value of services provided by the service providers. Furthermore, service providers might be considered as the stakeholder in the demand side because they received the value of goods from the supplier or manufacturer.

The institutions would play significant role mainly to establish regulations that might be used as a tool to standardize and legalize the use of e-scooters in Bangkok. The possible stakeholders for this group of ecosystem are the policy makers. To understand this issue, the legislative process in Thailand should be uncovered first. Thailand has a system of government that combines a constitutional monarchy with a parliamentary form of governance. Its legal system is modeled after the civil law countries of Europe and is based on two major sources: legislative and executive branches of both central and local governments. The primary laws in Thailand are created through Acts of Parliament, which are supported by administrative laws and regulations issued by various government officials such as the Thai Cabinet, minister, and director general of the department (Ongkittikul & Thongphat, 2016). The government official that deals with the regulation and law of transportation is the Office of Transport and Traffic Policy Planning (OTP) under the Ministry of Transport in the national level. Although the legislative process needs to undergo several procedures, the stakeholders of institution group in Bangkok's e-scooters ecosystem under the open system is the Office of Transport and Traffic Policy Planning (OTP). One should take into consideration that the infrastructure available in a closed system may vary from that of an open system, depending on the entity responsible for managing the closed environment.

In summary, the stakeholders of e-scooters ecosystem in Bangkok is depicted into Figure 5.

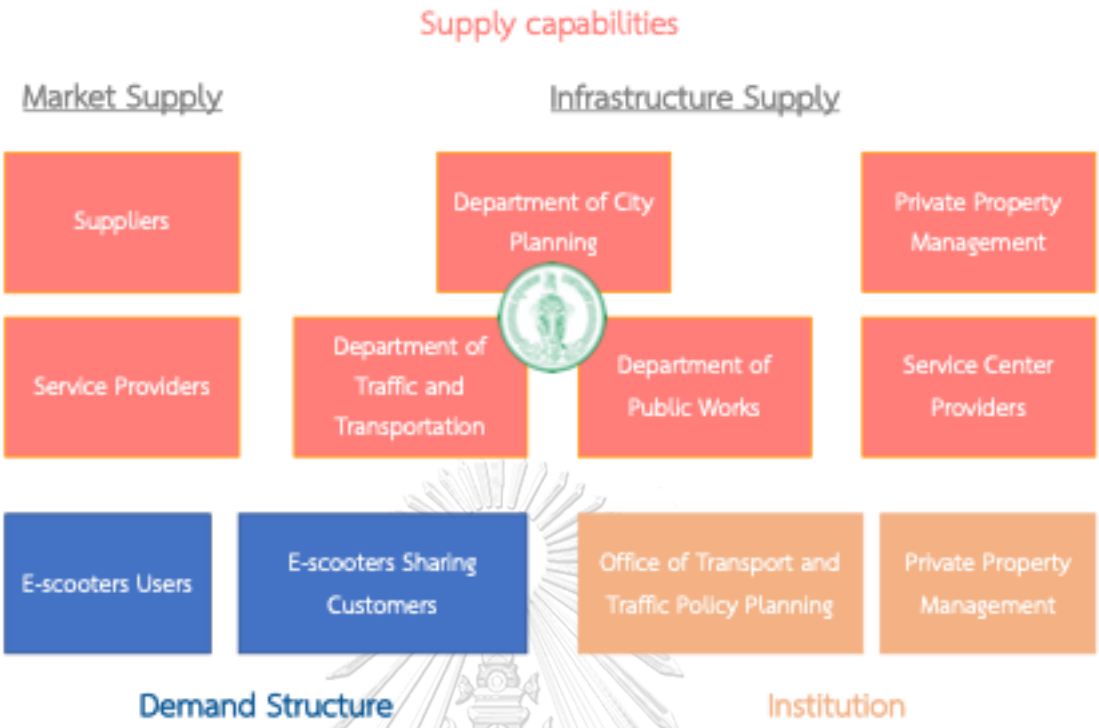


Figure 5. The stakeholders of e-scooters ecosystem in Bangkok.

2.5. The situation of e-scooters utilization among cities

The e-scooters ecosystem in most cities across the world might resemble the open system, such as cities in the United States. However, there are also some cities that practice the closed system approach, such as cities in Australia.

2.5.1. European cities

Currently, Europe is one of the most advanced continents in developing an e-scooters ecosystem. Countries have established standards and regulations that specifically address the electric scooters issue, among those are Germany, France, the United Kingdom, Sweden, and Belgium (Zagorskas & Burinskiene, 2020). One of the European Union's steps was establishing a regulation about two-wheel, three-wheel, and quadricycles' market examination and approval in 2013. According to the parliament's document, e-scooters were classified as a light two-wheeled powered vehicle which maximum speeds and maximum continuous power are 45 km/h and 4

kilowatt respectively. Incorporating vehicle definition into the regulation context is very significant for accommodating future event. Indeed, one of EU's strategic target related to reducing air pollution, noise pollution, and traffic emission is through electrification of traffic (Sachs et al., 2016). The market growths in EU shows high rates as it becomes attractively environmentally friendly.

To standardize the e-scooters usage on EU's cities, most countries adapt a speed limits that were set as not more than 25 km/h. The users should also be at least 14 years old. Besides directing the users, the regulation also focused on controlling e-scooters companies. The regulation could be used as a tool to manage the number of service providers. In addition, the city of Paris does not allow e-scooters to run on the sidewalk and require the fleet to be parked in the designated area. There would be fines/penalty scheme for users who do not obey proper parking regulation. Not only restricting the users without solution, the Paris municipality provides a plot of parking space addressed for e-scooters. The city of Paris committed to building 2500 new parking spaces every upcoming year (Zagorskas & Burinskiene, 2020).

One of the strategies that some countries adopted in regulating electric scooters is through flexible implementation. The authority in Italy revised the regulation to equalize e-scooters with normal bikes according to Article 75 in Italian Micromobility Ministrial Decree 2019. The speed limit were also planned to be decreased from 25 km/h to 20 km/h. Another example came from the capital city of France. The authority of Paris municipality updated the regulation to give penalty scheme for users who rides e-scooters in sidewalks (Zagorskas & Burinskiene, 2020). After doing some periods of trials, Belgium officials increased the speed limit from 18 km/h to 25 km/h (Zagorskas & Burinskiene, 2020).

2.5.2. States in the USA

Electric scooters started to be familiarly running around cities in the United States in 2017. Although regulations that specifically adress e-scooters has not been established, companies already came to the market and becomes the early of deployment (Riggs et al., 2021). Subsequently, in mid-year of 2018, municipalities began to consider methods of regulating electric scooters which measures vary, such as: operators permit requirement, vehicle operation under pilot program, and in some cities, outright bans of the use (Riggs et al., 2021). The element that being included on the jurisdiction depends on the city/state's particular needs and concern. For example, in California, an e-scooters regulation were done statewide by aligning the e-bikes law (Anderson-Hall et al., 2019). E-scooters in California's regulation A.B. 2989 were identified as a standing scooters with allowed speed no more than 20 mph. In addition to that, cities in California were given freedom to choose whether or not e-scooters are allowed on sidewalks.

In the operator permit requirements, the authority in many cities incorporated the equity policy to equalize the access and distribution of e-scooters to all people regardless anything. The inequity issues were addressed with: low-income payment plans that includes cash payment, non-smartphone usage, and fee waiving; distribution requirement to ensure specific percentage of operator's scooters available in targeted neighborhood; fleets caps to reassure the equal distribution in city's parts; and incentivizing the operators who provide services in targeted areas (Riggs et al., 2021). For example, in San Francisco, service provider's permit to operate e-scooters are required to include plan for low-income users' accessibility (Anderson-Hall et al., 2019).

2.5.3. Australian cities

Moving to the Australian city, the municipality of Victoria provides a platform to educate both users and non-users about the standards to properly use e-scooters along with other beneficial information. The regulation in Victoria does not allow the use of personal e-scooters on the street. It only allows licensed service providers to operate in the city's designated area. The regulation also specifies the penalty amount for those who do not obey the rule. Similar to Victoria, the Brisbane city government has made effort to regulate e-scooters sharing use (Field & Jon, 2021). However, the issue related to helmet use, speeding, and space competition has not been well managed which is probably caused by the lack of willingness to obey the rules. The e-scooters can be used on the footpath if there is no signage of prohibition (Haworth et al., 2021b). The riders should strictly prioritize the pedestrians while using e-scooters on the sidewalk.

2.5.4. Asian cities

Singapore is accounted as one of the largest share in Asia's e-scooters sector. Startup companies of e-scooters sharing, such as Neuron and Telepod, sprouted and occupied the urban landscape with their tipical standing-decked vehicle (Cao et al., 2021). A Singapore based company, Neuron, have interestingly expanded their services to many countries, such as Australia, Canada, New Zealand, and United Kingdom. Singapore's authority underlined the significance of enhancing the potential of new mobility services to serve more door-to-door mobility options (Cao et al., 2021). The authority launched an agenda that includes delivering incentives to the public that use green transportation mode during peak hours.

In Singapore, the speed of riding e-scooters on bike- and shared-lanes are limited to maximum 25 km/hour (Zhu et al., 2020). E-scooters were allowed to be operated on footpaths as long as the speed does not exceeds 10 km/hour according

to Active Mobility Act 2017 (SLA, 2022). However, the rule was updated to only allow PMD (Personal Mobility Device) that does not have handlebar, such as PMD for disabled people, to operate in footpaths with specific speed. This rule addressed the issue that e-scooters implicates nuisance that possibly becomes the hurdle of promoting micromobility (Cao et al., 2021). The good thing is, not only limiting the space usage, the authority is trying to provide more bicycle lane up to 1.300 km by 2030 to accommodate more micromobility, according to Singapore's The Land Transport Authority. Another approach to address the nuisance of e-scooters in Singapore is by not allowing the riders to park arbitrarily. The government created a regulation for the e-scooters service providers to fine the users if they parked the fleets not in a designated area (Zhu et al., 2020).

In the developing world in Southeast Asia, Indonesia have also adopted the speed limits similar to 25 km/hour on their regulations according to 45/PERMEN/2020. Users are not required to both register the vehicle and obtain driving license. While the use of electric scooters The Philippines, the speeds are not exactly limited but the users are prospected to have a driving license in operating the fleets that can rolls more than 25 km/hour (Cutaran, 2021), the regulation is under review. According to Administrative Order No. 2021-039 by The Philippines's Department of Land, the fleets should not be registered. In both countries, e-scooters riders are regulated to wear safety helmets as well as protective shoes.

The legal aspect in regulating e-scooters' driving license are still on debate since it can increase the cost of users to operate the fleet. On the other words, it potentially become the barrier of the deployment as well as the inequity issues if the licensing were being charged too much. One of the examples of regulation adjustment for considering the license happened in Japan. The council amended the regulation to no longer necessitate driving license as long as the electric scooters' speed not exceeding 20 km/hour (Shimbun, 2021).

2.6. Challenges for electric scooters implementation

Electric scooters as an urban mobility are a relatively new phenomena which many countries are currently on their pilot project and trial phase. From the implementation that has been conducted in cities across the world, factors that affect its operation could be identified. This section discusses about challenges and opportunities for future electric scooters implementation that would help to construct the analysis of this research.

Electric scooters were a relatively new mode of transportation injected to cities across the globe. In some countries, e-scooters arrive within a short period of time that confuses the municipality. In Brisbane for example, the influx of e-scooters sharing was realized as a crisis of policy caused by an “overnight” appearance (Field & Jon, 2021). In addressing such phenomena, the authorities have to maturely consider whether or not to necessarily accept the new technology. Examination of plentiful elements in regulating either to allow or to turn-down the operation electric scooters is one of the early challenges for the municipal authority (Anderson-Hall et al., 2019). In advance to permit the e-scooter’s operation, cities have to analyze and evaluate the impacts to other road users (Zagorskas & Burinskiene, 2020). On the other words, regulations related to safety are significant for the powered micromobility implementation. In addition to that, many details of the regulation become the challenges for the city’s authority, such as the charge for permit fee, fines, or even service fee of e-scooters which are also important to be considered when designing the regulation (Anderson-Hall et al., 2019). Another challenge for the municipality, service providers, and even the manufacturer is designing regulation that could provision of affordable e-scooters to the low-income people as an unreliable transportation mode could affect the vulnerable group (Anderson-Hall et al., 2019).

In relation with the safety issue, the municipalities are challenged with the decision where electric scooters should be ridden. Commonly, powered micromobility have impact for other space users, such as accident associated with riding danger and improper parking that could impede other road users (Zagorskas & Burinskiene, 2020). It has been concerned by planners that conflicts between pedestrians, cars, and micromobility user becomes a significant challenges for implementation (Field & Jon, 2021). According to a research conducted in Singapore, motorized micromobility could tripled the risk of injury caused by an accident compared to the non-powered one (King et al., 2020), mainly because of the higher speed. However, e-scooters users actually choose to better ride the vehicle in a lane separated with cars (bike lane and sidewalk) due to safety reason as it has less interactions (Pazzini et al., 2022). This option is supported by an observation in Trondheim wherein e-scooters users are actually aware of other road users and they tend to reduce the speed when passing by (Pazzini et al., 2022). Though, speeding still becoming an issue because some supplier manufactured the vehicle with a speed much higher than the speed regulations in many cities. Those issues urged the key actors to provide and plan for a safer road infrastructure (Cao et al., 2021) as well as a wise regulation.

Many cities have provided regulations to manage issues for e-scooters usage in their landscape. However, executing the regulations itself would be another challenges (Field & Jon, 2021). One of the hardest challenges for service-provider-based implementation is improper parking. In Singapore, the government required the service provider to fine the users that does not park their fleet in a designated parking area. Conversely, the case of improper parking still becoming a common problem (Zhu et al., 2020). In Rosslyn, Virginia, 16% of the observed e-scooters were parked improperly which fleet blocked the sidewalk or parked in a private property

(James et al., 2019). This issue would require extra workforce to pick up e-scooters on other location and bring them back to the station (Anderson-Hall et al., 2019). The lack of appropriate implementation would result in cease and desist of many service providers in a city. Some municipalities in the USA requested the service providers to stop operating because either the users do not obey the rule or the operators does not solve the issues of bad implementation (Anderson-Hall et al., 2019). In this case, e-scooters regulation had not been well penetrated in public (James et al., 2019). The situation in many cities draw a conclusion that educating the users is very important and become another challenge for implementing e-scooters.

2.7. Conceptual framework

This research would like to know about the ecosystem framework of e-scooters utilization in Bangkok as well as to discover its challenges and potential that would be beneficial to construct strategies reccomendation for future development in Bangkok. As it has been explored in the literature review about the ecosystem building, this research pre-defined the e-scooters ecosystem as Supply Capabilities, Demand Structure, and Institution. The pre-defined ecosystem framework is used as a part of the conceptual framework of this research. To achieve the objectives, this research assess the ecosystem of e-scooters in Bangkok for both open and closed system by collecting data with several actors, that includes supply, infrastructures, users experience, regulation state, and so on. The conceptual framework of this research is shown in Figure 6.

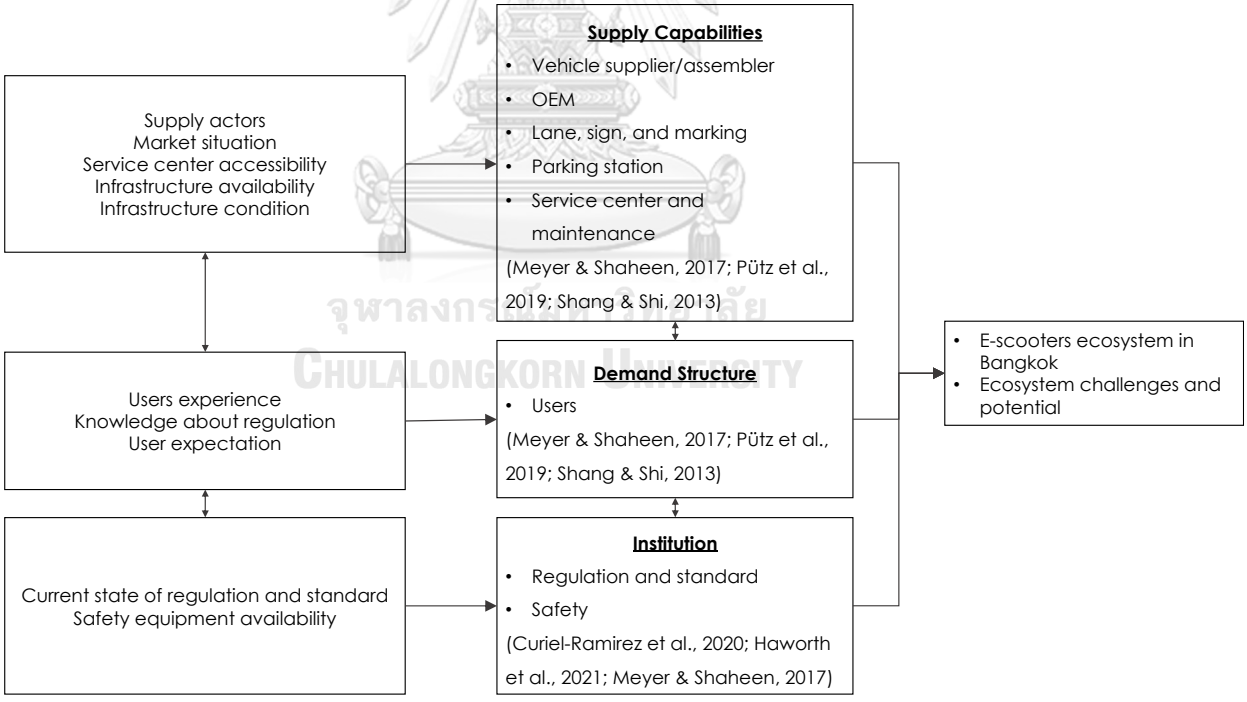


Figure 6. Conceptual framework

CHAPTER 3 : METHODOLOGY

The research is using a mixed-methods approach to assess the potential of the electric scooter ecosystem in Bangkok. After the framework for e-scooters is identified, data would be collected and analyzed according to the framework. There are several data collection methods for the data: such as interviews with the purposive sampling method; field research for the primary data; and internet source for the secondary data. As there are many types of purposive sampling explained by Palinkas et al. (2015), this research would adopt the "Criterion-i" and "Snowball" strategies. In this case, the interviews would be practiced by collecting data from the demand structure and supply capabilities. In addition, for the supply capabilities, in particular infrastructure, the primary data would be collected using field research. While on the institutional side, the information would be collected by conducting exploration on internet sources and also through the interview with the demand side and the supply side. Subsequently, the interview data would be analyzed qualitatively using thematic analysis. The data would be triangulated to increase the reliability of the assessment.

3.1. Mixed-method approach

Research that uses both qualitative and quantitative methods of both data collecting and analysis in a single study is known as a mixed-method study. Mixed-method research gives policy analysts the ability to comprehend qualitatively as well as quantitatively explain the phenomena with numbers, charts, and simple statistics (Creswell, 1999). Compared to either a qualitative or quantitative approach, the mixed-methods is perceived as an approach that provides a better understanding of research issues (Palinkas et al., 2011). According to Creswell (1999), when designing a mixed method study, several elements are crucial, such as: making sure whether a

mixed-method study is required to explore the research problem; consider the feasibility of using a mixed-method research; design a research question that is suitable to be analyzed quantitatively and qualitatively; form a types of data collection for both methods; visualize the research design; and define the analysis tools.

3.2. Data collection

Purposeful sampling is a procedure to identify the “information-rich cases” and select individuals that are knowledgeable or experienced with the issues so that the sampling would be effective (Cresswell & Plano Clark, 2011; Patton, 2002). On the other word, information-rich cases are obtained from specific individual who suitable with our purpose of collecting the data. This procedure also often addressed as "purposive" and "judgement" sampling, meaning that researchers choose the purpose that they expect the interviewees to serve (Patton, 2002). Purposive sampling usually involves small samples (not more than 30 cases), and the size of samples depends on the research question and the type of qualitative research (Teddlie & Tashakkori, 2009).

There are many strategies of purposive sampling explained by Palinkas et al. (2015), some of the strategies emphasize on the similarity of the sample. This research would adapt the “Criterion-i” and “Snowball” strategies. The Criterion-i could be used to select cases that meet some predetermined criteria (Palinkas et al., 2015), for example selection of program leaders and consultant trainers at study sites (Marshall et al., 2008). Snowball sampling could be used to select respondents by asking informants that have similar characteristics (Palinkas et al., 2015), for example asking program managers to select the staff, clinicians, and consumers (Green & Aarons, 2011).

