Between User's Practice and Infrastructure Condition: Safety Challenges of E-scooters Utilization in Bangkok, Thailand

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Abstract

In Bangkok, e-scooters have become one of the transportation options for many users. Despite the growing number of users, e-scooters remain illegal to operate on public roads. The absence of regulations raises concerns about the safety of utilizing e-scooters in Bangkok. This paper aims to explore the safety challenges associated with the use of e-scoters in Bangkok, based on the practice of users and the infrastructure condition. Semi-structured interview with purposive sampling is conducted for Group A (n=6) and Group B (n=2) to discover the situation from the perspective of users, supplier, and service provider. Additionally, a combination of user interviews and field observations was conducted to assess the infrastructure. Thematic analysis was applied to analyze the interview data, leading to the identification of four themes: infrastructure condition, users practice, accident experience, and maintaining safety. The findings reveal that both user practices and infrastructure conditions contribute to the safety of e-scooters utilization in Bangkok. These include dispersed speed usage, unsafe space choice, and the lack of bike lane availability. To improve safety, Bangkok needs more bike lanes and parking spaces, standardized e-scooters use, and e-scooters education platforms. Policymakers must consider regulating and standardizing the use of e-scooters in Bangkok for its safety.

Keywords: Bangkok, e-scooters, micromobility, safety, urban mobility

1. Introduction

The idea of sustainable mobility emphasizes the interconnection among urban infrastructure. As development is indivisible by its mobility system, that idea ascents the challenges of providing sustainable urban transportation. By definition, cities are challenged to deliver a transportation mode that: allows for its inhabitant's basic needs in terms of access and development; is affordable and operated efficiently; and produces low emissions (Goldman & Gorham, 2006). Municipalities in many countries have attempted to elevate the modal share of public transportation to address congestion and environmental issues due to the externalities of private cars. Public transportation was designed to meet the sustainable principle. However, the deficiency of delivering door-to-door service with public transportation makes it inconvenient for some groups.

With millions of people commuting on a daily basis, the capital city of Thailand needs more options for its transportation system. Micromobility offers the option to serve door-to-door transportation needs. The usage of micromobility during the COVID-19 pandemic has grown in popularity because of the lower chance of contracting the virus (ITDP, 2021). In addition, powered micromobility provides benefits for short-distance trips (Cao et al., 2021) to travel in a small vehicle without being affected by traffic and possibly to be integrated with public transportation. The integration potentially upsurges the accessibility and, in the longer run, shifts the car travel behavior to a more sustainable transportation mode (Oeschger et al., 2020).

E-scooters are not fully perceived positively because of some issues of parking and safety (Gössling, 2020). Nevertheless, e-scooters remains a good option for urban mobility as long as having clear regulation and are implemented cautiously (de Bortoli & Christoforou, 2020). In Thailand, e-scooters have become one of the options for many users, in particular in its capital city. In 2020, Thailand's micromobility market earned more than 430 million THB, and it is expected to continue to expand (PS Intelligence, 2021). E-scooter users could be found on the roads and even on Bangkok's public transportation.

While the number of users grows, e-scooters remain illegal to operate on Bangkok's public roads. Apparently, the absence of regulation also questions the safety of utilizing e-scooters in Bangkok. This paper explores about safety challenges of using e-scoters in Bangkok based on the user's experience and the infrastructure condition. This paper is expected to stimulate the urban mobility strategy to involve e-scooters as a transportation option as well as to stimulate the future regulation design of e-scooters utilization in Bangkok.

2. Literature review

The concept of micromobility emerged from the new mobilities paradigm introduced by Sheller (2011). Small-sized, short distances, light vehicles, and two-wheelers are all critical components of micromobility (Eccarius & Lu, 2020). According to the International Travel Forum, micromobility refers to the use of micro-vehicles. The proposed definition specifies that micro-vehicles have a mass of less than 350 kg and a speed of less than 45 km/h (ITF, 2020). Micromobility is further subdivided into kinds based on mass and speed. Micromobility, according to this definition, comprises both driven and unpowered vehicles such as bicycles, electric bicycles, kick scooters, electric scooters, skates, and one-wheeled balance boards.