This research would like to understand detailed information about the e-scooters phenomenon in Bangkok. Instead of using surveys that would come up with quantitative analysis, in-depth interviews with a small number of respondents would be more suitable for this research topic. The interviewees are classified into two groups, which are Group A and Group B. The participants of Group A are e-scooters users, which samples are targeted around 4-8 people. While Group B are other actors that are significant to the ecosystem. The sampling number of Group B is targeted two people. The details of each target group are shown bellow:

a. Group A: E-Scooters Users

Number of interviewees	:	4-8 people
User target	:	1) Minimum age 14 years old[3] 2) Students or workers who own and use e-scooters 3) Have been using e-scooters in Bangkok for atleast 2 months[4] 4) Have been living in Bangkok for atleast 90 days[5]
Duration of interview	:	30 minutes
Procedure	:	Semi structured interview
Basic information	:	Name, age, sex, occupation, the age (how long) and frequency of using e-scooters, purpose of using e-scooters
Questions	:	Appendix B (Table 14)

b. Group B: Supplier and Service Providers

Number of interviewees	:	At least 2 people
Target	:	Momentech, Monowheel, Zendrian, and Beam

[3] The minimum age requirements for EU countries which considered as the youngest age among other countries.

[4] The minimum period of usage to make sure that users are advanced with e-scooter utilization. Retrieved from Fomiatti, R., Moir, L., Richmond, J., & Millsteed, J. (2014). The experience of being a motorised mobility scooter user. *Disability and Rehabilitation: Assistive Technology*, *9*(3), 183-187. https://doi.org/10.3109/17483107.2013.814171

[5] The duration (90 days) is used make sure that users are not tourists.

Duration of interview	:	45 minutes
Procedure	:	Semi structured interview
Questions	:	Appendix B (Table 16)

There are three datasets on this research. The first dataset was obtained from semi-structured interviews with e-scooter users in Bangkok that have ever ride e-scooter around Phayathai Road, Samyan area, and Chulalongkorn University area. The sampling method were designed to use purposive sampling and snowball sampling. However, practically, none of users is being sampled using snowball sampling. The participants were chosen through both field observation and online announcement. At first, the author analyzed the interview results from four participants. However, the author would like to know more from the user's side. Two more participants were incorporated. The result shows that two more participants do not change the significantly. Therefore, the author decided to analyze the user's data from six participants of e-scooter users within a timeframe of three months. It is tricky to get users who are willing to be interviewed because of two reasons: e-scooter users run faster than human walking or even bicycle which make them harder to be reached through field observation; and the language barrier to reach users through online announcement. Nevertheless, the interview result of six participants is sufficient to give the author different perspectives about the phenomenon of e-scooters utilization in Bangkok.

The second dataset was obtained from semi-structured interviews with a service provider of e-scooters sharing and a supplier of e-scooters in Bangkok. The sampling method were designed to use purposive sampling. The author selected the service provider because they provide the service around the area of observation (Chula – Samyan). Indeed, they are one of the e-scooters sharing service who reopen the business after the halt due to Covid-19 pandemic. The supplier itself were

chosen through the information provided by one of the user being interviewed. The author tried to reach three suppliers whose businesses are significant to e-scooter's deployment in Bangkok. However, only one supplier is willing to be interviewed. Despite, the second dataset which meaningfully important for the triangulation method is sufficient to be analyzed.

The third dataset was obtained from field observation. Author conducted field observations around Phayathai Road, Samyan area, and Chulalongkorn University area. The field observations are conducted two times: before the first and second dataset were collected; and after the datasets were collected to crosscheck what the interviewees have explained. The third dataset investigate about the supply and demand side of the ecosystem, such as bike lane availability, parking space availability, service centers availability, and user's practice. Those data would be presented as a form of pictures.

3.3. Thematic analysis

Qualitative research are broad, nuance, and complex, which makes academia to define approaches for its analysis (Holloway & Todres, 2003). In research projects, there are numerous techniques and methods for qualitative text analysis. One of the most used tools is thematic analysis. This approach often and should be understood as a fundamental methods for qualitative research (Braun & Clarke, 2006). Thematic analysis offers useful core skills that would be beneficial to conduct several procedures of qualitative analysis. By definition, thematic analysis ias a technique to identify, analyze, and report some themes of data. According to Braun and Clarke (2006) thematic analysis is flexible, meaning that it could be compatible in a different theories (e.g., essentialist vs. constructionist paradigm in psychology). From its benefit of flexibility, it should be noted not to attempt to bound the flexibility.

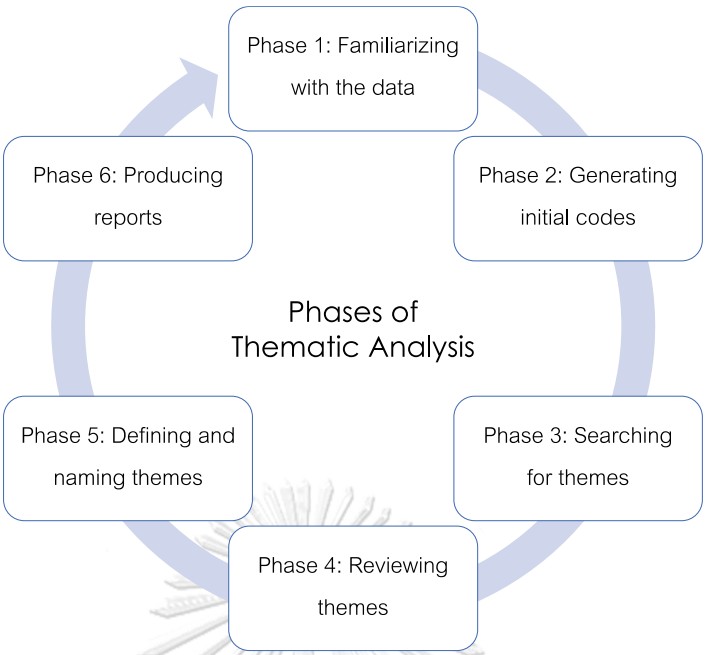


Figure 7. Phases of thematic analysis. (Braun & Clarke, 2006).

Braun and Clarke (2006) defines basic process to conduct a thematic analysis which explained into six phases as shown in Figure 4.

a. Phase 1: Familiarizing with the data

Analysis data could either be collected by analysts or other people in the research. If the data is collected by themselves, it would be easier for analyst to familiarize with the data. However, if analysts receive the data from others, it needs more efforts to getting to know the ideas in the data. Regardless, it is important to immerse with the data. In this phase, taking notes and highlighting ideas for coding would become a good start. If the data is verbal data (e.g., interviews), the way to familiarizing with the data is through writing transciption. Although the process of transcribing data is time consuming and boring, it helps the analysts to dive into the data.

b. Phase 2: Generating initial codes

After the analysts have familiarized with the data, coding phase begins. The second phase would generate initial codes that would be used to identify pieces of

the data that appeals to be interesting for describing some phenomenon. Codes are more specific compared to themes which usually broader. In this phase, it is adviced to code as many prospective patterns as possible because later on it might produce interesting themes. Analysts should keep surrounding data to maintain the context, because a common mistake in coding is the lost of context. The extract of data is possible to be coded in different themes, meaning that extracts might be uncoded, coded once, even many times.

c. Phase 3: Searching for themes

In this phase, analyst refocus the coded data at the wider level of themes and assembling all applicable coded data extracts to the specified themes. Using visual illustrations (e.g., mind maps and table) to help organize the different codes into themes may be useful at this stage. This phase would end with a group of candidate themes along with the data that has been put into the themes. However, it is still unclear whether the themes are still relevant as they stand or some need to be integrated, clarified and splitted, or even rejected.

d. Phase 4: Reviewing themes

This phase would find out whether or not some candidate themes are really the themes. Analyst should review if the evidence is insufficient or too diverse to support the themes. The themes will be reviewed and improved on two different levels throughout this phase. The first level is reviewing at the level of the coded data extracts, while the second level is similar steps but applied to the complete collection of data. If the theme map fits, analysts could go to the next stage. If the map does not fit, analysts must go back and examine to refine the codse until an acceptable theme map could be generated.

e. Phase 5 and 6: Naming themes and producing reports

When a satisfactory thematic map of the data has been produced, themes are refined and named to be presented in the analysis. Meaning to figure out the "substance" of each theme's subject and what part of the data each theme focuses on. After a group of completely developed themes has been created, it is the task to tell the reader of the phenomenon in a way that persuades them of the accuracy of the research, which is producing reports. However, the writings must be more than only presenting information, but extracts must be included into the narrative.

3.4. Triangulation

The data that were collected from interviews are precarious to result in biases if not cross-checked and confirmed with another source. To anticipate that, this research would adopt triangulation. Triangulation is an approach in qualitative research that combines multiple methods or sources of data to achieve and acquire a comprehensive knowledge of the phenomena (Patton, 1999). Triangulation are classified into four types: methods triangulation, investigator/analyst triangulation, theory triangulation, and data source triangulation (Carter et al., 2014; Patton, 1999).

Triangulation of methods refers to a comparation of data collected by a kind of qualitative methods with data collected by a kind of quantitative methods (Patton, 1999). According to Polit and Beck (2012), methods triangulation also refers to multiple methods of data collection within a phenomenon, such as a interviews, field notes, and observation. This kind of triangulation is utilized with such complementary approach to answer research question that could not be answered with a single methodology (Patton, 1999). Analysts triangulation is a comparation of data or even analysis result collected by multiple observers or analysts to lessen potential bias if being conducted by a single person (Patton, 1999). Investigator triangulation could give confirmation from different perspectives. The third kind of

triangulation is theory triangulation, meaning that there are different theories as perspective to analyze the same data (Patton, 1999). Theory triangulation could help the researcher to combines different theories to support the findings (Carter et al., 2014). Last but not least, is data sources triangulation, which main idea is to cross-check the reliability of information. According to Patton (1999), data sources triangulation could involve comparation between: 1) observational data vs. interview data; 2) opinion in public vs. opinion in private; 3) opinion within different timeframe; and 4) opinion from different perspective (e.g., different people).

This research would utilize the data source triangulation approach to examine and cross-checking the consistency of different sources of data. The interviews are designed for two groups of people, which are Group A (e-scooters users) and Group B (supplier and service provider). The approach would be a comparison of people's perspective from diverse point of view and a comparison of interview data with observational data (Patton, 1999).

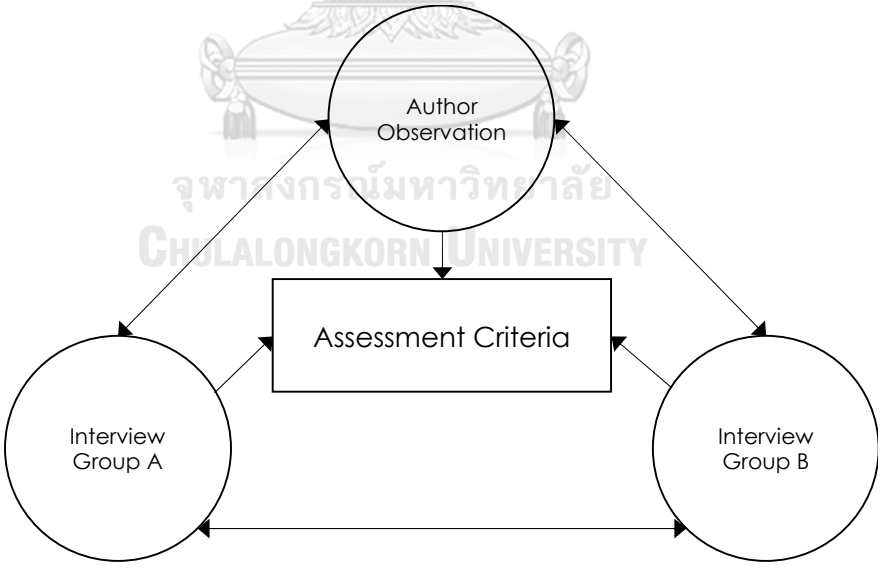


Figure 8. Triangulation approach

CHAPTER 4 : ANALYSIS AND DISCUSSION

4.1. Data

This section would contain information about the data that would be analyzed and discussed in the next chapter. The first dataset was obtained from semi-structured interviews with e-scooter users in Bangkok that have ever ride e-scooter around Phayathai Road, Samyan area, and Chulalongkorn University area. The second dataset was obtained from semi-structured interviews with a service provider of e-scooters sharing and a supplier of e-scooters in Bangkok.nThe third dataset was obtained from field observation. Author conducted field observations around Phayathai Road, Samyan area, and Chulalongkorn University area.

4.1.1. Group A

The interviewee from Group A consists of 6 e-scooters users which represent the demand structure of the ecosystem framework (Figure 9). Six users were chosen with purposive sampling with criterias described in Chapter 3. This research attempted to use snowball sampling as well, however that sampling method does not work during the data collection. Therefore, six e-scooters users of personally owned e-scooters are able to be interviewed with the characteristics described bellow.

Figure 9. Representation of Group A in the e-scooters ecosystem actors

a. User 1

User 1 is a 16 year-old pre-engineering student who daily commutes with e-scooter from his accomodation to a university in the north part of Bangkok. He is Thai nationality and has been living in Bangkok since he was born. The reasons of using e-scooters instead of other modes of transportation are due to its low cost that he needs to spend every day and its flexibility to be able to be brought in public transportation. He also utilizes the scooter to travel around the city centre (Siam and Samyan) by taking rail transportation (MRT). His average travel distance in a day is approximately 5 kilometer, however, it could be more if he is riding to the city centre during weekend, which could reach until 20 kilometer. User 1 has been using e-scooters for more than 6 months, which makes him fit into the interview criteria. He obtained the e-scooter by on-site purchase in a shopping mall, which cost 29.000 THB.

In a daily usage, User 1 rides the scooter with an average speed of 30 km/hour, which is the maximum speed that the scooter can get. User 1 has experience accident while riding e-scooters for more than three times. The worst accident that he had gets him into a sewer system and leaves an injury. This situation forces him to put extra care to ride safely. For example, he always wear a full face helmet when riding e-scooters to anticipate head injury if facing accidents. When his e-scooter broken, the brand provides a service center for the customers to fix the scooter.

Most of the times, he chose to ride the scooter on the roadside because he considers to rarely find bike lanes. User 1 finds it hard to get a safe parking space for his e-scooter which makes him have to carry along his micro-vehicle with him in some places (e.g., shopping mall). However, in the university, he usually bring the scooter inside the building so that it is safe from stealing. User 1 thinks that it is conveinient to ride e-scooters in Bangkok as long as equipped with safety protection.

b. User 2

User 2 is a Cambodian master's student who has been living in Bangkok for more than a year. In a daily basis, he rides e-scooters from his apartment to the university which approximately take around 4 km travel distance per day. The main reason of using e-scooters is because of a strict requirements to buy a motorcycle in Thailand that leads him to get e-scooters instead. He bought the scooter online and cost around 10.000 THB. User 2 sometimes use the scooters to travel around the university area, but still considerably short distance. He has ever taken his scooter in public transport, but he rarely do that. User 2 has been using e-scooters for more than 9 months.

The maximum speed of his e-scooter is 20 km/hour, thus User 2 always ride on that speed. He consider his scooter speed is slow which makes him decide not to wear any safety equipment (e.g., helmet). User 2 has never experience accidents when using e-scooters, eventhough he chose to ride on the side of the road. However, it is considerably dangerous to ride on the road because of the large vehicle running quite fast. Sometimes, User 2 has to lift his e-scooters on the pedestrian skybridge to cross the road to avoid crash.

User 2 finds it easy to find e-scooters parking inside the university area, but it is tricky to get a parking space outside. User 2 always lock his scooter with an equipment because it is prone to stealing. If he could not find a proper parking space that has a medium to attach the scooter with a lock system, he has to park in free space around the building and monitor the scooter. User 2 has ever brought the scooter inside the university's library, in addition to get a parking space, he tried to charge the scooter inside. However, he got rejected by the officer for charging electronics other than laptops and tablets.

c. User 3

The third user being interviewed is a 38 year-old engineer which nationality is Thai. User 3 has been using e-scooters for more than 3 years and has lived in Bangkok for over 10 years. She regularly ride e-scooter to go to the workplace which located 5 kilometer away from her apartment. Before using e-scooter, User 3 travel using bicycle everyday about 10 kilometer in Bangkok's hot wheather which makes her decides to shift into e-scooters. In addition, rather than a motorcycle, she chose e-scooter for its less cost for the energy consumption, less pollutant, and its small size so it can be parked inside a studio apartment room. Apart from utilizing e-scooter to go to work, she often use e-scooters to commute to leissure destination during weekends.

Generally, User 3 rides the scooters with an average speed of 50 km/hour. However, the scooter's maximum speed is 80 km/hour, which considerably very fast for an e-scooter. She bought the e-scooter on-site and cost 40.000 THB, much more expensive than normal e-scooters. When riding e-scooters, User 3 always wear a safety helmet to protect her from injury that could happen due to accidents. Indeed, she has experienced accidents two times triggered by the unfamiliar of using the new and powerfull braking system that she has just replaced. Although the accidents did not cause bleeding or need a medical treatment, it hurts enough. When the scooters are broken, she would repair the scooters by herself and obtain the spare parts from online stores.

As a user of a powerfull e-scooters, she chosed to ride the scooters in a road like a motorcycle. She thinks that it is dangerous to ride the scooters on sidewalk, both for herself and for pedestrians, because her scooter is very fast and quite bigger than other scooters. User 3 usually park the scooters in front of her office. Although it is not a designated parking area, she choose that space because it is considerably spacy, safe, and would not invade other people. Besides, in some

buildings, she also parked her scoooter in a motorcycle parking or in a bicycle lane if available. Certainly, she always lock the scooter with an external locking system.

d. User 4

User 4 is a 19-year-old undergraduate student who daily commmutes with electric scooters to the university which located around a kilometer a half from his accomodation. He has lived in Bangkok since he was born and has used e-scooters for 3 years already. User 4 needs a transportation mode that is safe and do not require him to go to the main road. Thus, he chose e-scooters to commute on a daily basis. His average travel distance a day is more than 3 kilometer. User 4 rarely integrate the scooter with public transportation, since the travel destination is mostly around the university. He purchased the e-scooter on-site which cost 18.000 THB.

Having the maximum speed of 25 km/hr, regularly, User 4 ride the scooter on its maximum ability. He used to wear a safety helmet, but recently, he is not wearing any safety protection while riding e-scooters. User 4 has ever experienced accident two times, which one of them resulted in bleeding. However, he considered that the accidents are both not serious and not urgently need a medical help. Similar to User 1, when his e-scooter broken, the brand provides a service center for the customers to fix the scooter.

Most of the times, User 4 chose to ride e-scooters on bike lane. He ponder that the bike lane availability on where he usually ride electric scooters are good. However, outside his university area, he is rather pessimistic that the road has a bike lane. User 4 finds it easy to get a parking space for his e-scooter. Whenever there are bicycle parking or even motorcycle parking, he would park the scooter on that area with a locking system that he has.

e. User 5

User 5 is a 37-year-old British expat who has been using e-scooters as a daily transportation mode for about 3 years. Since he came to Bangkok, he started using e-scooters whose main purpose is to commute to his workplace, which is around 2 km from his accommodation. He chose e-scooters for their less cost spending rather than other types of transportation modes. However, he never combines e-scooter with public transportation and rather utilize them separately. His average travel distance a day is around 4 kilometer. During 15 months living in Bangkok, he has purchased three e-scooters. The first e-scooter were purchased online and cost 7.000 THB. Because it was broken, he purchased his second scooter for 10.000 THB online as well. Due to some problem with its battery, he decided to purchase a secondhand scooter for 13.000 THB from his friend.

User 5 rides the scooter with an average speed of 25-35 km/hour depending on the scooter model that he rides. His current scooter could run at 25 km/hour and he rides on its maximum speed without wearing helmet. User 5 experienced an accident while riding e-scooters because of hitting to a bump on the road. However, it was considerably a light accident that does not require special treatment.

Generally, he chose to ride the scooter on the road because the bike lane availability is modest. User 5 considers the bike lane quality in Bangkok is not good compared to Shanghai, China, where he used to stay before coming to Thailand. User 5 believes that it is easy to find a parking space for his scooter. As long as there is a space available near the place he visits, he would park the scooter there without a locking system.

f. User 6

User 6 is a 28-year-old dog walker or pet sitter who has been living in Bangkok for over 20 years. On everyday routine, she rides e-scooter from her

apartment in Sukhumvit to her workplaces which approximately take around 30 km travel distance a day. User 6 has been using e-scooter for 3 months. The main reason of using e-scooters as the current main transportation mode is because of its small size so that she can flow through the traffic jam. Compared to a car and a motorcycle that she has previously used as a daily driver, she considers that e-scooter is a better option to stay convenient even though facing a congestion. She bought the scooter on site and cost around 13.000 THB. User 6 also bring her scooter inside a public transportation (MRT and BTS) quite often because sometimes she needs to travel far and changing places for her job.

The maximum speed of her e-scooter is 30 km/hour which makes her rides on its maximum speed. She always wears bicycle helmet as a safety equipment when riding e-scooter. During three months of using e-scooter, User 6 has experienced accidents two times triggered by interaction with other road users, such as cars and motorcycle. The accidents did not need a medical treatment and she claimed that the accidents are bearable. If there is something broken with her e-scooter, she could fix the scooter in a service center provided by the scooter brand.