Electric scooters, also known as e-scooters, fall under the category of powered micromobility. E-scooters are considered personal electric vehicles that can transport a single passenger for distances of up to 10 km, utilizing electricity as their energy source for the motor (Ulrich, 2005). However, some literature defines e-scooters as powered two-wheelers, similar to mopeds, with a maximum speed of 30 mph or 45 km/h (Hardt & Bogenberger, 2019). In this research, e-scooters are defined as vehicles designed for short-distance transportation, equipped with a small electric motor and a deck where a single rider stands (Hollingsworth et al., 2019).

In cities all across the world, e-scooters were a relatively new form of mobility. E-scooters have recently appeared in various nations, surprising the local government. For instance, the rise in e-scooter sharing in Brisbane was recognized as a crisis of regulation brought on by an over-the-night arrival (Field & Jon, 2021). One of the first issues for the local authorities is the examination of several factors in deciding whether to permit or reject the operation of e-scooters (Anderson-Hall et al., 2019). Cities must investigate and assess the effects on other road users before approving the usage of e-scooters (Zagorskas & Burinskiene, 2020). Meaning that safety rules are important for the adoption of e-scooters. An accident risk associated with motorized micromobility is believed to be three times higher than that associated with non-powered micromobility, mostly due to the higher speed (King et al., 2020).

Due to the safety concern, municipalities face a dilemma when deciding where e-scooters should be used. E-scooters frequently have an influence on other road or sidewalk users, such as riding accidents and inappropriate parking (Zagorskas & Burinskiene, 2020). The issue compelled the major players to design and construct a safer road system in addition to a sensible regulatory framework (Cao et al., 2021). Due to safety concerns and the fact that there are fewer big vehicles, e-scooter riders actually prefer to ride in a bike lane that is separated from the traffic (Pazzini et al., 2022). Safety issues are significant to be addressed for their benefit to help municipalities to define the ideal space usage and the standard requirements (O'hern & Estgfaeller, 2020).

To address concerns about e-scooter use in their urban environments, many municipalities have established regulations that specifically refer to e-scooters as powered micromobility. It is because, safety issues (eg. crashes) on e-scooters do not completely intersect with bicycle crashes (Shah et al., 2021). Several nations in Europe have adopted rules and legislation that particularly address the problem of e-scooters (Zagorskas & Burinskiene, 2020). Most nations in Europe adopt speed limitations of no more than 25 km/h in order to standardize the use of e-scooters. Speed limitation is extremely important because it is found that e-scooters speed usage is dispersed and it should be incorporated into the policymaking scheme (Almannaa et al., 2021). Additionally, users must be at least 14 years old. Children and the elderly are more vulnerable to getting injured while using e-scooters (Yang et al., 2020). In addition to guiding users, the legislation concentrated on overseeing e-scooter firms as well. The law could be employed as a tool to control the number of service providers in the city.

In the Asian cities context, Singapore is recognized as one of the major players in the e-scooter sector in Asia since several e-scooters startup companies have emerged and established a presence in there (Cao et al., 2021). According to Singapore's Land Transport Authority, up to 1.300 km of bike lanes would be provided across the country by 2030 in order to promote more e-scooters and other micromobilities. Although regulation has been established in Singapore, however, executing the regulations would be another challenge (Field & Jon, 2021). Improper parking is one of the biggest obstacles to service-provider-based deployment. In Singapore, the service provider was mandated to penalize customers who failed to park their vehicles in an allocated space. However, inappropriate parking is still a widespread issue (Zhu et al., 2020).

In Thailand, according to the Motor Vehicle Act B.E. 1979, e-scooters fall under the category of motorbike which definition is "a vehicle operated by a motor or electric power with not more than two wheels". However, it is important to note that currently, e-scooters are not able to be registered in Thailand, which means their operation on public roads remains illegal. Indeed, as stipulated in Section 6 and Section 59 of the Motor Vehicle Act B.E. 2522, operating an unregistered vehicle is considered a violation and can result in a fine of up to 10,000 THB. This legal situation poses a challenge for both e-scooter service providers and personal users who wish to operate e-scooters on Bangkok's roads. The current state of regulation creates an absence in ensuring the safety of using e-scooters in Bangkok.

This research explores the safety challenges of e-scooters utilization through the lens of both users' practice and infrastructure. The users' practice refers to the activity of users during the utilization of e-scooters as a transportation mode which includes speed usage, helmet usage, and space usage. These three elements are most important based on the e-scooters regulation across the world. On the infrastructure side, to achieve the objective of sustainable mobility, there is the need to provide streets, public spaces, and parking spaces (Meyer & Shaheen, 2017) . In the context of e-scooters, the infrastructure refers to parking stations and lanes with signs and marks.

3. Methodology and data

The paper is qualitative research that assesses the safety of e-scooters utilization in Bangkok, Thailand. There are several data collection methods for the data: such as interviews with the purposive sampling method; research for the primary data; and internet source for the secondary data. For the sampling method to conduct the interview, this paper adapts the "Criterion-i" strategies among many types of purposive sampling explained by Palinkas et al. (2015). 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). Criterion-i could be used to select cases that meet some predetermined criteria (Palinkas et al., 2015).

The semi-structured interview would be practiced by collecting data from Group A (users) and Group B (service provider and supplier). The criteria for Group A include the following: individuals should be a minimum of 14 years old, students or workers who own and have been using e-scooters for more than two months, and have resided in Bangkok for at least 90 days. On the other hand, the criteria for Group B are actors working in the e-scooter sector in Bangkok, such as service providers and suppliers.

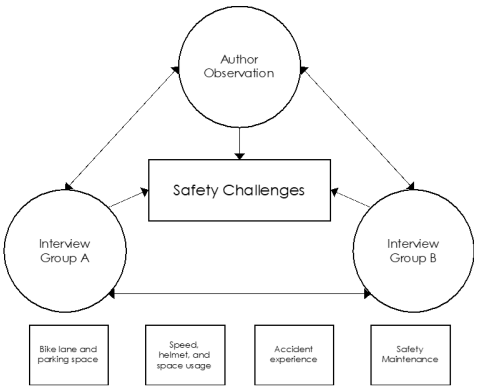

Figure 1. The research conceptual framework

Table 1. Information of participants (Group A)

No	Information	Participants					
		User 1	User 2	User 3	User 4	User 5	User 6
1	Age (years old)	16	24	38	19	37	28
2	Time period of using e-scooters	6 months	9 months	3 years	3 years	3 years	3 months
3	Speed usage	30 km/hr	20 km/hr	50 km/hr	25 km/hr	25-35 km/hr	30 km/hr
4	Helmet usage	Full face helmet	No	Bicycle helmet	Not anymore	No	Bicycle helmet
5	Accident experience	More than three times	Never	Two times	Two times	One time	Two times
6	Space usage	Road side	Road side	Road	Bike lane	Road	Road side

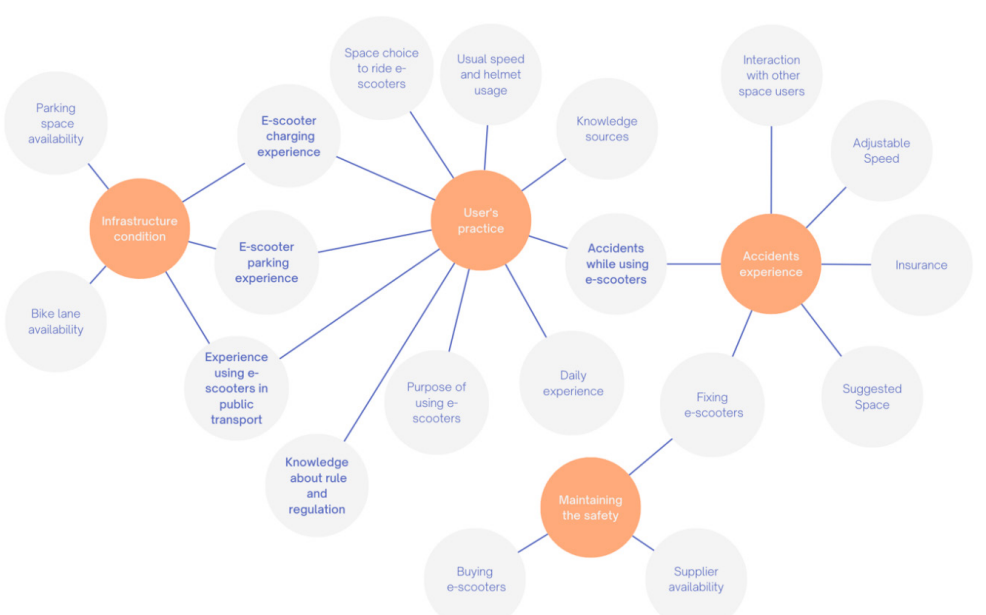

Figure 2. The thematic analysis map

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 author would like to understand the real situation of e-scooters utilization and safety in Bangkok from the participants' stories. In this case, it should be noted that the sample size is small and become the delimitation for this research.