In a daily basis, User 6 chose to ride electric scooter on the side of the road, but sometimes on the sidewalk as well. She considers the bike lane availability in Bangkok is not good. In some area, the bike lane is misused for motorcycle to ride and even park. If the bike lane availability is sufficient, she would likely to ride the scooter on its dedicated right of way. User 6 perceives e-scooter could be easily parked anywhere for its small size. She does not require a specific place to safely park her e-scooter. Generally, she would bring her scooter with her if going to a shopping mall, then park the scooter in front of the destination outlet. If she goes to a café, she will ask the staff whether she could bring the scooter inside to park and/or charge.

g. Summary table

Table 3. Users' information

No	Information	Participant					
		User 1	**User 2**	**User 3**	**User 4**	**User 5**	**User 6**
1	Age (years old)	16	24	38	19	37	28
2	Nationality	Thai	Cambodian	Thai	Thai	British	Thai
3	Occupation	Student	Master's Student	Engineer	Student	Teacher	Pet sitter
4	Time period of using e-scooters*	6 months	9 months	3 years	3 years	3 years	3 months
5	Speed usage (km/hour)	30	20	50	25	25-35	30
6	Travel purpose	University; Leissure	University	Work; Leissure	University	Work	Work; Leissure
7	Average travel distance/day	5 km	4 km	10 km	3 km	4 km	30 km
8	Using e-scooters in public transportation	Quite often	Seldom	Never	Seldom	Never	Quite often
9	E-scooter price (Thailand Baht)	29.000	10.000	40.000	18.000	10.000	13.000
10	Helmet usage	Full face helmet	No	Bicycle helmet	Not anymore	No	Bicycle helmet
11	Accident experience	More than three times	Never	Two times	Two times	One time	Two times
12	Space usage	Road side	Road side	Road	Bike lane	Road	Road side
13	Knowledge of regulation	Good	Good	Good	Good	Good	Quite good

4.1.2. Group B

The interviewee from Group A consists of two actors: supplier and service provider which represents supply capabilities in both supply and infrastructure side. During the analysis process, it is interesting that service provider can also be positioned into the institution side. This research attempted to interview as much actors as possible by sending invitation to several companies. However, only a service provider and a supplier are willing to be interviewed. Both actors were chosen with purposive sampling with criterias described in Chapter 3.

Figure 10. Representation of Group A in the e-scooters ecosystem actors

a. Service provider

A service provider (Provider 1) is an e-scooter sharing service which generally operates with dock-less system. After experiencing halt due to Covid-19 pandemic, a scooter sharing service finally started to be available again in Bangkok. Provider 1 has previously operated in Phuket, experiencing a break due to regulation issue. However, Provider 1 then firstly spotted in Bangkok on the beginning of September 2022 in a university area at Phayathai Road. A month after that, Provider 1 started to expand the service in alleys located in Phra Khanong which surrounded with residential, shopping mall, parks, and schools. The service provider is moving forward

to enlarge the area coverage in Bangkok, targeting universities and privately owned areas.

The main reason of targeting universities in providing the service is to serve the need for short transportation as in first- and last-mile. In fact, most riders use the service to travel less than 3 kilometer per trip. E-scooters itself is a small sized electric mobility which they believed could solve the parking problem in the city in addition to the congestion issue. Subsequently, Provider 1 chose universities as a deployment partner mainly because of the greyness of e-scooter regulation in Thailand which makes a privately owned area suitable as a sandbox project. Moreover, the infrastructure in most top universities in Bangkok are decent and biking friendly. It supports the convenience of deploying e-scooters sharing service in a sufficiently good area in terms of infrastructure.

Under the current state of regulation, the service provider does not require any permit from the municipal authority to operate in Bangkok, specifically inside the private area. The service provider needs to obtain a buy-in from the property owner. However, in the case of other cities in Thailand, Provider 1 has attempted to operate on a public road. In this case, Provider 1 has to get a permit but rather unofficial through the lens of legal and regulation. Knowing that the regulation of e-scooters is not clear, Provider 1 has their riding rule adopted from their headquarters' regulation in Australia. The riding guide were being informed in the application, such as: how to properly use e-scooters; prohibition to bring passenger when riding e-scooters; prohibition to ride e-scooters drunk; minimum age of 16 years old; and compulsion to park in a designated area. For the maximum speed, they set the vehicle to allow running at 25 km/hour, adopting the speed limit in some cities in Australia. However, the fleets' maximum speed is adjustable if the property host request for reduction.

b. Supplier

Supplier 1 sells a powerful model of e-scooters and considered one of the key players of e-scooters deployment in Bangkok. The company has started the business in Thailand for approximately five years. The reason of selling e-scooters in Bangkok was firstly intended to popularize e-scooter in the city, as they saw potentials in the market. The scooters that they offer are imported from China and South Korea, some are assembled in Thailand. Supplier 1 also provides an after sales service for one year, wherein within that timeframe customers receive an access of service centers for free. However, Supplier 1 does not accept scooter models of other brands outside their products. They also do not sell wearable safety equipment to comply while riding e-scooters (e.g., helmet and knee protector). But they offer an advance add-ons in the form of spare parts which they claim increase the user's safety (e.g., damping system and high quality tire).

Most countries have attempted to limit the speed usage, ranging from 20 to 30 km/hour for safety purpose. The existence of e-scooters with powerful motor triggers the curiosity of why those scooters is made at the first place. Supplier 1 explained that the speed limit of powerful e-scooters is adjustable for every situation that the users want. For example, users who want to use a powerful e-scooter as a regular e-scooter can set the speed limit into 30 km/hour. They can go further if intending to bring the scooter outside the city (e.g., mountain). Users could carry the e-scooters inside a car and use as a high performance scooter for recreational purpose. Analogically, in the motorcycle market, they have a regular motorcycle and a powerful motorcycle. Supplier 1 claim that the scooters they offer are the powerful one to fulfill the demand on the market.

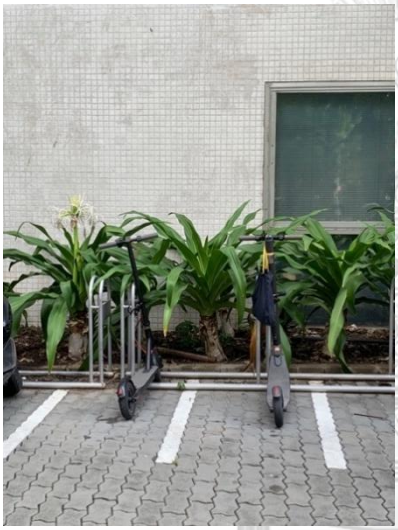
With the current state of regulation, it is interesting to know about what kind of permit that the supplier obtains to sell e-scooters in Bangkok. Supplier 1 explained that the business needs to be registered as a regular business who sells general

goods. They are required the pay taxes to The Revenue Department like other businesses do. In addition to selling scooters and providing maintenance service, Supplier 1 conduct a campaign on social media as well, such as YouTube and Facebook. Not only to make users aware of the safety when riding e-scooters, the social media are also utilized as their marketing strategy. To educate their customers, Supplier 1 allow the customers to try and practice using e-scooters in the store. Supplier 1 are mindful of customer's safety by uploading videos about tips and trick how to ride e-scooters on the road, such as: ride the scooter on the left side of the road; wear a safety equipment; and obey the rule based on motorcycle rule.

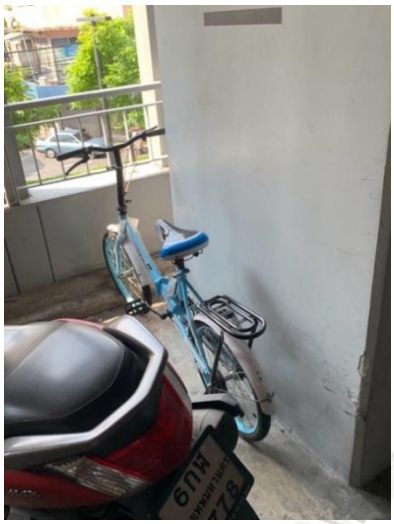
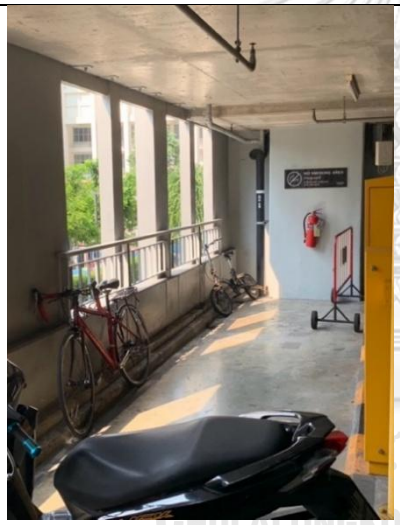
4.1.3. Field observation

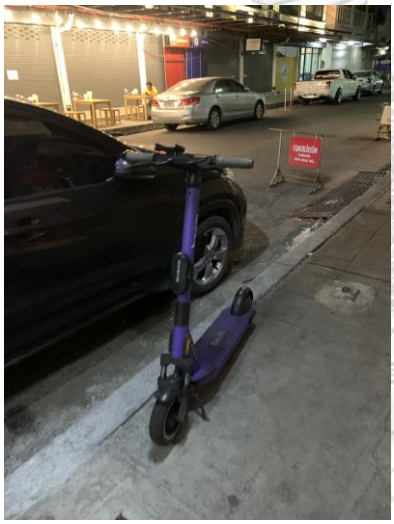
This section displays pictures and/or description (Table 4) that would be utilized to support the analysis and discussion in the next chapter. The field observation looks into the ecosystem's supply and demand, including the availability of bike lanes, parking spaces, service centers, as well as the practice of users.

Table 4. Field observation dataset

No	Picture	Description
1		The picture was taken at Chulalongkorn University. There are two e-scooters being parked in a multipurpose parking (bicycle and motorcycle). Both scooters are locked into the structures. Inside the university area, the author observed that the parking space availability is good and decent.
2		The picture was taken at Samyan MITRTOWN. There is a bicycle parking facility in front of the building. E-scooters, mopeds, and bicycle are parked adjacently. Some of the micro vehicle are locked to the bicycle rack. The space of bicycle parking is relatively large with a good condition.

3		The picture was taken at Chulalongkorn University. The bike lane availability is good and decent, where in it is unphysically separated from cars and motorcycle. However, the bike lane flow is one way, same as the car lane. This might be confusing for some users who wants to ride efficiently.
4		The picture was taken at Samyan area, wherein one of e-scooters supplier located. Beside offering a product of e-scooters, they also have a service center for the customers to maintain and fix their vehicle. They also have spaces for customers to try out the scooters before purchasing.
5		The picture was taken at Chulalongkorn University Centenary Park. There is a bike lane separated with car lane. However, this bicycle lane reaches nothing more than surrounding the park itself.

6		The author tried to crosscheck the information from User 3 about free parking spaces for both bicycle and e-scooters. The picture was taken in a motorcycle parking at Samyan MITRTOWN. According to the parking staff, bicycle and scooter users are exempted from the parking fee. The parking spaces are merged for motorcycles, bicycle, and even e-scooters.
7		In addition to Samyan MITRTOWN, Siam Discovery also provide a free parking spaces for both bicycle and e-scooters. The spaces are not merged with motorcycle parking. The parking spaces are equipped with bicycle rack for locking purposes.
8		The bike lane availability in several universities in Bangkok are indeed good and decent, such as Chulalongkorn University, Mahidol University, and Thammasat University. The picture was taken at Mahidol University Salaya Campus. The bike lane is a two-way lane with an adequate width.

9		There are many people utilize e-scooters sharing in Chulalongkorn University. Users rides e-scooters for short distance travel which usually takes less than 2 kilometers.
10		This photo was taken near Chulalongkorn University. A shared e-scooter was parked improperly in a sidewalk outside the designated parking zone. In fact, according to the service provider, there is around 6% of the users who do not park the scooters in a designated parking space.
11		This photo was taken inside Chulalongkorn University. Several e-scooters user brings a passenger while riding. People are neglecting safety to avoid high cost that the service provider charged per minute.

4.2. Thematic Analysis

In thematic analysis, there are six phases should be done so that reports could be produced (Braun & Clarke, 2006). To familiarize with the data, the author transcribes the interview results and translate some of the data into English. In the next step, twenty eight initial codes were generated. The author came up with nine themes with its own distinction. However, after conducting a review of themes, the author reduces the themes and come up with six themes: Supplier Availability, Infrastructure, User Practice and Knowledge, Safety, Regulation and Institution, and Scooters as an Option. The result of thematic analysis is depicted in a thematic analysis map on Figure 6. The six themes are reported and would be discussed in Chapter 5.

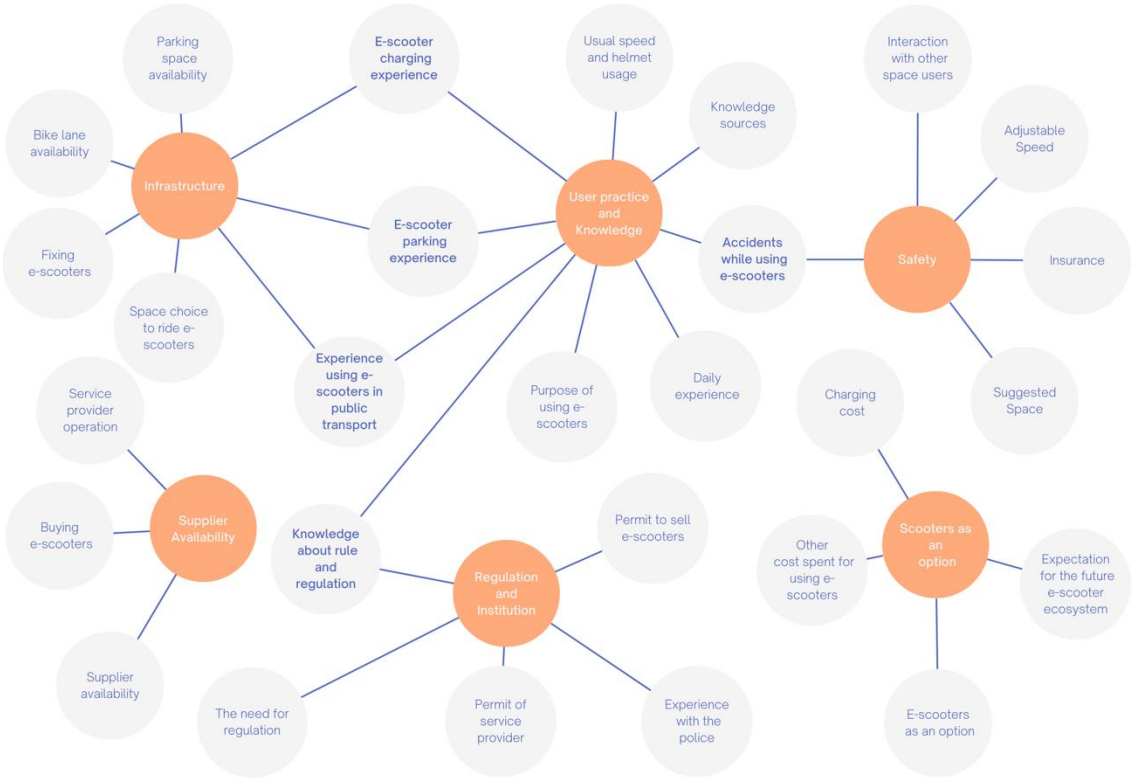


Figure 11. The map of thematic analysis

From the analysis, six themes were generated: Supplier Availability, Infrastructure, User Practice and Knowledge, Safety, Regulation and Institution, and Scooters as an Option. This chapter focuses on presenting discussions on each themes to assess the potential of developing an ecosystem for e-scooters in Bangkok.

4.2.1. Theme 1: Supplier availability

E-scooters are available both online and offline

Every activities in the city development requires the existence of its supply and demand. It applies to electric scooters implementation as well. In the economic principle, supply comes in when demands are available. Demands of e-scooters implementation could be from the market or from the government itself who wants to provide better transportation. In Bangkok, the supply-demand relationship of e-scooters implementation are fostered by the supplier and users. After e-scooters started to get popular in Bangkok in the past three to four years, people become more curious about the new type of transportation mode which believed able to make its user travel faster. Suppliers takes position to accelerate the popularity of e-scooters utilization in Bangkok. (Quote 1)

(1) "Since we start doing the marketing, because we are engaged in public, we produce content. And there is more and more customer to buy it. And the amount of buyer are increasing. And they require more and more performances. It's getting to be popular obviously three years ago."

Electric scooters could be purchased both in online and offline market. Among the stores of e-scooters are located in: Pathumwan, Sukhumvit, and Rangsit area. For the online stores, users purchased e-scooters on Shopee and Lazada. The criteria of choosing e-scooters are likely the performance (e.g. speed, battery

capacity), size (whether or not it is foldable, and the price. The prices of e-scooters vary among users (Table 5). The average of e-scooters price among participants is 15.500 THB which much cheaper than a motorcycle. The cheapest e-scooter that participants owned is 10.000 THB, purchased online from a relatively popular brand. Most of the price of e-scooters are cheaper than a motorcycle, except for User 3 e-scooter that is distinct from other users. User 3 own a fast and big e-scooters which could operates in 80 km/hour speed. (Quote 2 and Quote 3)

(2) *"Yes, I bought it from shopee. Three hundred dollar. Roughly thousand, hmm, 10.000 baht."*

(3) *"Hmm, I see it online, on the Facebook, and then I go to the shop at the, in Pathumthani, and then they let me try a lot of scooters there, so I can choose what performance that I like for my, for myself."*

Table 5. E-scooters prices among users

Participants	User 1	User 2	User 3	User 4	User 5	User 6	Mean	Median
Price (THB)	29.000	10.000	40.000	18.000	10.000	13.000	20.000	15.500

E-scooters in Thailand are mostly imported

According to Supplier 1, most of the e-scooters are imported from China and South Korea. There are some e-scooters that is imported as a vehicle, but there are also those which assembled in Thailand. The same story goes the same with e-scooters that Provider 1 utilized for the e-scooters sharing service. Although there is a supplier for that particular brand, they imported the vehicle from foreign manufacturer in China. Provider 1 also order the spare parts in case of the needs for service and maintenance. Importing vehicle from other country have a risk of inappropriate vehicle design for Bangkok's physical condition. If the foreign

manufacturer surely understands the situation of their market, the risk could be reduced. For the vehicle that is assembled in Thailand, the assembler could adjust to local situation, such as what Supplier 1 did in providing extra safety feature upon request for the vehicle. (Quote 4 and Quote 5)

(4) *"There is both (assembled in Thailand and imported as a vehicle). Yes, mainly from China and Korea. And there is some of micromobility that we import from the USA."*

(5) *"Yeah, the spare part we ordered directly from from Ninebot our suppliers so we have some spare already. It comes with the scooters when we first like, you know, ships the scooter into the country, right."*

E-scooters could be rented from service providers in some areas

For people who do not own e-scooters, service providers deliver a service of e-scooters sharing in some location. As for now, they operate in several universities and private property in Bangkok. The service provider wants to serve the demand for short distance travel as well as the first- and last-mile transport. In fact, most of the users of e-scooters sharing ride for around two to three kilometer in average. Provider 1 believes that, besides answering the congestion problem, e-scooters could be used as a tool to manage the parking problem. In the future, Provider 1 and other service providers are working towards providing more e-scooters sharing service as a transportation option in Bangkok. (Quote 6)

(6) *"I think it can serve with the the short transportation as a first mile last mile, which for us be, from what we operate, we see that most riders tend to to use the scooters for around like maybe two- or three-kilometers max."*

Fast e-scooters have its own market

The first thing came up into people's mind when seeing e-scooters run very fast in Bangkok's road would be the rider's safety and other road users' safety. Having no rules and regulation, there are groups of users who ride e-scooters more than 30 km/hour or even more than 50 km/hour. It was due to the supply of a powerful and fast e-scooters were made. Judging for its safety, the faster the e-scooters' speed could induce the risk of getting injured due to accidents (Nikolaj et al., 2019). However, according to Supplier 1, the purpose of a powerful e-scooters is its flexibility to be utilized in different situation. Users could use it as a regular scooter because its speed limit is adjustable. However, if the users want to utilize it in other situation (e.g., leisure activities in other provinces), users could go with the powerful engine. (Quote 7)

(7) *"Because, it can be used in many occasion. When it has high speed limit, customer can choose the speed limit within its range. They can use it as a regular e-scooter "25 km/hr" or if they go to other provinces, they can put it in their car and they can use as a high performances. It answers the demand in the bigger scale."*

Summary of Theme 1

The summary of discussion for Theme 1: Supplier availability is shown in Figure 12 bellow.