The participants from the users' side being selected for the interview should satisfy the requirements. Six participants from the users' side have successfully interviewed using semi-structured interview which takes around 20 minutes each to understand the safety phenomena of e-scooters. For Group B, we interview Provider 1 and Supplier 1 using semi-structured interviews which take around 30 minutes each. This paper is qualitative research that involves an in-depth interview as a data collection method. With a relatively small sample size (n Group A=6; n Group B=2), therefore, it is not designed for statistical analysis. Subsequently, the thematic analysis would be used to qualitatively analyze the interview data. By definition, thematic analysis is a method for defining, examining, and summarizing certain themes in data. Thematic analysis is adaptable and flexible, it may be compatible with several theories (Braun & Clarke, 2006).

The thematic analysis involves six phases comprised of familiarizing with the data, generating initial codes, searching for themes, reviewing themes, naming the themes, and producing reports (Braun & Clarke, 2006). To begin, the author transcribes the interview results and translates relevant data into English to familiarize themselves with the material. Next, nineteen initial codes are generated to identify key concepts and ideas. The author then identifies and develops four distinct themes: e-scooter utilization infrastructure, user practices including speed, helmet usage, and space utilization, experiences with accidents, and strategies for maintaining safety. The results of the thematic analysis are visually represented in a thematic analysis map, shown in Figure 2.

4. Results and discussions

In this section, the phenomena of e-scooters safety in Bangkok would be discussed through four themes that were identified at the end of the thematic analysis: bike lane and parking space; user's practice (speed, helmet, and space usage); accidents experience; and maintaining the safety.

4.1 Theme 1: Infrastructure condition

Municipalities around the world have made built environment infrastructure adjustments – such as building shared paths, bike lanes, and sidewalks – to encourage active transportation (Lanza et al., 2022). In contrast to other vehicles which normally operate in defined lanes, e-scooters lack specialized facilities for travel, which makes e-scooters often interact with their surroundings due to the use of shared infrastructure (e.g., sidewalks and roads) with other users (Ma et al., 2021). In Virginia, it is discovered that most e-scooters users prefer to ride on bike lanes rather than other spaces, for example, sidewalks and roadsides (Lanza et al., 2022). Riding on bike lanes is more comfortable because users do not need to adjust to pedestrians' speed and do not require to put extra awareness of big vehicles on the road. It is found that e-scooters users tend to ride subtly faster on bike lanes rather than on roadways and sidewalks (Zuniga-Garcia et al., 2021). Scholars also discover that riding on bike lanes could result in less injury due to accidents compared to other spaces, especially on roads (Lanza et al., 2022). However, if bike lane availability is poor, users would have no choice but to ride on the roads. E-scooter users are more prone to engage in risky activities compared to bicycle users, such as being more likely to ride on roads (Bai et al., 2015).

The situation that occurred in Bangkok is nothing much different from the finding from Lanza et al. (2022), wherein users prefer to ride on bike lanes to avoid conflicts with cars if using the roads and conflicts with pedestrians if using sidewalks. However, 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 (Quote 1). The situation forces e-scooters users in Bangkok to ride on the road, even though their preference is bike lanes themselves (Quote 2).

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

(2) *"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…."*

Nevertheless, in universities area (Chulalongkorn University, Kasetsart University, Mahidol University, and Thammasat University), the bike lane availability is considerably good (see Figure 3). Thus, students who use e-scooters inside the university choose to ride on a bicycle way (Quote 3). Not only the users, but Provider 1 also believe that the presence of bike lanes in most of Bangkok's leading institutions is adequate

(a) (b) (c) (d)

Figure 3. Bike lane availability in (a, b) Mahidol University and (c, d) Chulalongkorn University

(Quote 4). Indeed, the availability of bike lanes is one of the reasons that e-scooter service providers chose colleges as their deployment strategy for the e-scooter sharing business. Logically, if bike lanes are plentiful, service providers would not be concerned about the safety of their consumers riding e-scooters. However, the bike lane needs some adjustment as it is viewed that the route is less effective for e-scooters users.

(3) *"….so I think the bike lane in Chula is good, but it has weakness, so for example if I want to go straight from Hor Nai, to go to the U-center, I want to go straight right? But the lane is forced me to go around this, this section, and go over there."*

(4) *"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."*

Parking spaces are another significant infrastructure for e-scooters utilization in the city. If e-scooters are parked improperly, this will increase the risk of making other people uncomfortable with taking the space (Zagorskas & Burinskiene, 2020). The lack of parking provisions could escalate the risk of vehicle stealing (Chen et al., 2018), meaning that it is not safe to park e-scooters without locking the vehicle in the bicycle parking. In Bangkok, most users would park their scooters in the bicycle parking and lock the scooters to the structure (see Figure 4a). Users found that e-scooters are prone to get stolen if they do not lock them. (Quote 5 and 6)

(a) (b)

Figure 4. The situation of e-scooters (a) in bicycle parking and (b) being brought inside shopping malls.

(5) *"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."*

(6) *"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."*

The availability of parking space for either e-scooters or bicycles in Bangkok depends on the user's perspective on how they would perceive the space to park their e-scooters. Some users believe that, as long as there is motorcycle parking, they can park their scooters alongside and lock them. But other users might argue that it is hard to find a specific parking space for their scooters, which forces them to bring the scooters with them (see Figure 4b). Though, it is found that many buildings in Bangkok provide free parking spaces for bicycles to be parked in motorcycle parking. E-scooters are counted as bicycles by the parking management; so, they exempt them from the fees. (Quote 7 and 8)

(7) "It is hard (to find parking spaces) haha. Yeah, but sometimes you aaa it is normal that you take carry on with e-scooters to the space."

(8) "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. Many, many buildings like that."

Parking areas are thought to be easily defined in e-scooters sharing services. E-scooters parking does not require any structure for safety reasons because the scooters have their own technology to secure the vehicle. The dockless e-scooter sharing concept eliminates the requirement for a "bicycle parking" infrastructure provided by either the service provider or the landowner. In the instance of Provider 1, numerous factors are used to define parking locations, including the origin and destination of the trips, the location of the public transportation station, and so on. (Quote 9)

(9) "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."

4.2 Theme 2: User's practice (speed, helmet, and space usage)

Having no rules and regulations could be interpreted that users having more flexibility on how they operate the e-scooters. Meaning that users in Bangkok are vulnerable to unsafe riding that potentially induces accidents. While e-scooters users in some countries are fenced not to overuse certain speed limits, users in Bangkok use their scooters' maximum speed as their limitation. There is barely a chance for users to use an average speed less than its maximum speed unless they are interacting with pedestrians either on sidewalks or on the side of the road. Users feel that their scooter's maximum speed is not so fast and is considered safe. (Quote 10 and 11)

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

(11) 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."

However, it has also often been found on the road, there is some standing e-scooters model which able to run very fast just like a motorcycle. These types of e-scooters are sold through both online and on-site stores. The size is usually much bigger and heavier than the normal e-scooters. When riders stand up, they can see the traffic above cars in the front. Referring to micromobility and e-scooters definition (Hardt & Bogenberger, 2019; ITF, 2020), these types of vehicles are excluded from either e-scooters or micromobility for their maximum speed exceeding 45 km/hour. In Thailand, since there is no clear regulation of what e-scooters are, this type of e-scooters is placed on the same illegality status level as regular e-scooters. Subsequently, users of fast e-scooters rely on their own judgment to ride at a certain speed for their own safety. (Quote 12 and 13)

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

(13) "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."

According to Supplier 1, the speed limit of fast e-scooters can actually be adjusted depending on the purpose and requirements of usage (Quote 14). Users can use the scooters as a regular e-scooter which speed is around 20-30km/hour. However, if the users want to go further to use the e-scooters for leisure activity in other provinces (e.g., tracking), users can utilize the scooter's powerful speed.