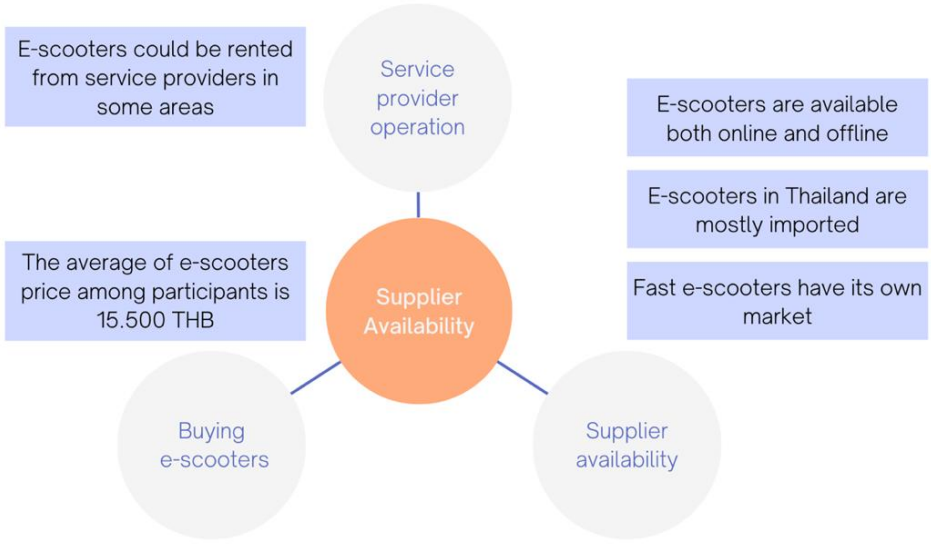


Figure 12. Summary of Theme 1

4.2.2. Theme 2: Infrastructure

There are barely bike lanes, except in universities area

E-scooters lack specific facilities for travel, which makes them often engage with their surroundings because to the usage of shared infrastructure (such as sidewalks and roads) with other users (Ma et al., 2021). Most e-scooter riders in Virginia have been shown to favor bike lanes over other areas, such as sidewalks and roadside areas, for their rides (Lanza et al., 2022). Riding on bike lanes is more pleasant since riders do not have to adjust to the speed of pedestrians or keep an eye out for large cars on the road. Another good side is that bike lane could reduce the risk of getting injured due to accidents compared to the road (Lanza et al., 2022). However, riders would have no other choice to use the roads if there are insufficient bike lanes availability.

According to data from Bangkok GIS, the bike lanes in Bangkok are only around 128 km in total (bike lanes on private property are not included). With this length, people question the bike lane availability in the city. All participants assess that bike lane availability in Bangkok is insufficient. Moreover, to accommodate the

rising trend of micromobility, availability itself is not enough. The bike lane quality should be good, comfortable, and well maintained to build trust for people to use micromobility even more in the bike lane. User 5 thinks that there are actually spaces for bike lane in Bangkok, however, in comparison with other ahead cities (e.g., Shanghai, China), the bike lane in Bangkok is less safe and less comfortable. (Quote 8 and 9)

(8) *"I want to ask a question that, the Bangkok have the bike lane? I didn't see that before."*

(9) *"They're not good. So I know there is space, but for me the comparison, so I lived in Shanghai before here and they have designated lanes for electric bikes and bicycles and scooters, and they were very well maintained. Very safe, so here I'm I'm very cautious about riding on the bike lanes because they're not trustworthy."*

Nevertheless, opportunities and chances for e-scooters utilization comes through the approach of universities. The bike lane availability in most universities in Bangkok are good and decent (Table 4: No 3, 5, and 8). E-scooters users who rides inside a university area are pleased with the bike lane. Not only the users, but Provider 1 also agree that the bike lane availability in most of the top universities in Bangkok are sufficient. Indeed, bike lane availability is also one of the reasons of e-scooters service provider to choose universities as their strategy to deploy the e-scooters sharing service. Logically, if the bike lane availability is good service providers would not worry about the safety of riding e-scooters for their users. In addition to that, avoiding conflicts with other road users would be the best way to keep the business be accepted and perceived positively. (Quote 10 and 11)

(10) *"Yeahh, so I think the bike lane in Chula is good."*

(11) "For Chula, here in campus of course most of the area they have bike lanes. So this is our first choice. So if you see bike lanes. Please go to the bike lane. Most of the top university in Bangkok. We believe that they have bike lanes inside campus."

E-scooters are usually parked with a personal lock

Parking spaces are another important infrastructure for the use of e-scooters in the city. When e-scooters are parked incorrectly, they raise the possibility of making other people feel uncomfortable about invading the space (Zagorskas & Burinskiene, 2020). Indeed, the absence of parking spaces may increase the possibility of vehicle theft (Chen et al., 2018). Most scooter riders in Bangkok would park their scooters in the bicycle parking and secure the scooters to the structure (Table 4: Pcture 1 and 2). If they could not find a structure in the parking space, they would lock the vehicle's tire so that the e-scooters could not be moved. Users discovered that e-scooters are easily stolen if they are not locked. (Quote 12 and 13)

(12) "Yeah, I just lock it at.. I already lock it as... Ahh, more than that, it's just a bicycle station, I don't know how to call it, the bicycle parking and the motorcycle parking. So, if I go to the bicycle parking, they have aaa, a frame, so I can just lock with my chain to the structure. So, if I go to the place that there is no structure, I just lock the back wheel, yeahh, so they cannot push my scooter."

(13) "I will park it in front of my office, but they don't have, like, a lock to anything. Just lock my wheels to the body of the scooter. So, they can't turn the wheels."

Parking spaces are perceived into two views

The availability of parking spaces for e-scooters or bicycles in Bangkok is determined by the user's perception of the space to park their e-scooters. First, considering e-scooter parking spaces as bicycle parking. In this situation, not all buildings would provide safe e-scooter parking places and some users may remark that it is difficult to find a designated parking area for their scooters, forcing them to carry the scooters with them. (Quote 14)

(14) "It is hard haha. I usually park my scooter with myself because when I go to the shopping mall, I prefer to ride aaa carry with me, not to park somewhere because it is easy to get stolen. Yeah. But when at the school I have park a personal parking space, so it's not a problem"

Second, defining an e-scooters parking the same as motorcycle parking and any spaces. That would make users feel that as long as there is motorcycle parking, they may park and secure their scooters beside motorbikes. Indeed, it is discovered that in many buildings in Bangkok, they provide free parking spaces for bicycle to be parked in a motorcycle parking. E-scooters are also exempted to be parked there with a proper security level. If integrating motorcycle parking with other micro mobilities and announce it well to the public, this would make a trust of the opportunity to better deploy the utilization of e-scooters in Bangkok. (Quote 15 and 16)

(15) "Yes, I I think I think it's easy to parking. Yeah, because e-scooter is small to parking, can fold."

(16) "But here, you can park at the motorcycle parking lot at the Camchuri Square, for free (laugh). They look, ahhh, they see e-scooters like a bicycle. So, they not charge for parking (laugh). Many, many buildings like that."

In e-scooters sharing service, parking spaces are perceived easy to be defined. Since the scooters have its own technology to lock the vehicle by itself, the e-scooters parking does not require any structure for safety purposes. The dock less system of e-scooters sharing reduce the need for a “bicycle parking” infrastructure provided by either service provider or the landowner. In the case of Provider 1, defining parking spots have several criteria: the origin and destination of where the travels are made, the location of public transport station, and so on. However, for several case, Provider 1 have to collaborate and fit the request of the landowner.

(17) *“First thing is that our parking spot we require no attachment at all. No rack, no bicycle rack. Scooters, it can lock itself. Uh, when it's not in use, right? So to determine the parking spot there quite many factors.”*

Users could charge in a private property if it is allowed

When electrified mobility comes in, the issue of fulfilling the energy need could not be separated from its operation. E-scooters need to be charged but normally do not require special charging plug. Most e-scooters users in Bangkok would likely to charge at their home every day. However, if they are running out of battery outside, they would rely on facilities on coffeeshop, workplace, and university. Charging on that facility is possible if they allow e-scooters users to utilize the electricity there. But, in some places, charging e-scooters are prohibited. In this case, there is a need for e-scooters charging station on the city, however, the necessity to provide it would require more investigation whether e-scooters charging station are worth to be built.

(18) *“I ever charge here, in the library, when they told me not to like, the like, they didn’t allow us to charge like a, anything rather than aaa the aaa the*

ipad, the macbook. So, yeah, it's not allowed to charge our scooters in here."

(19) "Uh, yeah I I have charged on other place when I I go to café, I can charge at at the cafe too yeah and we charge in my workplace."

Service center availability is sufficient

Vehicle maintenance is typically considered as an inevitable transportation expenditure (Murthy et al., 2002). Nonetheless, vehicle maintenance is an important activity for improving the safety and reliability of transportation operations, as well as important to extend the life of a vehicle (Dobromirov et al., 2018; Shafi et al., 2018). In terms of maintenance, electric scooters are no different from conventional vehicles. E-scooters require regular, but not frequent, replacement of brake pads and tires. Furthermore, if users have recently had accidents, it will ruin various sections of the scooters, necessitating the requirement for a service centers facility. (Quote 20)

(20) "It's not uhh, in a month, no, no need to repair anything in a month, but uhh, it's around six months. I have to change, uhh, the brake pads, yeah."

Surprisingly, the number of service centers in Bangkok is enough for several manufacturers. Customers of that particular brand have access to service centers. In certain circumstances, the maintenance service is included in the guarantee provided to clients for a set period of time. Supplier 1 claimed that they would always accept request for maintenance from their customers. To make sure of the spare parts availability, Supplier 1 would only accept e-scooters models that they commercialize. However, consumers of some manufacturers who do not have service center networks in the city may find it difficult to fix their scooters if difficulties arise. Users must take special precautions to keep the vehicle in good condition. Alternatively, users must repair their own scooters. Spare parts for some

brands are commonly accessible in the internet market, either locally or internationally. (Quote 21 and 22)

(21) *"Uhhh, I can, I can take it to the shop that I buy it, they have another shop at Phra Ram 2, maybe if it's not require so, like a, like a, manpower, like a stronger than me, I can fix it myself. Because it has, uhh, many parts online, I can buy."*

(22) *"Yes, we have after sales service for one year. We have our service center located in Rangsit. But, we don't fix any e-scooters, we only fix our own brand. Because we are sure that we always have the spare parts."*

E-scooters are allowed on public transportation

To address the advantages and opportunity of e-scooters integration with public transportation, this research also investigates the current situation of e-scooters usage in public transportations. E-scooters are allowed to be brought in public transportations (Bus, BTS, and MRT) as long as it is folded. Most of e-scooters model are foldable, except for the powerful one. Regular e-scooters are more suitable to fill the gap of public transportation for not being door-to-door. Users of regular e-scooters in Bangkok have integrated the use of e-scooters with BTS and MRT for more accessibility. In addition to that, referring to Provider 1's goal to provide first- and last-mile service, many of the customers use e-scooters to transport from the BTS/MRT stations to the university. (Quote 23 and Quote 24)

(23) *"Yes, I I bring my scooter to BTS and MRT. It's very comfortable for me, yeah. Is easy if I use elevator elevator. And sometime. I use. A train, yeah. So I pick up to a train. To also to move move to other places."*

(24) "The place I go, well, the university, King Mongkut North Bangkok and Samyan Mitrtown, which also I ride on the take a MRT too. I have to fold it and carry with my hand."

Summary of Theme 2

The summary of discussion for Theme 2: Infrastructure is shown bellow.

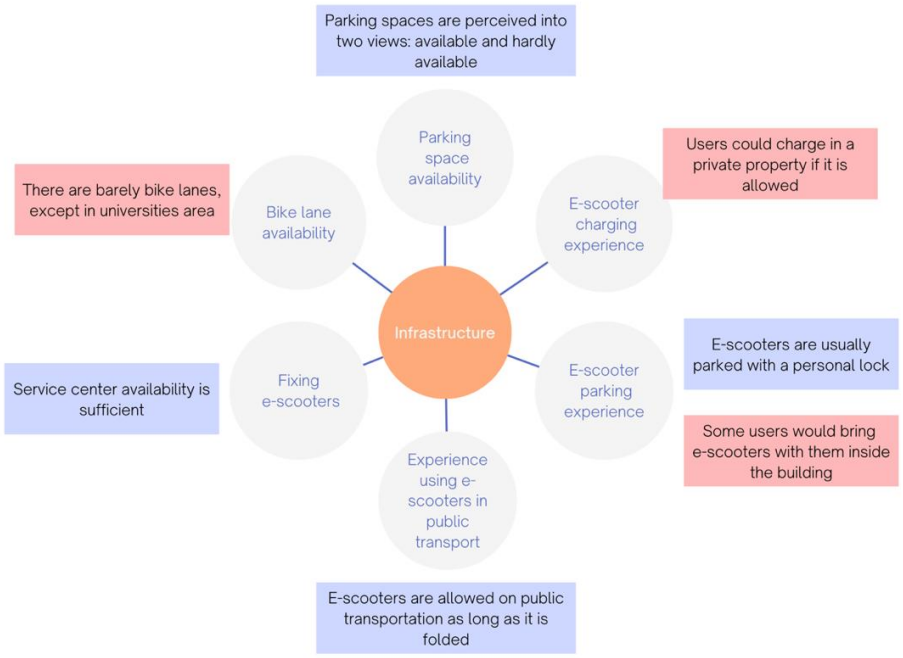


Figure 13. Summary of Theme 2

4.2.3. Theme 3: User practice and knowledge

Participants use e-scooters as a main transportation mode

E-scooters could be utilized both for leisure purposes and main transportation mode to support daily activities. In Phayathai Road areas, all participants utilized e-scooters as the main vehicle to transport from their residential to either school/university or workplace destination. Some users also integrate the use of e-scooters with public transportation to get a seamless experience of faster mobility. In average, users travel with e-scooters for 4.5 kilometer a day (Table 6). However, it could be more or less during weekends. (Quote 25 and 26)

(25) "Yes, uhhh, because of the, uhhh, before I'm using the scooter, I use bicycle for work, far from my living about 5 kilometers. So, sometimes the weather is very hot and I choose something else, to make my travel more easier and, like a, I can travel far, far from usual."

(26) "I have to transport to other place yeah, because my my job I have to go condo all in Sukhumvit area. Yeah, so I use scooter because very fast to transport. It can I can take in BTS or MRT or Airport Link to transport"

Table 6. Daily travel distance among users

Participants	User 1	User 2	User 3	User 4	User 5	User 6	Mean	Median
Distance	5 km	4 km	10 km	3 km	4 km	30 km	9.33 km	4.5 km

Speed usage depends on the vehicle's maximum speed

The lack of laws and restrictions may be perceived as giving users more freedom in how they use their e-scooters. As a result, users in Bangkok are exposed to risky riding, which may result in an accident. While users of electric scooters in some countries are restricted from exceeding particular speed limits, users in Bangkok utilize the maximum speed of their scooters as their limit. Regular e-scooters model normally able to run at 20km/hour to 30km/hour. Unless they are engaging with people on sidewalks or on the side of the road, users have little possibility of using an average speed less than their maximum speed. Users believe that the maximum speed of their scooter is reasonable and safe. (Quote 27 and 28)

(27) "Ahhh, normally, I use as 25 km/hour and it's the maximum limit that my scooter can ride."

(28) "Well, for riding, this kind e-scooter is about 30 km max so I ride at about 30 km max because well 30 km is too slow but I'm good at it."

Table 7. Speed usage among users

Participants	User 1	User 2	User 3	User 4	User 5	User 6	Mean	Median
Usage (km/hr)	30	20	50	25	25	30	30	27.5
Max (km/hr)	30	20	80	25	25	30	35	27.5

However, it has also been seen on the road that certain e-scooter models are capable of running as quickly as a motorbike. These e-scooters are available for purchase from both online and in-person retailers. The size and weight are often substantially larger and heavier than standard electric scooters. Riders may view the traffic through the above cars at the front when they stand up. Because their top speed exceeds 45 km/h, these vehicles are not eligible for either electric scooters or micromobility. Because there is no clear definition of what constitutes an electric scooter in Thailand, this sort of e-scooter is given the same legal status as ordinary e-scooters. As a result, users of rapid e-scooters must rely on their own discretion to ride at a specific pace for their own safety. (Quote 29 and Quote 30)

(29) *"And the speed, I usually use around 50 kilometers. Maximum for the scooter is about 80."*

(30) *"I have one that it goes about 55 kilometres very fast. Uh, that one if I use, I go roughly 35 kilometres. The one I have now that I use most is the Xiaomi. And it goes 25 kilometres per hour."*

Speed limit of e-scooter sharing adopted from other country

Provider 1 utilize a speed limit of 25 km/hour for the operation of e-scooters sharing. The model of e-scooters that they use itself could run faster than that. Since there is no speed limitation in Bangkok, Provider 1 limit the speed usage by adopting the maximum speed restriction from their headquarter country, Australia. Not only

applying that speed limit to Bangkok, but Provider 1 also applies to other cities in Thailand (Chiang Mai and Phuket). Provider 1 believes that 25 km/hour is the best speed for the current implementation. Moreover, the partners also agree to set the speed limit of 25 km/hour. If the speed is set too slow, it would be dangerous to cross the street between two sides of a university which might fail the users to keep up with the traffic. (Quote 31)

(31) "We got it from our, uh, another market which is Australia. They had the regulation about the speed limit, the safety measure and everything. So we kind of apply that from Australian market. And to share in Thailand overall. Uhm, in Bangkok in Chiang Mai, Phuket, we do 25 km/hour"

The slower the speed, the more likely not to wear helmet

The use of helmets by scooter users varies depending on their judgment and knowledge. It varies from other nations that have explicit norms and regulations requiring e-scooter riders to wear helmets. In Bangkok, helmet use may one day be linked to the maximum speed of their electric scooters. Half of the participants wear helmet while riding e-scooters (Figure 7). Users are less likely to wear helmets if the scooter's speed is slower because they believe it is already safe. However, those who ride at a higher pace and with more intensity will most likely use helmets as protective equipment. Users whose speed is equal or more than 30 km/hour wears helmet (Table 8).

(32) "So, I didn't wear like anything to protect myself, but actually my scooter max speed is only twenty kilometer, so it's a bit slow."

(33) "I don't wear a helmet. The speed I go. The one I have now that I use most is the Xiaomi. And it goes 25 kilometres per hour."

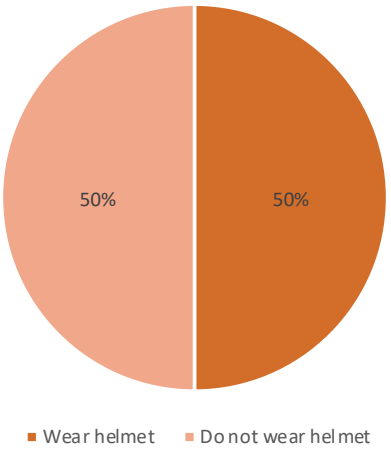


Figure 14. Helmet usage

Table 8. Helmet usage among users

Participants	User 1	User 2	User 3	User 4	User 5	User 6
Speed (km/hr)	30	20	50	25	25	30
Helmet use	Yes	No	Yes	No	No	Yes

Road is still a chosen space to ride e-scooters

Because it is tied to contact with other space users, space usage is an interesting issue to examine. E-scooters are not permitted to be used on sidewalks in several countries (for example, France and Germany). Some jurisdictions (for example, Singapore and Victoria) permit the use of e-scooters on the sidewalk with speed limitation. While some nations aim to limit or prohibit the use of e-scooters on pedestrian paths with a regulation, the space choice for riding e-scooters in Bangkok is determined by the state of the infrastructure. Most riders choose to ride on the road since it offers greater comfort than riding on the sidewalk. The state of the sidewalk makes it difficult to ride e-scooters there. Furthermore, they prefer to interact with vehicles and motorbikes rather than pedestrians since they must slow

down if they pass by on the sidewalk. However, some most users prefer to ride on bike lanes if the availability and quality are good. (Quote 34 and Quote 35)

(34) *"So I'd rather ride in the road where the road surface is more reliable than a a bike lane that has lots of holes in."*

(35) *"Well, if there is a bike lane, I would prefer ride on bike lane, but in Thailand bike lane is not often see as the road and sidewalk, but I prefer to ride on the side aaa on the road"*

For a powerful e-scooters, the space choice is tightly connected to the safety of the riders and other road users. It would be risky to ride on sidewalk or bike lanes knowing the current situation of its availability and quality. The risk of accidents would be higher if those users ride on sidewalks and bike lanes. (Quote 36)

(36) *"Yes. Mostly on the road. Because my scooter, when you're using the powerful scooters, like you use a motorcycle. Yeahh, because it's too fast. Maybe some of the sidewalk, like a, have a, what's it called, not, not like a straight. You cannot control your scooter"*

Users are aware with some issue of e-scooters

Even though Thailand currently does not have a clear regulation of e-scooters utilization, users in Bangkok are aware of that. Most users understand that e-scooters in Thailand are illegal to be operated on the road. Users are unable to obtain a license plate because the vehicle itself is not recognized. Users are also aware that there are no riding rules in Thailand, but they are trying to find information on the internet of the good case in riding e-scooters from other countries' perspective. When riding on the road, users tried to ride as safe as possible on the left side of the road. (Quote 37)

(37) *"Uhhh, I already searched it. Maybe, around one year ago, they say that e-scooters is between the bicycle and the motorcycle. Because, the e-scooters there is no lot power, then you can't just register as a motorcycle, yeah. Yes, so, we cannot count it as motorcycle, and we cannot count it as bicycle. So, it's a very grey area. You cannot just register for the, I don't know how to call it,* ทะเบียน. *Yeah, the license plate. So we, I cannot go to the main road, because I don't have the license plate. Yeah. And, I cannot ride on the walk path because this is not the bicycle, so it's really the grey around here."*

Another issue of e-scooters utilization among countries across the world is parking issue. In Bangkok, Provider 1 claims that only less than 10% of e-scooters trips made by the e-scooters sharing are violating the rules that Provider 1 has set. The awareness of users might be associated with the fines that Provider 1 would give if the riders do not park the scooters in a designated area. (Quote 38)

(38) *"Yeah, so basically we have the convenience fee like extra fee charge right when you park outside parking spot. But here Chula I can say that from the, this two months of operation, I can say that there are less than 10% of the trips the are not parking around the parking spot."*

Service provider and supplier are aware of delivering essential knowledge

Most e-scooter users in Bangkok have obtained essential knowledge about e-scooters utilization through several sources, such as social media groups, websites, and news. Not only that, the service provider and supplier also provide essential knowledge of riding e-scooters. Provider 1 deliver the knowledge through their application platform with a specific menu for riding rules. Often times, Provider 1 push a pop up message to the riders about the safety measure for riding e-scooters.