(14) "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."

For the operation of e-scooter sharing, Provider 1 uses a speed limit of 25 km/h. The model of e-scooters they utilize is capable of exceeding that speed. Because there is no speed limit in Bangkok, Provider 1 restricts speed usage by using the maximum speed limit from their headquarters nation, Australia (Quote 15). Provider 1 considers that the ideal speed for the current implementation is 25 km/h. If the pace is set too slowly, crossing the street between two sides of campus becomes unsafe, and users may fail to keep up with vehicles.

(15) *"We got it from our, uh, another market which is Australia. They had the regulation about the speed limit, the safety measure and everything."*

The use of helmets among scooter users varies based on e-scooters users' judgment and awareness. It differs from other countries that have clear rules and regulations to mandate helmet usage for e-scooters users. In Bangkok, at some point, helmet usage might be associated with the maximum speed of their e-scooters. If the scooter's speed is slower, users are unlikely to wear helmets because they think it is safe already (Quote 16). However, users with higher speeds and more intense riding in traffic would likely wear helmets as protective tools (Quote 17).

(16) *"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."*

(17) *"I usually use around 50 kilometers…. Yes, I'm wearing the helmet, but it's a bicycle helmet."*

Currently, the safety equipment provision does not become a priority for Provider 1 since there is no regulation for e-scooters usage in Bangkok. They provide safety equipment in another country to comply with the regulation. However, Provider 1 would like to try out the deployment without providing a helmet first in Bangkok. In spite of that, they are willing to provide safety helmets if required by the regulation. (Quote 18)

(18) *"So, uhm, we have helmets in Australia and New Zealand. But here in Thailand we have no rules. If there's a regulation specific regulation, and they say, you have to wear your helmet. Our company is more than happy to do that."*

Space usage is a fascinating topic to be discussed since it is linked to interaction with other space users. In some countries (e.g., French and Germany), e-scooters are banned to be operated on sidewalks (Zagorskas & Burinskiene, 2020). Some municipalities (e.g., Singapore and Victoria) allow e-scooters to be operated on the sidewalk with speed limitations (Haworth et al., 2021). While other countries try to limit or ban e-scooters to run on pedestrian ways, space choice to ride e-scooters in Bangkok is situated by the infrastructure condition. Most users prefer to ride on the road because that space could provide more comfort than riding on sidewalks (Quote 19). It is because of the sidewalk's quality that makes e-scooters hard to be ridden there (Quote 20). Moreover, they prefer to interact with cars and motorcycles rather than pedestrians, since they have to reduce their speed if they pass by on the sidewalk.

(19) *"I prefer to ride on the aaa on the road because the sidewalk is not good as a road, also there is the people on the sidewalk, not as the road there is a car."*

(20) *"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"*

However, riding on the road is considered dangerous to some users (Quote 21). There are big vehicles (e.g., buses and trucks) that could trigger adrenaline while riding on the road. Users need to be aware of using protection gears because, in some areas, the roads have certain dynamics. The lack of bike lanes makes roads in Bangkok unsafe for riding not only e-scooters but also bicycles as well. The same goes with crossing the wide road (Quote 22), for example, in some areas, users have to choose either to cross in traffic or use pedestrian crossing (on different elevations). If the pedestrian crossing is bicycle friendly, that would not be tricky, otherwise, the users need to lift their scooters or cross in dangerous traffic.

(21) *"So, I'm cautious of the other vehicles 'cause I know the accident rate here is very high and road safety is not a big thing. Like it's very dangerous on the roads."*

(22) *"Yes, I follow with the green lights. Just go cross when the green light is already on. So, I just cross. But, sometimes, I think it's very dangerous, because I think, I think it's three lanes road, so if you just have an accident (laugh), it's just very dangerous. I don't like to go cross with that. Normally, I just go with the tunnel, yeah. But sometimes, if I need to go quickly, I use the road."*

4.3 Theme 3: Accident experience

E-scooters accident becomes a significant issue for the user's vulnerability to getting injured. E-scooters have a faster speed than unpowered micromobility, which triggers accidents (e.g., falling and crashing). Faster e-scooters could result in riders experiencing injuries, which fosters the recommendation to mandate using protective helmets (Nikolaj et al., 2019). The case of accidents among e-scooters users in Bangkok is related to the fleet's maximum speed. One of the users has never faced accidents while riding the scooter. It is claimed that their speed maximum is 20 km/hour, similar to the speed

of a regular bicycle when the riders are in a hurry (Jensen et al., 2010; Thornley et al., 2008). Never experiencing accidents could also mean the user is not triggered to wear a safety helmet as in the case of User 2 (Quote23).

(23) "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."

However, other participants have experienced accidents more than once. In cases from other countries, many major injuries are brought about by incidents involving e-scooters, which involve surgical intervention frequently to treat the wounds (Störmann et al., 2020). According to Störmann et al. (2020), accidents are also caused by the low usage of safety equipment, such as helmets, in addition to the fast speed and quick reaction time associated with using an e-scooter. In the case of Bangkok, some accidents are related to the quick reaction time of users seeing obstacles on the road as well, such as asphalt holes. The accidents do not require surgical suture but are hurtful enough that sometimes involves bleeding. Despite the quick reaction time to obstacles, the case portrays that the condition of infrastructures (e.g., roads and sidewalks) are another factor that roots accidents of e-scooters. (Quote 24 and 25)

(24) "I never get bleeding something like that, but ohhh, there is one time that I go to the stadium, the Chula stadium. So, there is a hole, a deep hole on the floor, today they already fix it. But, that day, I just go and I didn't see the hole, and I just "buzz", and I fell out from the scooter and yeah, you know "buzz" on the floor. So, sometimes, I got some blood, but not that much. It's just some bleeding, just yeah yeah, just there is nothing."

(25) "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."

Another cause of e-scooters accidents, which is still related to a quick reaction, is not getting familiarized to utilize the scooters. For example, some e-scooters brand has a sensitive braking system. When the user faces a sudden situation (e.g., asphalt hole or vehicle crash), the user falls into the road after over-pushing the powerful brake. Even though it does not involve bleeding, however, the accident makes the user's head very hurtful. (Quote 26)

(26) "Yes, yes. Only two times, and yeah really hurt. But, but, any other one not hurt, only me (laugh). Because, first time, I just, not usually using this brake, so it's very powerful brake when you press it really hard so you hit the floor, hit the road, yeah."

Interestingly, a case shows that users still rely on e-scooters even though have experienced accidents frequently. User 1 uses regular e-scooters with a speed of 30 km/hour which is relatively higher than other models. Compared to User 2, who never experienced accidents with their 20 km/hour e-scooters, it depicts that faster speed induces the risk of facing accidents. Even though does not require the user to get medical help, the accidents give injury to the user and was considered bad accidents. This might be the help of helmet usage as well because the user wears a full-face motorcycle helmet to protect the head. In fact, User 1 uses more safety protection than other participants which is probably associated with the accident experiences that trigger User 1 to protect themselves if the same accidents happen. (Quote 27)

(27) "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."

On the e-scooters sharing side, if the users experience an accident while using the e-scooter sharing service, users can claim the medical expenses using sharp insurance provided by Provider 1. Users are eligible to claim the insurance if they follow the right safety measures, such as not riding under alcohol influence (sober) and not taking passengers while riding e-scooters. The scheme would make users stay in a safe riding so that they could claim the insurance if accidents happen. (Quote 28)

(28) "For for riders, we have riders insurance. You can claim if you got into accident."

4.4 Theme 4: Maintaining the safety

Transport operations are connected to the production structures where those services are provided, and it is dependable on vehicle maintenance (Hedvall et al., 2016). Vehicle maintenance has frequently been perceived as an unavoidable cost for transportation

(Murthy et al., 2002). Nevertheless, vehicle maintenance is an essential activity to enhance the safety and reliability of transportation operations (Dobromirov et al., 2018; Shafi et al., 2018). It is also significant to increase the lifetime of a vehicle (Shafi et al., 2018). E-scooters themselves are not different from other vehicles in terms of maintenance needs. E-scooters need at least replacements in braking pads and tires regularly, but not often. Moreover, if users have just experienced accidents, it will break some parts of the scooters, hence, the need for a service center is necessary (Quote 29 and 30.

(29) "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."