Provider 1 also posted the safety rules on their social media as well. They keep updating the safety rules, but currently (December 2022), the safety rules that they provide include prohibition to ride while getting drunk, minimum age of 16 years old, prohibition to take passengers, riding and parking in a designated area, suggestion to ride on bike lane and sidewalk. Not only providing the knowledge access, Provider 1 also let customers to try out the e-scooters in some event. (Quote 39)

(39) *"Normally we have two things. One is the riding rules that will always be there on the application when you can, yeah, you can go to that section, but. Uh, another thing is popup message. On the application as a pop up message when when you open the application or even on our social media, we we post a lot about safety measure like how you should ride dos and don'ts."*

Similar to Provider 1, the "demo" activities are also available when purchasing e-scooters on Supplier 1. Customers that came to the showroom are allowed to try out the vehicle before deciding to buy it. According to Supplier 1, e-scooters have a low learning curve, meaning that it is easy to be used. For instance, customers that came to buy, they can practice and use it instantly if they have the ability to ride bicycle. But, in some cases, they don't even have experience in riding bicycle, but they can still use it. Supplier 1 provides an education channel for customers through YouTube, and it has gained a lot of exposure to public. The safety rules that they provide include how to ride e-scooters, where to ride, rule obligation, and safety equipment suggestion. From the investigation, it is found out that the information are provided only in Thai language and most of the content are basically review contents for marketing purposes. (Quote 40)

(40) *"Customers that came to buy, they can practice and use it. But the thing we do to educate is how to use e-scooters in public with other people. We*

have YouTube channel, we make a content of tips and trick how to ride on the road, for instance, use it as a same as motorcycle. Saying, ride it on the left side on the road, wear the safety equipment, and obey the rule, but based on the motorcycle rule."

Summary of Theme 3

The summary of discussion for Theme 3: User practice and knowledge is shown in Figure 15 bellow.

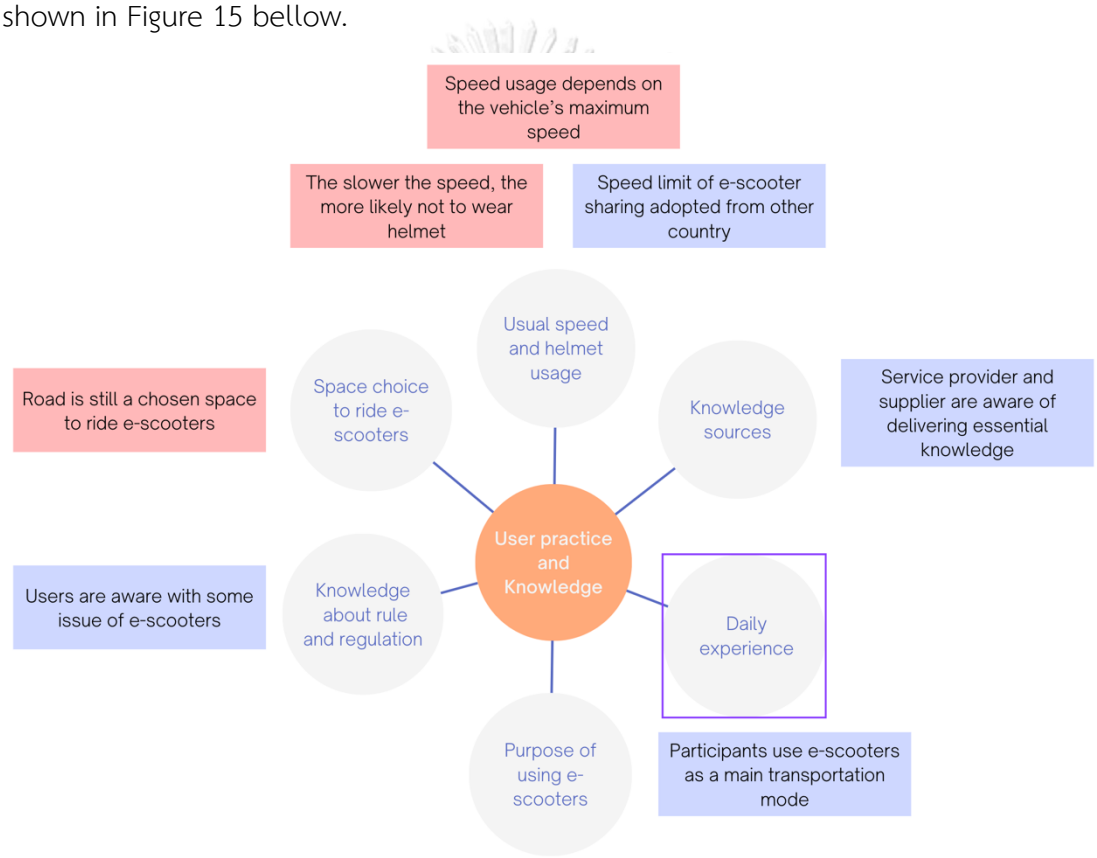


Figure 15. Summary of Theme 3

4.2.4. Theme 4: Safety

Riding on sidewalk is unsafe for both riders and pedestrians

As many users choose to ride e-scooters on the road rather than sidewalks, it is discovered that riding e-scooters in Bangkok's sidewalk is inconvenient, leading to

an unsafe riding. Users have to reduce their speed to 10km/hour when interacting with pedestrian. Moreover, for a powerful e-scooters, it is quite tricky to ride on the sidewalk. Users of powerful e-scooters would prefer not to risk the safety to ride on the sidewalk. In addition to that, the condition of sidewalks in Bangkok are not uniform. Supplier 1 claims that most sidewalks in Thailand are not suitable for vehicle with wheels because of several reasons. Firstly, there are barely slope for riders to shift between sidewalks or to the road when needed. Second, the quality is inadequate which could reduce the comfortability of riders. Lastly, the space of the sidewalks is limited which for pedestrian themself is already narrow. Riding e-scooters on sidewalks. (Quote 41 and 42)

(41) *"I will not ride the scooter on sidewalk because it's very powerful. And.... It's.... it's a bit bigger than the Segway (brand) and something else. And, I think it's, it's like a, if you use it on sidewalk, maybe not, like a, maybe not the security."*

(42) *"For the footpath, its purpose is for pedestrian. If there is any vehicle on it, it will make them uncomfortable. Especially, the footpath itself in Thailand, it does not suit for any vehicle with wheel."*

Accidents are associated with speed usage, quick reaction time, and infrastructure

Accidents using e-scooters become a big concern due to the user's vulnerability to injury. Electric scooters travel quicker than unpowered micromobility, which causes collisions. Faster electric scooters may cause injuries, reinforcing the suggestion to require the use of protective helmets (Nikolaj et al., 2019). The maximum speed of the fleet has been linked to incidents among Bangkok e-scooter riders. One of the users has never been involved in an accident while riding the scooter. It is stated that their speed maximum is 20 km/hour, equivalent to the

speed of a standard bicycle when the riders are in a rush (Jensen et al., 2010; Thornley et al., 2008). (Quote 46)

(43) *"Not yet (laugh) I think not yet. Because like, I'll be aware for like during driving on the road, and I'm being aware a lot. Yes, the speed is too slow, only twenty kilometer per hour, so, not yet hahaha."*

Table 9. Accidents among users

Participants	User 1	User 2	User 3	User 4	User 5	User 6
Speed (km/hr)	30	20	50	25	25	30
Accidents	3 times	Never	2 times	2 times	1 time	2 times

Other participants, on the other hand, have been in accidents more than once. Accidents might be caused by the infrequent use of safety equipment, such as helmets, as well as the high speed and short response time associated with riding an e-scooter (Störmann et al., 2020). Some accidents in Bangkok are attributed to users' short response time when detecting obstructions on the road, such as asphalt holes. The incidents do not necessitate surgical suture but are painful enough to cause bleeding. Despite the short reaction time to obstacles, the instance depicts that the quality of infrastructures (eg. roads and sidewalks) are another component that causes mishaps of e-scooters. (Quote 47)

(44) *"So, there is a hole, a deep hole on the floor, I just go and I didn't see the hole, and I just "buzz", and I fell out from the scooter and yeah. I got some blood, but not that much. It's just some bleeding, just yeah yeah, just there is nothing."*

Another reason of e-scooter accidents, which is also linked to a rapid reaction, is not being acquainted with how to use the scooters. Some e-scooter brands, for example, include a sensitive braking mechanism. When the user is confronted with an unexpected event (for example, an asphalt hole or a car accident), the user falls onto the road after over-pushing the hard brake. Even if there is no blood, the injury causes severe pain in the user's head. (Quote 48)

(45) "Yes, some. Some of the some motorcycle is stop and they don't notice I'm behind, yeah, so I think scooter is, scooter brake is very umm well it is really short to brake, yeah. So yeah, they have an accident."

Accidents bring more awareness to wear safety protection

Interestingly, one instance illustrates that customers continue to rely on electric scooters despite numerous accidents. User 1 rides standard e-scooters at a substantially faster speed of 30 km/h than other types. When compared to User 2, who never had an accident with their 20 km/h e-scooters, it shows that quicker speed increases the likelihood of an accident. Even if the user is not required to seek medical attention, the incidents cause harm and are classified as serious accidents. Because the user wears a full-face motorcycle helmet to protect his or her head, this may also aid. In fact, User 1 employs more safety precautions than other participants, which is most likely related to the accident experiences that compel User 1 to protect themselves if similar mishaps occur. Users who have had more accidents are more inclined to wear helmets as protective gear. (Quote 49)

(46) "Oooohh (excited) a lot of times. The last time I had is when because I try to signal the car to turn left but (ahh) I can't balance so I crashed it at about 20 km, I don't get hurt but the scooter hand just punches me at the

my aaa at my bottom. But it's not really bad accident. The last bad accident was about one month ago, when I fall into sewer pipe."

Figure 16. User 1 wears a full-face helmet and a safety shoes

Service provider is willing to provide safety helmet if required

Currently, Provider 1 does not prioritize the provision of safety equipment because there is no regulation for the use of e-scooters in Bangkok. In order to comply with the regulations, they supply safety equipment in other countries. However, Provider 1 would prefer to test the deployment without helmets in Bangkok first. Despite this, they are happy to offer a safety helmet if needed by law. (Quote 47)

(47) "So, uhm, we have helmets in Australia and New Zealand because they have the rules that the riders have to wear helmet. But here in Thailand we have no rules. If there's a regulation specific regulation, and they say, you have to wear your helmet. Beam is more than happy to do that. And and, and so we'll. We would try off with with no helmet first and and and see how it goes."

Insurance is provided by service providers

On the service provider side, if customers of e-scooters sharing are involved in an accident while using the e-scooter sharing service, they can claim medical bills through Provider 1's sharp insurance. Users are able to claim the insurance if they adhere to the proper safety measures, such as not riding under the influence of alcohol (sober) and not carrying passengers when riding. The program would require users to ride safely so that they could collect insurance if an accident occurred. (Quote 48)

(48) "For for riders, we have riders insurance. You can claim if you got into accident. Uhm, ridings on beam via code. As long as you are riding under the specific safety requirement. Such as your are not drunk, you only ride one person or per one scooters or something like that. You are covered by our insurance provider."

E-scooters maximum speed can be adjusted if required

According to Supplier 1, the maximum speed of fast e-scooters is able to be modified depending on the purpose and use needs (Quote 49). Users may operate the scooters like ordinary e-scooters, with speeds ranging from 20 to 30 kilometers per hour. However, if customers wish to go further and use the e-scooters for recreational activities in other provinces (for example, tracking), they may take use of the scooter's strong speed.

(49) "When it has high speed limit, customer can choose the speed limit within its range. They can use it as a regular e-scooter of 25 km/hour."

Service provider also claims that the maximum speed of e-scooter sharing service could be adjusted as well. Provider 1 are willing to reduce or increase the speed limit according to the partner's requirement. Indeed, currently, Provider 1

have implemented “slow zone” in several areas so that e-scooters’ utilization are limited to slower speed (15 km/hour) in designated area. (Quote 50)

(50) *“You know, the limit we can adjust if, uh, our partner, let's say Chula, they see that it's too fast.”*

Riding on the road is suggested for fast e-scooters, while bike lane is suggested for regular e-scooters

Because it is tied to contact with other space users, space consumption is an interesting issue to be discussed. As previously discovered that users of regular scooters who prefer to ride on bike lane chose to ride on the road due to infrastructure condition, there are suggestions came from different group. Riding on the road is preferable in particular for fast e-scooters model. Supplier 1 believes that fast scooters are not suitable to run on the sidewalks for its safety and convenience. For the bike lane, fast e-scooters are way faster than other micromobility, which could induce the risk of unsafe and inconvenient riding for both riders and other micromobility users. Thus, road is considered to be the most suitable space to ride e-scooters according to Supplier 1. (Quote 51)

(51) *“I think, we should add a regulation about speed limit in some area like any other car or motorcycle. Because, it (fast scooter) is a vehicle that is not suitable for the footpath. For the bike lane, I have a 50-50 opinion, because, some of the scooter model are faster than bicycle. For me, the road is the most suitable.”*

Meanwhile, Provider 1 who operates with regular e-scooters suggests differently. Provider 1 suggests the users to choose bike lanes over sidewalks and roads. However, if bike lanes are not available, they suggest the riders to choose sidewalk and stay aware of other road users. The different perspective might be the

result of operational area as well as the e-scooters model itself. Provider 1 use a 25 km/hour scooters to operate in a university area with a good condition of bike lanes and sidewalks, so they suggest the riders to prioritize riding on a bike lane. (Quote 52)

(52) *"So if you see bike lanes. Please go to the bike lane. So then, if not, when you want to go to maybe Banthatthong Road as you say Phayathai Road that you say right? You want to ride from Chula to Siam or vice versa. I think from this kind of area this kind of Road, uhm, I would suggest riders to ride on the foothpath."*

Summary of Theme 4

The summary of discussion for Theme 4: Safety is shown in Figure 17 bellow.

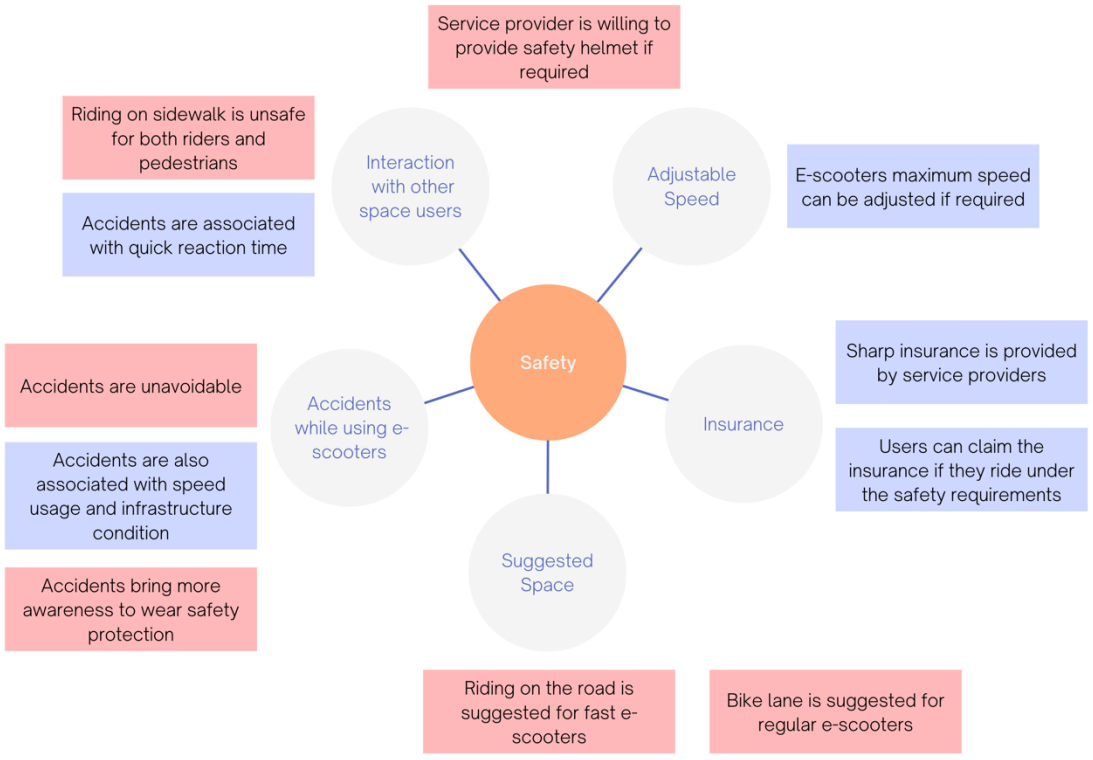


Figure 17. Summary of Theme 4

4.2.5. Theme 5: Regulation and institution

E-scooters are illegal on the road

Referring to the current regulation, e-scooters is considered to be unregistered vehicle which illegal to be operated on the road in Thailand. Most users understand the legal status of e-scooters utilization, but e-scooters remains as one of a transportation options for people in Bangkok because it brings positive impacts to the users. The unclear status of e-scooters often makes users come up with question of where they should position themselves when riding e-scooters, such as space choice and rule obligation. Some politicians might say that e-scooters could follow the bicycle rule, but users might argue that e-scooters are different for either bicycle and motorcycle, particularly in terms of the speed. (Quote 53 and 54)

(53) *"Hmm, it's, noooo, like a, no rule for scooter in Thailand, but ahhh, if you use it on the road in Thailand, uhh, it will illegal, but like a, many people still using it on the road."*

(54) *"There is no rule about scooter, it is just empty space, empty rule, they just told us to be aaaa bicycle, but we aren't just bicycle because when we aa we can't lie on the aaa pedestrian way, also on the road, but there is a question that if we are not as e-scooters then what are we?"*

Police rarely caught e-scooters users in Bangkok

The unclear regulation which positions e-scooters into an illegal vehicle to be operated on the road supposedly triggers the police to penalize the users who rides e-scooters on Bangkok's road. However, it is discovered that all participants have never been caught by the police when riding e-scooters. User 1 argue that the police would care about the helmet usage, meaning that as long as users wear helmet for their safety, it would be acceptable. User 5 believes that as long as they

use the scooters properly for commuting purpose, the police would not find any issue. (Quote 55 and 56)

(55) *"Well, the police just, because normally the police aaa just don't care about us, they just care about aaa helmet. Yeah."*

(56) *"Not yet, and fine so far in Bangkok. No I I go past police regularly or they're outside my work helping traffic. And they don't seek the care that I'm on the street or maybe here they know I'm not a tourist and I'm going to work, so they just. Leave me, but no, not here. I haven't experienced any issues yet."*

Service providers does not require permit from the government

Under the current regulation, it is clear that the government do not recognize e-scooters as the kind of transportation. Provider 1 claims that to operate in Bangkok, they do not required to obtain permit from Bangkok's municipality because most of their deployment areas are in private properties. Instead, they are required to get the buy-in from the property owner. The public authorities do not regulating to interfere with the e-scooters sharing where the company partner with the private property. For other cities, such as Chiang Mai and Phuker, Provider 1 deploys the e-scooters sharing service in a public road. In this case, Provider 1 receives involvements from the municipality in the form of permit which is considered unofficial since there is no clear regulation.

(57) *"No, uh, under current regulation I would say no. Uhm, with the university and another I I would say it as private property. Then mostly what we have to do is we have to get the buy-in from from the property owner. But for for the public area, well then the municipality can involve, but I I wouldn't say that it's a permit because we we don't have that kind of you know specific*

permit in in in Thailand. I wouldn't say it's it's a permit or or or yeah, yeah it's it's kind of unofficial."

Suppliers sells e-scooters as a regular goods

If e-scooters are illegal to be operated on public roads, then, why does e-scooters are legal to be sold in the market? Suppliers in Bangkok plays significant role for e-scooters deployment because they are the main actors who distribute e-scooters to people in the city. According to Supplier 1, the sale of e-scooters is basically equal to selling general goods wherein sellers are required to pay taxes to the government. There is no requirements for suppliers to obtain special permit to sell e-scooters because the vehicle itself could not be registered. (Quote 58)

(58) *"Right now, we are paying taxes as businesses in general. Because, scooter can not be registered, it is not in the special case that we have to register. It is just like selling general goods. But we still paying taxes."*

The importance of clear regulation as a tool for standardization

Regulation is important to position an implementation to be more arranged. The urgency of a clear regulation could be depicted from three sides of e-scooters deployment actors: users, suppliers, and service providers. The regulation could become a tool to encourage people using a sustainable transportation mode with a proper safety measures to lessen the risks of injury due to accidents. People would be more stimulated to ride e-scooters for daily use without worrying about its legal status (Quote 59).

(59) *"Yes, because, I think, uhh, it will be more, profit for, uhh, many people in using the scooter. Because, if you don't use it, you will use the car or motorcycle, it makes traffic really bad. If they can make it clear, to using in daily, so, I think it's very good"*

Using the analogy of a motorcycles that have different law with cars, e-scooters should have its own regulation under the micromobility umbrella (Quote 60). Supplier 1 believes that speed limitation is essential to be incorporated in the law, suggesting differentiating the speed limit according to the space and area of usage. Because not all area would have the same infrastructure conditions.

(60) *"We can't deny that if e-scooters are used as a vehicle on the road, there should be a specific law for this. Because, there is the law in the case of motorcycle, that is different from the car. Same goes to bicycle. For the e-scooter, it is a new type of vehicle, so it should have the regulation too."*

The clear regulation would help service providers to position their business in a right way, in particular regarding the requirements of safety equipment. Service providers would cooperate to adjust the speed limit, rule of utilization, and its operation standard if regulation are provided, so that they are able to optimally provide the service for customers. In addition to that, since e-scooters knowledge and safe riding campaign are mostly driven by private sectors, having a clear regulation would accelerate delivering essential knowledge for people about safe e-scooters usage as well as encourage people to utilize sustainable mean of transportation. (Quote 61)

(61) *"Yeah, I think that's the, the main thing that we want to work toward right to to get it right, great. So we have clear definition. Clear the requirement of what we should do. Not just us, but you know other service providers as well. And then riders can understand more about how they should, right? Right, so I think, uh to to get the regulation happens right? It's it's it's the end goal. Not not, not the end goal, but the ultimate code now. So we can provide a service like, uhm a hundred percent regulated, I would say."*

Summary of Theme 5

The summary of discussion for Theme 5: Regulation and institution is shown in Figure 18 bellow.

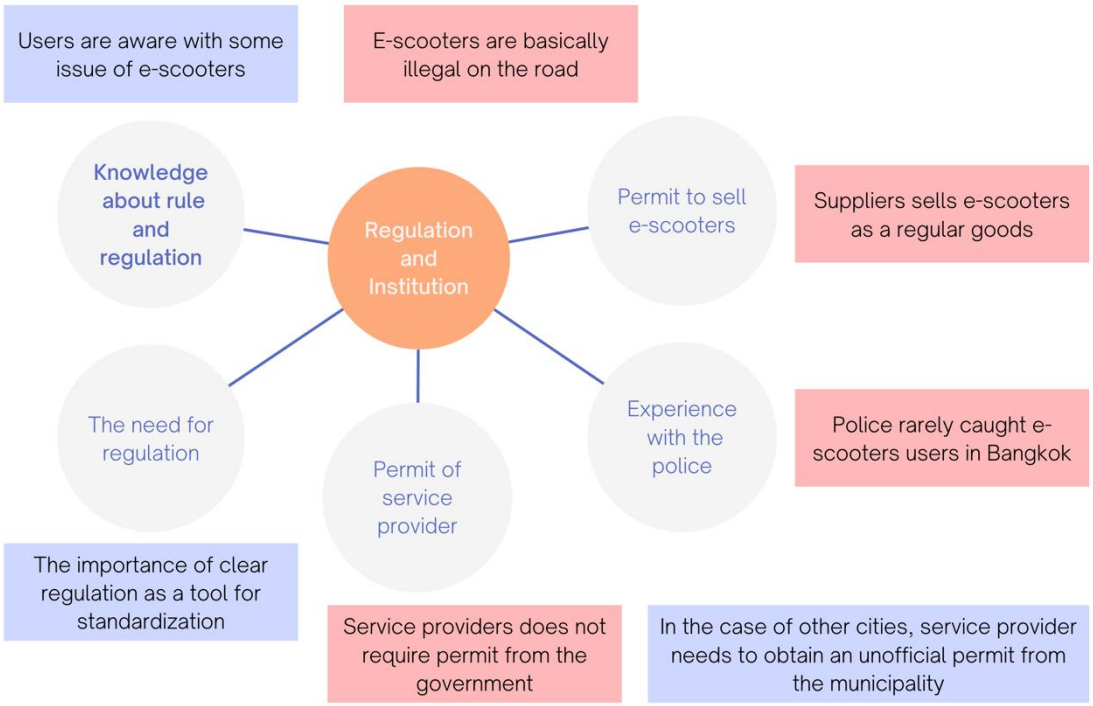


Figure 18. Summary of Theme 5

4.2.6. Theme 6: Scooters as an option

E-scooters does not consume much electricity

Most of e-scooter users justify their reason of utilizing e-scooters as their main transportation mode for its low travel cost. Compared to cars, motorcycles, and ride hailing transportation, e-scooters consumes less travel cost each day. It is claimed that e-scooters consume an electricity bill approximately 1 THB per kilometer or 5 THB a day. Some users claimed that the electricity bill after using e-scooters is not significantly increasing. Some users do not calculate the electricity cost for using e-scooters because they assume that the cost is not high enough for

them to spot. Its low travel cost makes users stay loyal in utilizing e-scooters. (Quote 62 and 63)

(62) *"It's not much, I already calculate that, it's just, for one kilometer it's around 1.2 baht. Maybe it's lower than that, because I use, already, I always use in the sport mode. So, if you use the eco mode, it's not, it's just less than this."*

(63) *"Yes, very very. It's not over, the scooter is not over, hmm, I think, around 5, 5 baht per day."*

Other costs are relatively low

Beside the charging cost (electricity), users are required to spend money for regular repairment of the spare parts (e.g., brake and tires). Once in several months, users have to change the brake pads which cost less than 200 THB for the front and rear wheels. In addition to that, some users would love to install additional accessories for their aesthetic as well as safety purposes, such as LED light bellow the scooter board so that it is noticeable at night, which cost vary from 1000 THB to 3000 THB. (Quote 64 and 65)

(64) *"It's not uhh, in a month, no, no need to repair anything in a month, but, uhh, it's around six months. I have to change, uhh, the brake pads, yeah. One front, front, front is about, they have front of the wheel, is one pair, around sixty baht. So, only two pairs."*

(65) *"Yes, last week I have changed my brake. Yeah, and some accessories. Yeah, a brake is 190 baht yeah. Accessory is about back. Back up light, 1000 baht to 3000 baht."*

Bangkok might not be ready for e-scooters

At the current state of regulation and infrastructures, some users argue that Bangkok is not ready for e-scooters. Riding e-scooters on public roads is dangerous because of the lack of bike lane and other infrastructures. Moreover, the lack of specific regulation provision misses the ability to back up and protect the utilization of e-scooters, in particular for its safety usage. (Quote 66 and 67)

(66) *"Hmm. Not yet, ahh, because, as I say before that the road is very scratched, yeah, we cannot use the scooter. I have ever use the one wheel, you know it. So, I think for all of this kind of personal vehicle is dangerous if you use in the traffic, I'm sorry, the main road. So, I think the Thailand is not ready for this."*

(67) *"A good option, but, at risk of dependent if they have bike lanes, for example the other night I was in a Yaowarat near Chinatown and there was a tour on those scooters doing a tour. But obviously with the streets very busy, it could be dangerous for someone who doesn't have experience on a scooter."*

E-scooters is a good option for students

On the other hand, e-scooters are potentially a good option for students to commute inside the university area. Some users claimed that e-scooters helped them to travel to the university with low travel cost and time. Indeed, the infrastructures availability in most universities are good with a decent quality. Even though currently there is no regulation, but the infrastructures could raise the guarantee of the user's safety. In addition, universities have a potential as well to manage the usage of e-scooters inside their territory without involvement of the

government in the municipal level. E-scooters could become a tool to promote a sustainable transportation mode for a green university campaign. (Quote 68)

(68) "But for Chula, that's nice, as you can see that they have a renting, so I think it's a good starting for the, for the electrical vehicle."

E-scooters would win the modal competition if infrastructure and regulation are provided

To make e-scooters go further and safe to be utilized as a transportation option for Bangkok citizens, adequate infrastructures and specific regulation are necessary. Moreover, many users agree that e-scooter could provide a faster and cheaper option to commute for work or study. In particular for those who daily commutes in a relatively short distance. During the peak hour, hailing cars, motorcycle, or even electric tuk-tuk would take forever for the driver to pick up the passengers. With electric scooters, either rented or personally owned, users could travel seamlessly to get into destination. (Quote 69)

(69) "Uhhh, I think it's a good option, but if for like a, but if you want to go faster when the, you have a lot of traffic jam around here, so, the scooter is a really best choice. And, its make like a no pollution in the air, so, it's better than the motorcycle."

Indeed, e-scooters do not emit pollution as well which makes it excellent for a cleaner air quality. Infrastructures that users expected are bike lanes, parking spaces, and its charging station, so that users would not running out of battery. Those infrastructures, specifically bike lanes, bring advantages not only for e-scooters users but also for cyclist as well. (Quote 70)

(70) "Somehow, I feel that it's a good option, because I use the scooters to only ride from my residence to my university, which is around three

kilometer, so, using e-scooters probably a bit beneficial for me somehow, and I think that I would encourage people to drive e-scooters, because in Thailand you know that a lot of people going in Bangkok and the traffic jam is a big problem in Thailand that they have to solve right now. Yes, top above all, I think that the regulation must be updated in Thailand, and the road must be built, specifically for the bicycle road. Actually, important for the e-scooters driver and also the bicycle users as well. And also, hmm, the charging part, I think that should be, for free for the e-scooters, so because, in the future, the energy would be free for everyone."

Summary of Theme 6

The summary of discussion for Theme 6: Scooters as an option is shown in Figure 19 bellow.

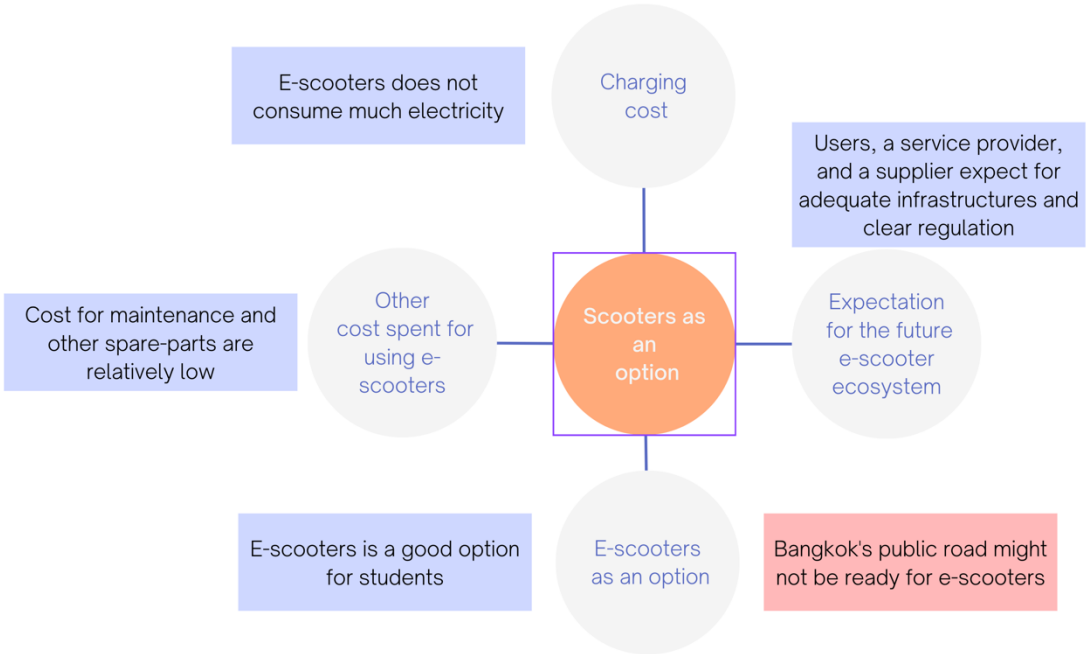


Figure 19. Summary of Theme 6

4.3. Criteria assessment

The Likert-scale assessment was conducted to summarize analysis and discussions. Three sources of data are triangulated to strengthen the validity of the assessment. The author triangulates the assessment data from Group A, Group B, and field observations. The criteria which are categorized by three elements of the ecosystem framework (supply capabilities, demand structure, and institutions) covers twelve indicators. (See Table 10)

The overall supply capabilities are placed the best among other elements. In particular, the supplier availability in Bangkok is widely available with decent service centers as well (C4 = 4). Customers of e-scooters could find the vehicle easily on both onsite and online market. The parking area provision is easily accessible to e-scooters users with a relatively good condition (C2 = 3). According to Quote 15 and Quote 16, most users find it easy to find parking spaces for their scooters. However, bike lane provision in Bangkok is only available in several places, such as universities, gated housings, and some roads in the CBD area (C1 = 2). The marking in the bike lanes in Bangkok are good with a road rule referring to the motorcycle rules (C3 = 3).

The demand structures are placed in moderate to good level of assessment. The users understood the basic rules of using e-scooters safely (C5 = 3), such as the importance of riding with a certain speed limit, wise space choice, and the use of helmet. However, the practice or implementation of the riding rules are not perfect (C7 = 2.5), particularly for the use of safety equipment. Half of the participants wear helmets, while others do not wear safety equipment (Table 7). In spite of that, according to Provider 1, most users would park their scooters in the designated parking area, wherein only less than 10% of users parked the e-scooters improperly (Quote 37). In terms of regulation awareness, some of the users understand the legality status of riding e-scooters on Bangkok's road (C6 = 2).

However, there are still some users who are unsure about the regulation of e-scooters in Thailand.

The institution's side, on the other hand, urgently needs action to make the implementation of e-scooters as a transportation option in Bangkok possible. There are no specific regulations to back up the usage of e-scooters in Bangkok's current situation (C8 = 1). Meaning that, there is no specific speed limitation as well as safety equipment compulsion by the law (C9 = 1; C10 = 1). The penalty for operating an unrecognized mode of transportation on the road is specified. The service provider, in addition, also specifies the penalty for not parking the vehicle in a designated area. In this case, the penalty specification is partly available (C11 = 2). The knowledge provision is also partly available (C12 = 2), mostly provided by implementation actors (e.g., suppliers and service providers).

Table 10. Overall Assessment

No	Criterias	Assessment Source			
		Group A	Group B	Observation	Overall
	Supply Capabilities				
C1	Bike lane availability	2	2	2	2
C2	Designated parking area provision	2.5	2.5	3	3
C3	Road rules and marking	3	3	3	3
C4	Supplier availability	4	4	4	4
	Demand Structure				
C5	Basic rules knowledge	3	2.5	3	3
C6	Regulation awareness	3	2	2	2
C7	Basic rules practices	2.5	3	2	2.5
	Institutions				
C8	Specific regulation	1	1.5	1	1
C9	Speed limitation standard	1	1	1	1
C10	Safety equipment compulsion	1	1	1	1
C11	Penalty specification	1	2	2	2
C12	Knowledge platform provision	2	2	2	2

*1 = Not available; 2 = Partly available or available but in a moderate condition;

3 = Available and in a good condition; 4 = Available and very good

4.4. The electric scooters ecosystem in Bangkok

Overall, the electric scooter ecosystem in Bangkok, in particular the open system, is still under development. The supply capability requires adequate bike lane provision to meet safe riding in an ideal environment. The parking spaces and road marking are sufficient, but preferable if improvements are being made. The demand structure needs more understanding of e-scooters utilization knowledge so that e-scooters could become a safe transportation mode option for people. Most users understand the basic knowledge of e-scooters utilization, however, not all of the users would ride e-scooters with ideal safety. The institutional side, likewise, requires the establishment of rules and regulations to standardize the use of e-scooters in Bangkok so that safer rides could be achieved.

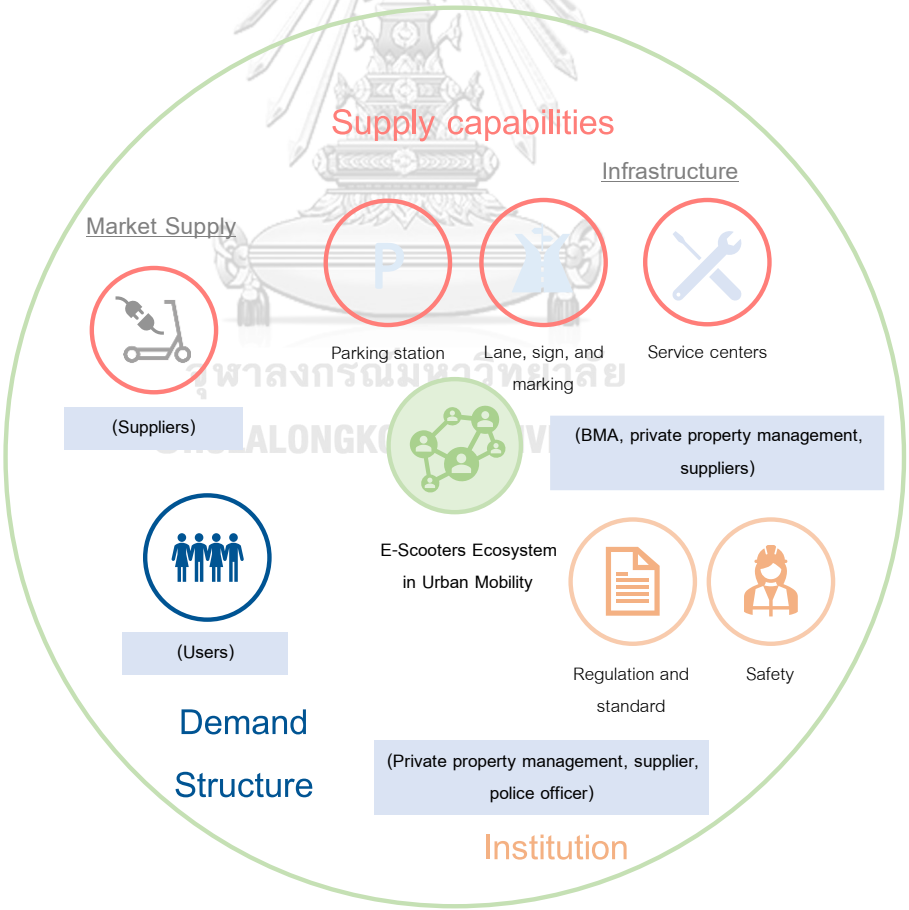


Figure 20. E-scooters ecosystem in Bangkok (open system)

There is the absence of role within the pre-defined actors of e-scooters ecosystem in Bangkok in Figure 5 (Chapter 2). The supply side was supported only by suppliers, because there is no service provider operating in Bangkok's public road under the open system. Subsequently, the demand is constructed by users of personal e-scooters. While the institution side is formed by private property management and suprisingly suppliers which also contribute to informally standardize the use of e-scooters in Bangkok. The details of the key actors are explained in Table 11.

Table 11. The ecosystem actors of e-scooters in Bangkok (open system)

No	Ecosystem Element	Actor	Functions
1	Supply	Supplier	Offer e-scooters into the market for both service providers and users of personal e-scooters. Provide a maintenance service for users.
		BMA	Provide and maintain the infrastructures that supports the utilization of micromobility in Bangkok's public road.
		Private property management	Provide and maintain the infrastructures that supports the utilization of micromobility in Bangkok's private property.
2	Demand	Users	A group of people who utilize e-scooters personally in Bangkok. Cooperate for safe rides and comply with the requirements.
3	Institutions	Private Property Management	Regulating the use of micromobility in a private property.
		Supplier	Ensure the safety of the customers.
		Police	Reinforcing the safety of micromobility users.

The ecosystem of e-scooters in the closed system is rather different than the open system. In the area of observation, the author finds out that the area around Chulalongkorn University is a controlled environment under the umbrella of Samyan Smart City. This area is a perfect example of an e-scooters ecosystem in a controlled environment, which would be explored in this section. Chulalongkorn University started a movement about micromobility utilization around the campus in 2009 through the cycling campaign. Several years after that, more bicycles were received from different institutions, mostly the government. Bike sharing becomes a new mode of mobility option at Chulalongkorn University after its introduction in 2013. The biking infrastructure inside the university gradually becomes sufficiently available, both the bike lanes and the safe parking stations.