(30) "Yes, last week I have changed my break. Yeah, and some accessories. A break is 190 baht yeah."

Interestingly, the service center availability in Bangkok is decent for some brands. Service centers are accessible to customers in that particular brand (Quote 31). In some cases, the maintenance service is included in the warranty given to the customers for a specific timeframe. However, for users of some brands that do not have service center networks in the city, it is quite tricky to repair the scooters if problems occurred. Users have to give extra care to maintain the vehicle's health. Alternatively, users have to fix the scooters by themselves. For some brands, spare parts are widely available in the online market either locally or overseas (Quote 32).

(31) "Yes, there is a service center at aa, near the Chula at the 100year park. It is only limited to that brand."

(32) "…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."

To prevent accidents from the manufacturing side, Supplier 1 claims that they have add-ons for the e-scooters to improve the safety of riding it, such as changing the damping system and tires to a better quality. Supplier 1 believes that those spare parts are significant to increase the safety of riders while using e-scooters. However, Supplier 1 is unable to install the add-ons to any scooters except what they sell because Supplier 1 needs to make sure of the availability of the spare parts. (Quote 33)

(33) "There is other safety equipment that we can instal it in the e-scooter, for example: damping system that can reduce the shake of the tire. Or the high quality tire in which we can install into the scooter."

5. Conclusions and recommendations

With millions of people commuting on a daily basis, Bangkok needs more options for its transportation system. E-scooters provide benefits for short-distance trips to travel without being affected by traffic and possibly to be integrated with public transportation. However, the safety of using e-scooters in Bangkok is called into doubt because e-scooters have not been specifically addressed in the regulation. That phenomenon is being researched by exploring the user's practice and the infrastructure condition to understand the safety challenges of implementing e-scooters utilization in Bangkok.

Even though riding e-scooters in a mixed-traffic is less safe than either on sidewalks or bike lanes, e-scooters users in the area of observation choose to ride on the side of the roads because bike lanes are not widely available. Indeed, due to infrastructure conditions, riding on sidewalks is considerably not comfortable. To park the e-scooters, users commonly utilize a lock system to keep the vehicle safe from stealing. The parking space availability itself is perceived in two views. First, defining e-scooters parking spaces as bicycle parking, in this case, not all buildings would have safe parking spaces for e-scooters. Second, if motorcycle parking is defined as a space for e-scooters to be parked, thus the parking spaces are easy to be found. Other infrastructures which also significant to maintain safety are service centers. Surprisingly, service centers for e-scooters in Bangkok are accessible to e-scooters users of certain brands.

The use of e-scooters in the area of observation is not standardized, resulting in dispersed speed usage. One of the factors that influence speed usage is the vehicle's maximum speed. Users believe that the top speed of their scooter is safe and not too high. However, users whose scooter's maximum speed is very high (more than 60 km/hour) would likely use personal judgment on which speed level is safe. In terms of safety equipment, some e-scooters users in the area of observation wear a safety helmet, while others do not. The helmet usage really depends on each user's awareness as well as their accident experience. Users who experienced more accidents would likely wear safety helmets, while users

who have never gotten injured are not wearing a safety helmet. In spite of that, the accidents that e-scooter riders in the area of observation have faced are associated with speed usage. Generally, while the accidents may not necessitate surgical sutures, they are nonetheless painful enough to occasionally result in bleeding.

This research might well represent the area of observation rather than Bangkok. Therefore, the findings are limited to depicting the situation of e-scooters utilization in Bangkok, also due to the small number of samples. However, the findings are beneficial to stimulate the future regulation design for policymakers if Bangkok will involve e-scooters as a transportation option. From the analysis, there are several aspects that should be considered to enhance the safety issues in Bangkok. First, bike lanes and parking space availability must be extended to accommodate the rising trend of e-scooters and other micromobilities utilization in the city, not only beneficial for e-scooters users but also for bicycles as well. Second, the use of e-scooters should be standardized to uniform its speed usage as well as to mandate the use of safety equipment. Third, providing a platform to educate about e-scooters' ideal utilization is important to increase the awareness of maintaining safety. Ultimately, e-scooters could be a good option for transportation mode if implemented carefully and supported by regulations. It is recommended for future research to consider different kinds of methodology that involve a significant number of samples.

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