The rising trend of micromobility use and its adequate infrastructure encourage some users to try out a new kind of transportation to commute inside the university. Several e-scooters users begin to be spotted inside the university. One of the participants has used e-scooters inside the campus for approximately three years. It is claimed that riding e-scooters inside the university is comfortable enough, even though there are still suggestions for infrastructure improvements. During the same timeline, there was an attempt to collaborate between the university's property management with an e-scooters supplier to provide ridesharing inside the campus, but the innovation experiences a halt due to COVID-19 and was unable to thrive. After the activities inside the university went back to normal, ridesharing flourished again not only with e-scooters but also bicycles. The existence of e-scooters sharing risen the trend of powered micromobility which makes more users utilize e-scooters as a transportation mode inside the university, either shared or personal e-scooters. People utilize e-scooters for a short distance travel from their housing to the university or within places inside the university area.

There are two types of e-scooters utilized inside the university, personally used e-scooters and ride-sharing e-scooters. If the implementation of e-scooters in Chulalongkorn University is depicted in an ecosystem (Figure 21), the structure would change a bit. The supply side was supported by a service provider, property management, and suppliers. The demand is constructed by users of personal e-scooters and customers of e-scooters sharing. While the institution side is formed by property management, a service provider, and road security inside the university. In the closed system ecosystem, there is an indirect role of the insurance provider that is a part of the service provider package. However, it is not considered as the key actors since they closely interact with the service provider instead of the ecosystem itself. The details of the key actors are explained in Table 12.

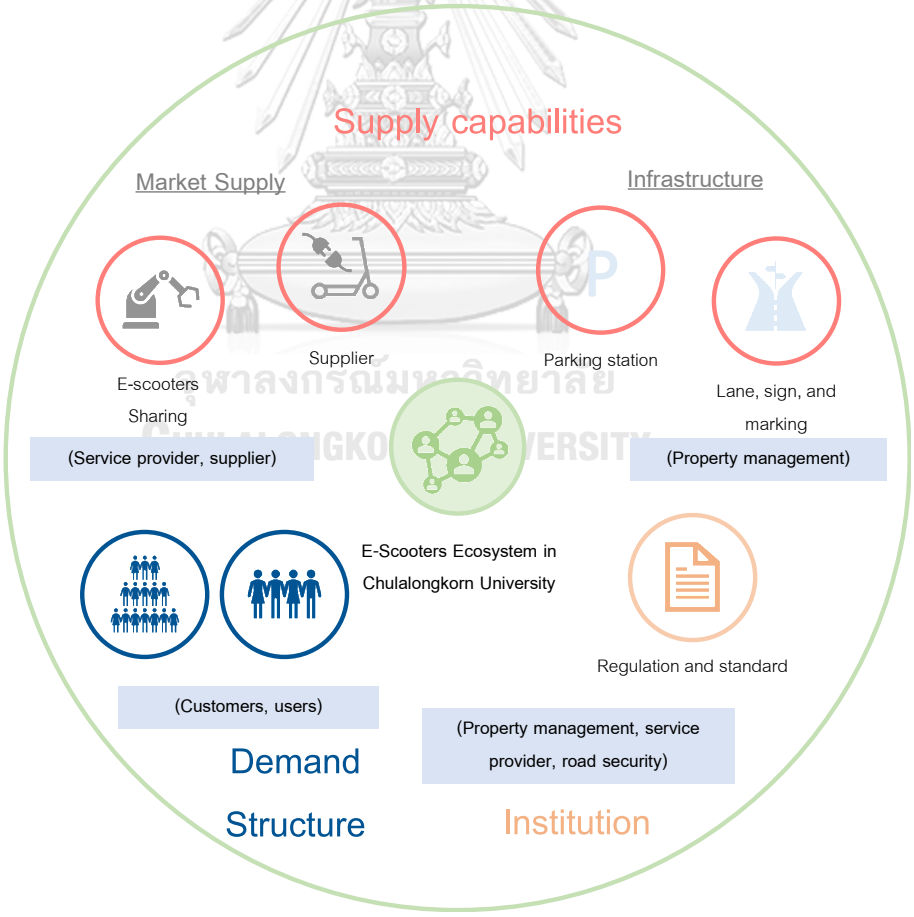


Figure 21. E-scooters ecosystem in Bangkok (closed system)

Table 12. The ecosystem of e-scooters in Chulalongkorn University

No	Ecosystem Element	Actor	Functions
1	Supply	Service provider	Provide e-scooters sharing service inside the university and other places.
		Property Management	Provide and maintain the infrastructures that supports the utilization of e-scooters inside the university.
		Supplier	Offer e-scooters into the market for both service providers and users of personal e-scooters. Provide a maintenance service for users.
2	Demand	Users	A group of people who utilize e-scooters personally inside the university. Cooperate for safe rides and comply with the requirements.
		Customers	A group of people who utilize e-scooters sharing inside the university. Cooperate for safe rides and comply with the requirements.
3	Institutions	Property Management	Permit e-scooters service provider to operate inside the university. Monitoring the safety of e-scooters users.
		Service provider	Establish rule and standards in riding the e-scooters sharing. Maintaining the safety of the customers.
		Road security	Reinforcing the safety of e-scooters users.

4.5. Challenges of e-scooters implementation in Bangkok

Several points discussed in the thematic analysis contributes to the challenges of e-scooters utilization in Bangkok. Firstly, unsafe riding, includes riding on the sidewalk, which poses a danger to both riders and pedestrians, and the fact that ccidents are inevitable. Secondly, issues related with standardization, since there is no standards to uniformize the space choice, speed usage, and its safety equipment. Thirdly, it is challenging to increase the users awareness because eventhough the users know about the basic knowledge, they do not fully follow the basic rule. Subsequently, regulation establishment is challenging because there are many aspects that should be considered. In relation to e-scooters knowledge enforcement, safety of the users is challenging to be achieved. Lastly, the provision of infrastructure in Bangkok is tricky to be provided. The challenges of e-scooters implementation derived from the thematic analysis is shown in Figure 22.

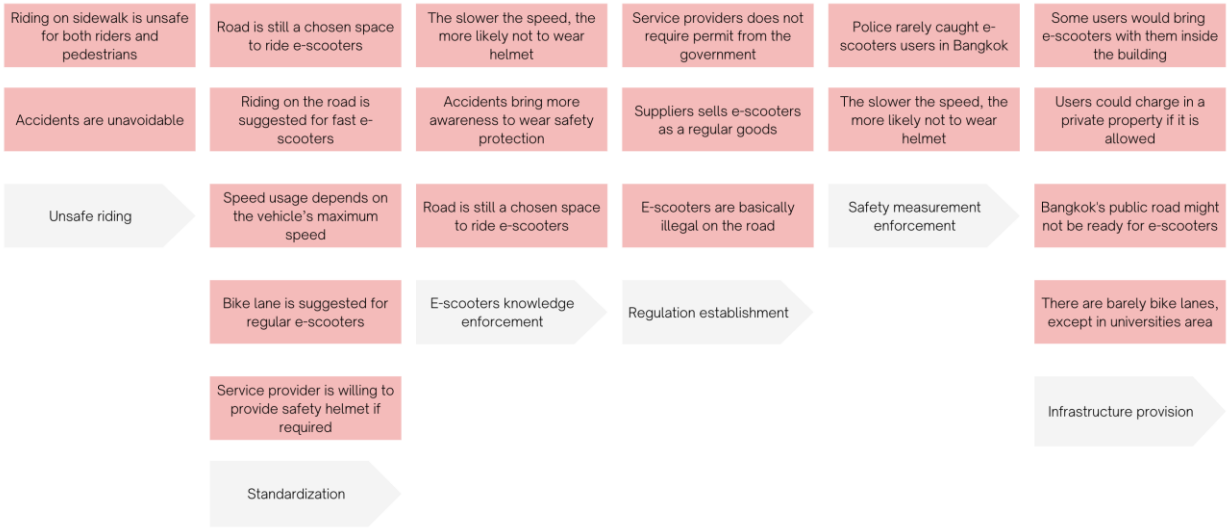


Figure 22. Challenges of e-scooters implementation derived from the thematic analysis

4.6. The potential of developing an ecosystem for e-scooters in Bangkok

The thematic analysis identifies several features that are foreseen as potentials of e-scooter utilization in Bangkok. Firstly, the implementation of e-scooters are potentially better to focus on using the approach of area-specific implementation. It is fostered by the fact that e-scooters are available for sharing service in some closed system and e-scooters is a good options for students. Secondly, e-scooters is potential to be utilized as a short-distance travel within local roads since the lack of readiness of the public road, not to mention about the safety. Thirdly, there has been attempt of informal standardization by service provider and a supplier which forseen the potential of private sectors-led standardization. Lastly, partnership with more actors are essential to be considered as the ecosystem potential because there are many doors that is currently open for partnerships, such as public transportation and insurance provider. The potential of developing an ecosystem for e-scooters in Bangkok derived from thematic analysis is shown in Figure 23.

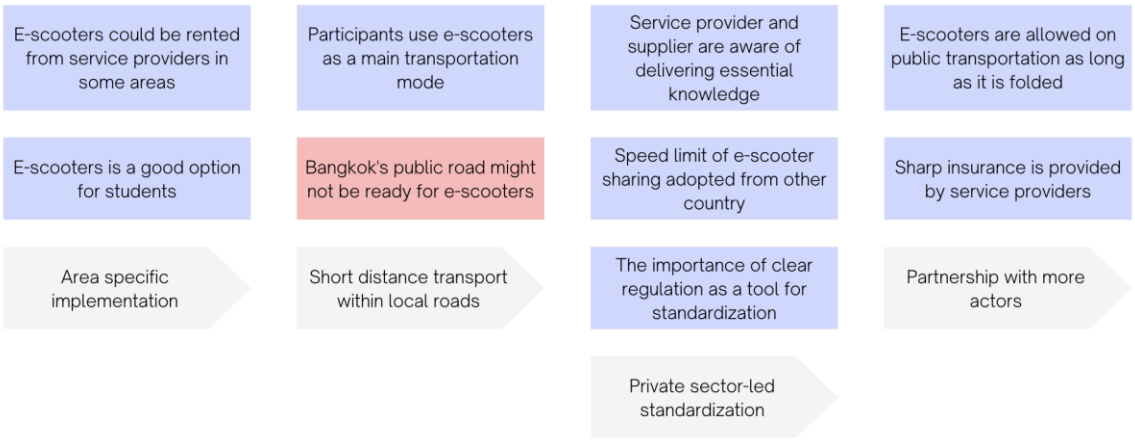


Figure 23. The potential of developing an ecosystem for e-scooters in Bangkok derived from thematic analysis

CHAPTER 5 : CONCLUSIONS AND RECCOMENDATIONS

5.1. Research findings

This section discusses about three findings that would answer the research question and its objectives: the electric scooters ecosystem in Bangkok; the challenges of electric scooters utilization in Bangkok; and the potential of electric scooters utilization in Bangkok.

5.1.1. The electric scooters ecosystem in Bangkok

Essentially, the city of Bangkok was not designed with micromobility-friendly features which makes it different from cities in Europe and the USA as discussed in Chapter 2 (Subheading 2.5). The infrastructures for biking in those cities are sufficient and safe for the riders (Anderson-Hall et al., 2019; Zagorskas & Burinskiene, 2020). Once the powered micromobility came in, the cities are ready to accommodate e-scooters and build an ecosystem. The people, indeed, are already familiar with the use of micromobility in the city. Most importantly, the regulation that needs to be utilized as a tool to control the safety and other crucial aspects of e-scooters implementation could be extended from the bicycle regulation as some countries have done (Anderson-Hall et al., 2019; Riggs et al., 2021; Zagorskas & Burinskiene, 2020). Meanwhile, in Bangkok, the roads were designed to accommodate cars which leave no space for a bike lane. Riding a micromobility vehicle on the main road risks the user's safety besides the fact about conflicts with cars and motorcycles that could possibly happen.

The elements of the e-scooters ecosystem are not entirely local-specific. Some could be addressed as a country-level element wherein the availability and quality of those elements may affect the ecosystem of e-scooters in all cities in the country. For example, the general regulation establishment in European countries

applies to the whole of Europe. However, cities could also have their local regulation for the use of e-scooters (Zagorskas & Burinskiene, 2020). In the case of Bangkok, the regulation could be established at a country level, in particular, to also address the absence of regulation in other cities. Some cities in Thailand, such as Chiang Mai and Phuket, have implemented e-scooters sharing services even on their public roads. The market supply could also be classified as a country-level element because some of the suppliers sell e-scooters nationwide. Subsequently, the rest of the elements are local-specific. In Bangkok, infrastructure provision is the responsibility of the local government which is also applicable to other cities as well. Addressing the issue of infrastructure in Bangkok would not fix the lack of infrastructure in other cities. The safety issue could be very locally specific since it is affected by the infrastructure condition and the user's practice. Different cities would not have identical safety issues. For example, the first wave of e-scooters sharing implementation in Phuket experienced a pause, one of the reasons was due to unsafe riding. The users in Phuket were predominantly tourists whose background varies which makes Phuket getting challenged with a particular safety problem.

The current situation of e-scooters phenomena in Bangkok or even Thailand delivers indications of how the future of e-scooters would be. There are several baseline futures for e-scooters utilization in Bangkok: suppliers and service providers would be the most influential in e-scooters deployment in Bangkok; e-scooters sharing would be available in many universities in Bangkok; e-scooters safety would remain an emerging issue; and the urgency of e-scooters rule and regulation would come up from the rising trend of e-scooters brought by suppliers and service providers. The baseline future could be either way good or bad for the city of Bangkok.

The ecosystem of e-scooters in Bangkok is not under the umbrella of rules and standards, unlike cities in European countries. Cities in Europe implemented the

use of e-scooters in a measured environment supported by regulations. The infrastructures are sufficiently available with good quality. That situation lessens the constraint of challenges in infrastructure supply. Conversely, the ecosystem of e-scooters in Bangkok is not ready to implement on public roads. One of the main reasons is the lack of micromobility-friendly infrastructure on public roads which would be hard to be addressed. These situations give ideas about creating a measured environment, such as “European cities” in a smaller area. If e-scooters are not ideally possible on Bangkok’s public roads, the implementation is better to be started in a controlled environment, such as schools, universities, and other private properties. The ecosystem of e-scooters in Bangkok is not ready to implement the use of a powered micromobility on public roads. However, there is a potential to develop an ecosystem of e-scooters in a specific area, what so-called controlled environment.

Ultimately, the first *objective* of defining an e-scooters ecosystem framework has been answered. This research has explored about the pre-defined ecosystem framework in Chapter 2 (see Figure 3). Subsequently, the framework is adapted and contextualized to assess the ecosystem of e-scooters in Bangkok. The ecosystem of e-scooters in Bangkok in both open and closed system has been presented in Chapter 4 (see Figure 20 and 21). In this section, author has emphasized what makes the e-scooters ecosystem in Bangkok similar/different with the context in other cities.

5.1.2. The challenges of electric scooters utilization in Bangkok

In general, cities in many countries were faced with challenges in standardizing the arrival of e-scooters as a new transportation mode (Field & Jon, 2021). The use of e-scooters has to be defined in terms of space usage, speed limit, and safety measurement. Although regulations have been implied in some developed countries, executions are trickier to achieve. Infrastructure provisions do

not seem to be the main issue of cities in those countries. In contrast, the challenges of e-scooters implementation in Bangkok are rather different from cities in developed countries, which would be discussed in this section based on the analysis on Chapter 5.

In the current situation, the most challenging issue of e-scooters utilization in Bangkok is to standardize the implementation of e-scooters that would be able to uniform the speed limit, space usage, service providers, as well as the market supply. What makes Bangkok and some other cities in developing countries is that there are many e-scooters users or even some e-scooters sharing businesses in the city while there is an absence of regulation. The standardization could be done by establishing regulation at the national level and/or in the specific area where the implementation of e-scooters usage would be conducted. However, the establishment of regulation could not guarantee that the e-scooters ecosystem in Bangkok would be uniform and standardized. For example, applying speed limits for the users could not directly fill the gap because some e-scooters models are designed with a powerful and fast speed. Meanwhile, limiting suppliers for selling e-scooters models in its regulation range bounds the supplier's wiggle room to conduct their business. The standardization through regulation should be wise enough to bring safety for the users as well as not disserve other key actors.

In addition to that, another issue in standardizing space usage is the challenge of providing sufficient designated lanes. Regulating users to ride e-scooters in the bike lane would not be possible without fixing the lack of infrastructure availability and quality (Zagorskas & Burinskiene, 2020). Nevertheless, based on Figure 9, standardization is significant to the deployment of e-scooters because it brings positive impacts on safety, infrastructure provision, and user awareness.

Infrastructure provision itself is challenging due to Bangkok's characteristics of its mobility system, road, and inhabitants. Infrastructure provision is a local-specific

issue that would be able to be solved by the local authority, not only in Bangkok but also in other cities. Different cities might have distinctive infrastructure conditions than Bangkok which becomes a consideration of a service provider to deliver services on the public road. In the case of Bangkok, the width of most roads is fixed and does not leave extra space for bike lanes. Forcing to allocate space for bike lanes may result in another problem of greater congestion in Bangkok. In addition to that, placing bike lanes by the road risks an increase in conflicts with other road users, especially during rush hour. Assigning bike lanes on the sidewalks would be a good idea if there was extra space and should be provided with clear markings. However, new problems will be generated if the width of the sidewalks is already narrow. Infrastructure provision is very important to ensure the safety of users as well as to encourage service providers to run e-scooters sharing in a bike-lane-sufficient area (Curiel-Ramirez et al., 2020). (See Figure 9)

Since the electric scooter is relatively a new kind of transportation mode in Bangkok, the understanding of its safety among users is not adequate, resulting in exposure to unsafe riding. Some users ride a standing e-scooter at a fast speed on the road. Even though wearing a helmet, fast riding is always dangerous. The safety of e-scooters depends on the infrastructure condition as well as the user's practice. The safety issue is also tightly related to whether or not the usage is standardized. With the current situation, the usage of e-scooters in Bangkok is prone to unsafe riding. The more people riding e-scooters, the more accidents would happen because of conflicts on the shared road. Accidents could not be avoided (Nikolaj et al., 2019), but that phenomenon is anticipatable. The city is challenged to increase the safety of using e-scooters so that the accident rate could be reduced. (See Figure 9)

Educating the users always become a challenge in every implementation, so reinforcement is necessary to be conducted. The absence of regulation questions

the standard of ideal e-scooters riding. The parameter of the knowledge would be unclear. In addition to that, there would be a risk of contradictive information. For example, the service providers might want the users to ride on the sidewalk if there is no bike lane, meanwhile, the supplier suggests the users to ride on the road. The regulation would help to form a parameter of an ideal knowledge of e-scooters utilization. Indeed, e-scooters' knowledge could induce awareness of safe riding, leading to massifying the use of e-scooters as a transportation option in Bangkok.

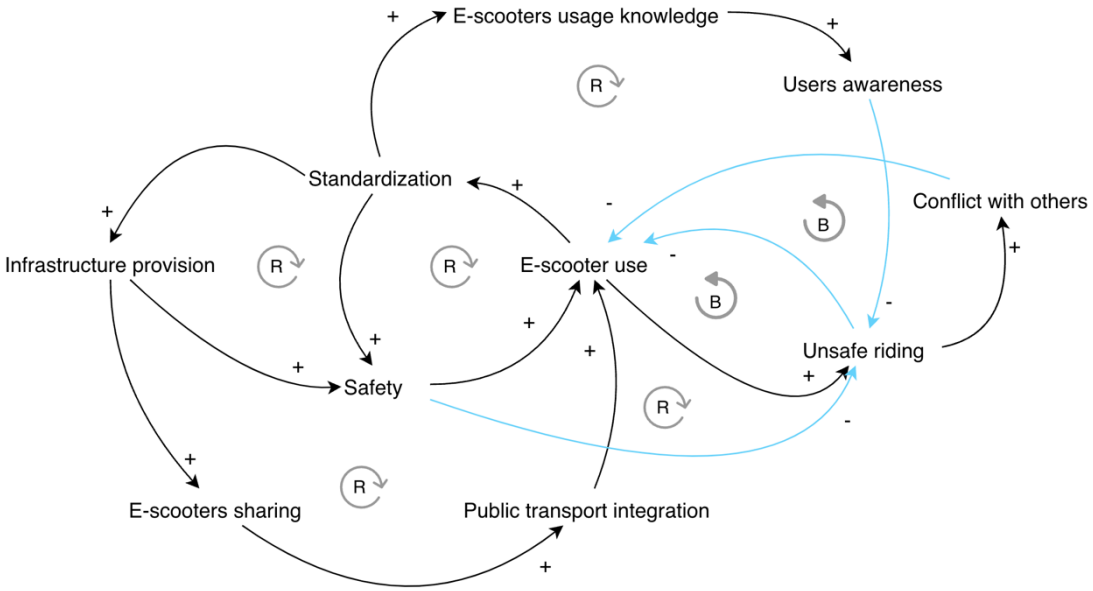


Figure 24. Causal loop diagram

Moving to the closed system, users who ride their own scooter claim that the travel cost is very low and so is the maintenance cost. It is convenient to travel using e-scooters inside the university to reach any destination seamlessly. However, for shared e-scooters, the travel cost is relatively high. Pricing competition with other mobility options plays a role in people choosing the preferred transportation mode. Compared to other modes (e.g., shuttle bus, ridesharing tuk-tuk, and bike sharing), e-scooters sharing is one of the most expensive modes. The affordability for low-income groups is questionable. Despite that fact, e-scooters are actually superior for its fast travel time compared to other modes. For example, the shuttle bus is free,

but the travel time is not rapid not to mention the waiting time. Bike sharing might be cheaper, but the experience during the hot weather is different and the travel time is slower. Ridesharing tuk-tuk might be cheaper, but the waiting time during rush hour is irrational. These facts make customers want to pay more for faster travel time, especially when they are in a rush.

The benefits of e-scooters sharing for the ability to travel rapidly might override its relatively high cost. Though, since not everyone could afford to rent e-scooters, the low-income group are vulnerable to a longer travel time. Meanwhile, access to transportation must be equal for any group to at least not rule out low-income people for not receiving the same accessibility. In addition to the equity issue, the benefit of being fast with a "per minute fare" being implied, it induces the risk of speeding. Even though the maximum speed of the vehicle was set not to exceed 25 km/hour, however, users need to adjust to the situation. Riding at its maximum speed all the time would lead to unsafe riding. Users would likely do that both to get to their destination faster and to not get charged more according to the minutes they spent. Meaning that people would neglect their safety while riding e-scooters to get its benefit as much as they can. In fact, accidents about e-scooters riding are not avoidable even in a controlled environment.

Subsequently, there are still other problems with e-scooters implementation in a controlled environment. The relatively high rent fees bring another impact on the rider's safety. Based on observation (Table 4 in Chapter 4), there are many spotted cases of riders bringing passengers. Even though there might be other reasons, sharing the rent fees with friends to reduce the travel cost is likely to be the main cause of bringing passengers. E-scooters are not designed for two passengers. According to the service provider, the recommended maximum capacity of the vehicle is 100 kg. Bringing passengers is not safe for both riders as well as people that share the same space. Despite induces the risk of accidents, this unsafe

riding would threaten the vehicle to be damaged, which in the end leads to accidents. In addition to that, the parking issue is still inescapable even in a controlled environment. Based on observation (Table 4 in Chapter 4), some e-scooters are parked improperly outside the designated area. According to the service provider, parking violations in Chula reached 6% of total trips. If there are still parking issues in a controlled environment, imagine about the violation that might happen in a broader implementation.

Finally, the *objective* of asessing the obstacles of e-scooters ecosystem in Bangkok has been answered by the finding in *Subheading 5.1.2.* This research has defined six main challenges of e-scooters utilization in Bangkok. The challenges of e-scooters implementation in other countries are explored in Chapter 2, while the challenges in Bangkok are discussed in Chapter 4.

5.1.3. The potential of electric scooters utilization in Bangkok

Under the current situation of the regulation absent as well as the insufficient infrastructure condition, the first potential is developing an ecosystem of e-scooters for an area-specific implementation. Those areas include schools, universities, and other private properties that have provided sufficient infrastructure. Indeed, the service provider claims that implementation in such areas is more manageable than in Bangkok's public roads. The reasons are due to the absence of regulation that makes collaboration with private property more feasible. University and other private areas are controlled environments that often provide sufficient infrastructures to guarantee the safety of the users as well as a part of the crucial ecosystem components. If the scope of the ecosystem assessment is narrowed down into these areas, the supply capabilities, the demand structure, and the institutional side could satisfy the criteria of assessment. This is because the actors of the ecosystem might change. For example, the institution of e-scooters' implementation

in a university is no longer the municipal authority, but the university's property management and the service provider that provides a university-level standardization of e-scooters.

E-scooter has a good potential to be utilized as a short-distance mode of transportation around the local road. In the current state of regulation, e-scooters are illegal to be operated on public roads in Bangkok. Even if the e-scooters are allowed to be operated on the road, the infrastructure condition is trickier to be enhanced. Therefore, e-scooters become a good option to travel on the local road, not to mention the superblock of certain areas in Bangkok. However, there should be minimum a standard to make sure the safety of the users, which could be from the government, the supplier, or the service providers.

Standardization of e-scooters has been started to be conducted by the private sector. For example, in some universities in Bangkok, the use of e-scooters sharing is standardized by the service providers. They created rules of how e-scooters should be ridden and other safety measures. Another example is from medium-sized cities in Thailand, Chiang Mai and Phuket. The implementation of e-scooters sharing was done as a result of a collaboration between a service provider and the authority. The local government issues a document of "unofficial permit" to allow the service provider to deploy the service. Later on, the service providers generate their own rule and standards of the e-scooters sharing usage and operation, in particular to manage safety. This situation gives the potential to put up private sectors on the institution's side. The private sector-led standardization creates rules implied by service providers to uniform the usage of e-scooters sharing as well as implied by suppliers to standardize the speed limit of the e-scooters. If e-scooters could not be legalized and standardized by the government, at least there would be standardization from other actors.

The current situation of e-scooters utilization in Bangkok gives a potential to flourish partnerships within more actors, such as partnerships between service providers with the government, universities, and parks, to provide e-scooters sharing service in the emerging area. Partnerships with the government mean providing the e-scooters sharing service in a governmental complex area so that more options for transportation would be available. Partnership with universities is what the service provider has started. The partnership would gradually be extended in the future. Meanwhile, the partnerships with park management could be utilized to address the idea of transportation as a tool for recreational purposes. E-scooter sharing could be provided in parks to accommodate the need for leisure activities. In those cases, the service providers would still take place as the actor of the institutional side that would dominantly standardize the use of e-scooters within the area of implementation. The partnerships also apply to other cities in Thailand by establishing collaboration between the local authority with service providers. The current implementation that happens in Phuket and Chiang Mai might foster the potential of other partnerships in other cities in Thailand.

In essence, the *objective* of assessing the potential of developing an ecosystem for e-scooters in the capital city of Thailand has been answered by the findings in *Subheading 5.1.3.* This research has identified four main potentials that need to be focused on for the future development of electrified micromobility.

5.2. Conclusions

Bangkok's electric scooter ecosystem, particularly the open system, is still in its early stages. To enable safe riding in an ideal environment, substantial provision of bike lanes is required. The demand structure requires a better grasp of e-scooter utilization knowledge so that e-scooters can become a safe means of transportation for people. Similarly, on the institutional side, norms and regulations must be

established to standardize the usage of e-scooters in Bangkok, allowing for safer riding. The ecosystem of e-scooters in the closed system differs from that in the open system and would meet the evaluation requirements. A service provider, property management, and suppliers assist the supply side. Users of personal e-scooters and clients of e-scooter sharing create demand. Meanwhile, the institutional side of the university is made up of property management, a service provider, and road security. The Bangkok ecosystem of open system e-scooters is not ready to adopt powered micromobility on public roadways. However, there is the possibility of developing an ecosystem of e-scooters in a specific area, referred to as a controlled environment.

The challenges of e-scooters implementation in Bangkok are actually challenges for many cities in developing countries that would like to tackle issues in e-scooters usage. It is inevitable that e-scooters becomes a new trend of mobility and the number of users itself increased rapidly. However, many cities are still in the dilemma of whether or not to accept the new kind of transportation and have not prepared for its standardization. Even cities in European countries are still changing their e-scooters rules depending on the result of the trial period. Cities should focus on doing trials to see the potential of e-scooters utilization because the safety of e-scooters usage is not yet defined firmly. In Bangkok, the current situation of e-scooters utilization is more like a trial by private sectors that foreseen Bangkok as a micromobility market. However, it could be the starting point to see the potential of e-scooters utilization in the future.

In conclusion, e-scooters have the potential to be a convenient and sustainable mode of transportation in Bangkok, especially for short distances. However, the current regulatory and infrastructure challenges make it difficult for e-scooters to be implemented on public roads. As a result, there is potential for e-scooter ecosystems to be developed in specific areas such as schools, universities,

and private properties that have adequate infrastructure. The private sector has already started to standardize the use of e-scooters in these areas, which could serve as a model for standardization in other locations. Additionally, partnerships between service providers and various institutions such as the government, universities, and parks could further promote the use of e-scooters for transportation and recreational purposes. Ultimately, with the right regulations and infrastructure in place, e-scooters could become a valuable addition to Bangkok's transportation landscape.

5.3. Recommendations

This section gives reccomendation from two sides: strategies reccomendation for the e-scooters ecosystem development; and reccomendation for future research shown bellow.

5.3.1. Strategy recommendations

There are many aspects that need to be adjusted in the implementation of e-scooters in the closed system, not only for Chulalongkorn University but also for other areas as well. Both the property management and the service provider need to provide standards/rules that would assure the utilization of e-scooters inside a controlled environment. In addition to that, safe biking infrastructures have to be provided as efficiently as possible to avoid an unwanted route that could be unsafe and increase travel time. Those two aspects are the bare minimum but do not guarantee the success of e-scooters implementation. Rule enforcement is necessary to suppress the violation that leads to unsafe riding for users. Either using a “fines” or “credits deduction” scheme, a penalty seems to be the most common and successful approach for rule enforcement. Indeed, as a new kind of transportation, it should be emphasized that educating even more both users and the public are important to increase the safety of e-scooters utilization. Last but not least, subsidies

for low-income groups hoped to become the concern of the implementor to address the issue of transportation equity.

The potential of developing an ecosystem for e-scooters utilization in Bangkok needs to be elevated to make that happen. It is assessed and foreseen that the implementation in Bangkok's public road is not possible to be advanced. Developing an ecosystem in a controlled environment rather becomes a strategic move that suits well not only for Bangkok but also for packed cities in developing countries. However, we are moving forward to enchance the potent aspect to scale up the well-assessed ecosystem in the closed system to the open system. The author proposes three recommendations for strategy that are critical to enhancing the potential of e-scooters development: **standardization**, **partnership** with transit systems, and massifying the e-scooters **knowledge**.

a. Standardization

Standardization could be done either by law/regulation or by the private sector. On the closed system, property management is aparently the main stakeholder of standardization. While on the open system, the municipality is primary actor of standardization in the city. This strategy should focus on providing comprehensive standardization that ensure the safety for e-scooters of personal use and sharing use which covers speed limitation, safety requirement, space choice, parking requirement, penalty and fines, and minimum age of riding. Standardization should also consider to manage zone-based speed limit that allows users rides at a certain speed for some occasion. For example, the speed limit on a park is slower than on the alley so that people would enjoy leisure activity without causing conflicts with those who walk. Standardization would also allow for better infrastructure provision of bike lanes and parking spaces by the building managements, service providers, and the authority.

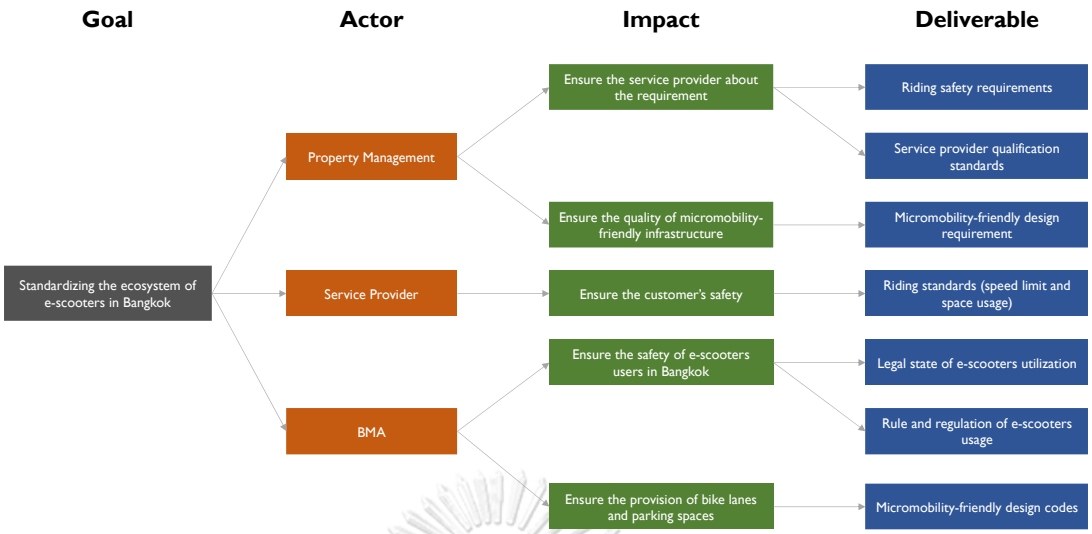


Figure 25. Impact map of standardization

b. Partnerships with transit systems

Targeting transit systems is beneficial to encourage modal integration of micromobility with public transportation. The partnership could either happen between service providers and public transportation with or without the involvement of the authority. The main ideas of the partnerships are:

1. To extend the area-specific implementation that allows e-scooters to be integrated with public transportation.
2. To allow service providers of e-scooters sharing to provide the service near the transit stations.
3. To answer the need for first- and last-mile transportation so that personal e-scooters can be brought on MRT and BTS.

c. Massify the e-scooters knowledge

E-scooters knowledge is essential to increase the safety of utilizing e-scooters in the city. This strategy must work simultaneously with standardization to make sure the same understanding of educating the people. The purpose of this strategy are:

1. To introduce the idea of micromobility as a transportation mode to society, including e-scooters.
2. To provide platform through government initiatives to share all information about e-scooters: the legality status, the fine, the standard of usage, the rule, etc.
3. To mandate service providers and suppliers to educate the customers comprehensively.

5.3.2. Recommendations for future research

This research has some limitation that leaves some recommendations that would be beneficial in shaping ideas for future research:

a. Targeting e-scooters sharing users as a sampling group to understand the customer's point of view.
b. Conducting interview with policy maker to uncover the initiatives that might have been planned either in the city level or the specific area level.
c. Focusing on equity issue that discuss about the affordability of e-scooters sharing.
d. Analyzing about e-scooters acceptance for public using technology acceptance model (TAM) or similar to that.

Conducting research on comparative study of regulations among countries.

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APPENDIX A: Assessment Criteria

In this research, the criteria to assess the e-scooters ecosystem in Bangkok are defined for each group of ecosystems as shown in Table 13. The assessment adopts a Likert scale that ranges from 1 to 4 points. The criteria came from the adaptation of the cases in some cities as mentioned in this section. The assessment score would be analyzed using simple descriptive statistc.

Table 13. Assessment design

No	Criterias	Assessment*			
		Not available	Partly available	Good	Very good
	Supply Capabilities				
C1	Bike lane availability				
C2	Designated parking area provision				
C3	Road rules and marking				
C4	Supplier availability				
	Demand Structure				
C5	Basic rules knowledge				
C6	Regulation awareness				
C7	Basic rules practices				
	Institutions				
C8	Specific regulation				
C9	Speed limitation standard				
C10	Safety equipment compulsion				
C11	Penalty specification				
C12	Knowledge platform provision				

*1 = Not available; 2 = Partly available or available but in a moderate condition;
3 = Available and in a good condition; 4 = Available and very good

APPENDIX B: Interview Design

Table 14. Questions for Group A

No	Questions	Criteria in Assesment
Q1a	Do you ride on sidewalks, bike lanes, or streets? What do you think of the bike lane availability in Bangkok?	C1
Q2a	How do you park your e-scooters? Do you find it easy to find parking spaces?	C2
Q3a	How do you aware of the road signs and marking?	C3
Q4a	How do you get e-scooters? How much cost do you spend to buy e-scooters?	C4
Q5a	What do you know about the rule of using e-scooters?	C5, C9, C10
Q6a	What do you know about the regulation of e-scooters?	C6, C8
Q7a	How are your practice of riding e-scooters (speed, helmet usage)?	C7
Q8a	Have you ever experienced accidents when riding e-scooters? Have you ever caught by the police when riding e-scooters?	C10, C11
Q9a	What are the sources of e-scooters usage knowledge that you have ever found?	C12
Q10a	Do you see e-scooters as a good or bad options for mobility in Bangkok?	-
Q11a	What do you expect for e-scooters ecosystem as a transportation mode in Bangkok?	-

Table 15. Questions for Group A in Thai

ลำดับ	คำถาม	เกณฑ์การประเมิน
Q1a	คุณขี่สกู๊ตเตอร์ไฟฟ้าบนทางเท้า เลนจักรยาน หรือถนน คุณคิดอย่างไรเกี่ยวกับความพร้อมใช้งานของเลนจักรยานในกรุงเทพฯ	C1
Q2a	คุณจอดรถ e-scooters ของคุณอย่างไร คุณหาที่จอดรถง่ายไหม	C2
Q3a	คุณรู้จักป้ายจราจร และ เครื่องหมายจราจรอย่างไร	C3
Q4a	คุณจะซื้อ e-scooters ได้อย่างไร คุณใช้เงินเท่าไหร่ในการซื้อ e-scooters	C4
Q5a	คุณรู้อะไรเกี่ยวกับกฎการใช้สกู๊ตเตอร์ไฟฟ้าบ้าง	C5, C9, C10
Q6a	คุณรู้อะไรเกี่ยวกับกฎระเบียบของ e-scooters	C6, C8
Q7a	คุณฝึกขี่ e-scooters อย่างไร (เช่น ความเร็ว และ การใช้หมวกกันน็อค)	C7
Q8a	คุณเคยประสบอุบัติเหตุขณะขี่สกู๊ตเตอร์ไฟฟ้าหรือไม่ คุณเคยโดนตำรวจจับตอนขี่สกู๊ตเตอร์ไฟฟ้าไหม	C10, C11
Q9a	แหล่งความรู้การใช้ e-scooters ที่คุณเคยพบคืออะไร	C12
Q10a	คุณเห็นว่า e-scooters เป็นตัวเลือกที่ดีหรือไม่ดีสำหรับการสัญจรในกรุงเทพฯ	-
Q11a	คุณคาดหวังอะไรสำหรับระบบนิเวศ e-scooters ในฐานะโหมดการขนส่งในกรุงเทพฯ	-

Table 16. Questions for Group B

No	Questions	Criteria in Assesment
Q1b	What is the purpose of providing the service and why e-scooters? Where is it better for e-scooters users to ride? How do you think of the bike lane availability in Bangkok?	C1
Q2b	Where should the riders park their e-scooters? Is there many cases of users don't park the scooters on a designated area?	C2
Q3b	Should e-scooters riders follow general motor vehicle road rules and marking? Is a campaign of being aware of road rules being included in the service?	C3
Q4b	If there is a problem with the scooters, do you hire special technician or do you fix the scooters on that brand service centers? What about the spare parts?	C4
Q5b	How is the situation of e-scooters users in Bangkok?	C5, C6, C7
Q6b	How do you think the urgency of creating specific regulation for micromobility, in particular the powered one?	C8
Q7b	Is there a particular reason of using 25 km/hour as the speed limit? How do you think the urgency of wearing helmets?	C8, C9, C10, C11
Q8b	If there is an accident, how would be the scheme for the users?	C10
Q9b	Where/how the users could find the knowledge about e-scooters usage?	C12
Q10b	Do you see e-scooters as a good or bad options for mobility in Bangkok?	-
Q11b	What is the expectation for e-scooters ecosystem as a transportation mode in Bangkok?	-

APPENDIX C: Assesment Result

Table 17. Group A assessment

No	Criterias	Assessment (U1=User 1)						
		U1	U2	U3	U4	U5	U6	Overall
	Supply Capabilities							
C1	Bike lane availability	2	2	1	2	2	2	2
C2	Designated parking area provision	1	2	4	2	3	3	2.5
C3	Road rules and marking	3	3	3	3	3	3	3
C4	Supplier availability	4	3	4	4	3	4	4
	Demand Structure							
C5	Basic rules knowledge	4	3	3	4	4	2	3
C6	Regulation awareness	4	3	4	4	3	2	3
C7	Basic rules practices	3	2	2	3	2	3	2,5
	Institutions							
C8	Specific regulation	1	1	1	1	1	1	1
C9	Speed limitation standard	1	1	1	1	1	1	1
C10	Safety equipment compulsion	1	1	1	1	1	1	1
C11	Penalty specification	1	1	1	1	1	1	1
C12	Knowledge platform provision	2	2	2	2	2	2	2

*1 = Not available; 2 = Partly available or available but in a moderate condition;

3 = Available and in a good condition; 4 = Available and very good

Table 18. Group B assessment

No	Criterias	Assessment		
		Provider 1	Supplier 1	Overall
	Supply Capabilities			
C1	Bike lane availability	2	2	2
C2	Designated parking area provision	3	4	2,5
C3	Road rules and marking	3	3	3
C4	Supplier availability	4	4	4
	Demand Structure			
C5	Basic rules knowledge	3	2	2,5
C6	Regulation awareness	2	2	2
C7	Basic rules practices	3	3	3
	Institutions			
C8	Specific regulation	2	1	1.5
C9	Speed limitation standard	1	1	1
C10	Safety equipment compulsion	1	1	1
C11	Penalty specification	1	1	1
C12	Knowledge platform provision	2	2	2

*1 = Not available; 2 = Partly available or available but in a moderate condition;

3 = Available and in a good condition; 4 = Available and very good

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