Barriers to the Implementation of the Shared Micro-Mobility services in a highly motorized context

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Abstract

Shared Micro-Mobility (SMM) services are a popular sustainable alternative to private vehicle use globally, particularly in European and Western cities, offering flexible, cost-effective, and on-demand transportation for short-distance trips and as a first/last-mile service. However, implementing SMM services in developing countries faces challenges, such as poor road conditions, private mode habits, and lack of connectivity. This research examines factors hindering SMM implementation and operation in Bangkok, Thailand, using a combination of a Systematic Literature Review (SLR) and stakeholder interviews. The SLR approach used a keyword-based search to identify relevant articles and applied stringent criteria to exclude irrelevant ones. Subsequently, further articles were sourced to complement the selected ones. For stakeholder interviews, a total of 33 stakeholders related to the implementation of SMM services in Bangkok, including researchers, government agencies, and service providers, were included. The study found 53 potential barriers to implementing SMM in Bangkok, including 35 from stakeholder interviews and 34 from the literature review. After filtering out duplicates and irrelevant barriers, 26 barriers were identified and categorized into six groups including User Barriers, Institutional and Governance Barriers, City Infrastructure Barriers, Technological Barriers, Geographical Barriers, and Operational Barriers. The findings of this research can assist practitioners and decision-makers in formulating planning policies that can address the challenges facing the implementation of SMM services in both developing countries and Bangkok. SMM service providers can also utilize the findings to improve the service's operation and implementation.

Keywords: Shared Micro-Mobility (SMM), Stakeholder interview, Implementation, Barriers

1. Introduction

Bicycle sharing began in 1965 with the Amsterdam "White Bicycle Plan," which distributed unsecured, white-painted bicycles throughout the city [1]. This initiative was short-lived due to theft and damage, but it set the foundation for subsequent bike-sharing programs with improved security and payment systems. The Bycyklen system introduced in Copenhagen, Denmark in 1995 with electronic locks and rental fees established the contemporary notion of bicycle sharing. Today, bike-sharing has gained global acceptance and expanded to cities worldwide [2].

The SMM typically serves short urban trips, especially with electric bikes and scooters. Lisbon residents primarily use shared electric bikes and scooters for short trips over 2 km, while Minneapolis users often use them for commuting or running errands, as a substitute for public transportation, citing traffic congestion and parking difficulties [3, 4].

The global expansion of SMM services is affecting both developed and developing countries, driven by urbanization, environmental concerns, and technological advancements [5]. However, developing countries encounter distinct challenges such as infrastructure limitations, safety issues, and regulatory barriers [6]. Despite these challenges, some cities like Beijing, Shanghai, Mexico City, and Santiago have implemented successful SMM services, offering affordable and flexible transportation alternatives through bike-sharing and scooter-sharing programs [7].

However, SMM services in Bangkok are limited in popularity and adoption, as reported by [8], due to barriers such as rental

station availability and accessibility, and safety and security concerns. This research aims to identify and address these barriers to effectively implementing SMM services in Bangkok.

2. Literature Review

The first part of the literature review outlines five qualitative data collection methods that researchers can choose based on their research objectives, each with its own strengths and limitations. The second part of the review focuses on systematic article searching, a crucial method for obtaining comprehensive data from published sources by identifying relevant articles and summarizing key findings. Lastly, the review discusses previous research on Shared Micro-Mobility (SMM) implementation, highlighting that success and failure factors differ across countries and operational areas.

2.1 Review of Qualitative Methods

Qualitative research analyzes non-numerical data, such as interviews, observations, and documents, to comprehend human behavior and experiences, especially complex social phenomena that are difficult to quantify, like emotions, attitudes, and social interactions [9]. Commonly used qualitative research methods include in-depth interviews, focus groups, ethnography, case studies, and content analysis, which researchers may use alone or in combination depending on their research questions and objectives [10].

2.1.1 In-Depth Interviews

In-Depth Interviews are a widely used qualitative research method for obtaining comprehensive information from research participants about their experiences, beliefs, attitudes, and perceptions. This face-to-face or audio recorded method is employed in social sciences, such as sociology, psychology, and anthropology, to explore complex phenomena and gain a deeper understanding of research participants' subjective perspectives [11].

2.1.2 Focus Groups

Focus Groups are a widely used qualitative research method where a small group of individuals participate in a moderated discussion to provide insights into their attitudes, beliefs, and opinions on a specific topic. The moderator asks open-ended questions and follow-up questions to encourage participants to share their experiences and perspectives. Focus groups are commonly used in social sciences, marketing, and business research [12].

2.1.3 Ethnography

Ethnography is a qualitative research method that involves systematically observing, describing, and interpreting the culture and behavior of a group. Researchers immerse themselves in the group's social setting to gather data on their beliefs, values, practices, and structures using methods like participant observation, interviews, and document analysis. This method offers valuable insights into people's ways of living and sense-making and is commonly used in social sciences like anthropology, sociology, and psychology [13].

2.1.4 Case Studies

Case Studies are a qualitative research method that involves an in-depth exploration of a particular case or phenomenon within its real-life contexts. Data sources include interviews, observations, documents, and artifacts. Case studies can use either a single-case or a multiple-case design and are widely used in social sciences to gain valuable insights into complex phenomena and understand the experiences and perspectives of individuals or groups. [14]

2.1.5 Content Analysis

Content Analysis systematically examines written, spoken, or visual communication to identify patterns and trends [15]. It involves defining research questions, selecting communication to analyze, developing a coding scheme, and analyzing data to gain insights into messages and representations [15]. SLR, which is a comprehensive analysis of existing literature on a particular topic, is considered a part of Content Analysis [15, 16].

Previous research has utilized the two qualitative methods in various situations. For instance, a study [17] used In-depth Interviews and a literature review to gather and analyze factors influencing care provision for patients with chronic illnesses. The combined approach provided a more detailed understanding of challenges and can inform strategies to improve care. However, further research is needed to expand on these findings and develop effective interventions.

2.2 Systematic Literature Review (SLR) approach

Scholars have utilized the Systematic Literature Review (SLR) [18] as an objective and comprehensive means of obtaining accurate information. This method involves categorizing and

screening relevant papers through a comprehensive search using pre-defined inclusion and exclusion criteria. The utilization of distinct search terms ensures clarity in tracking research articles while controlling the quality of the search, as shown in Figure 1.

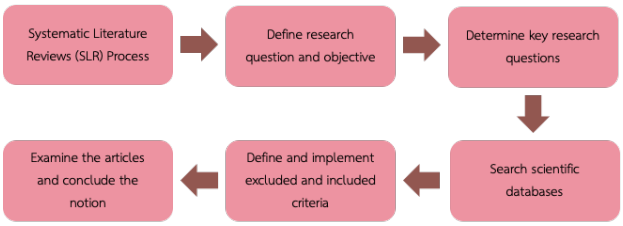


Fig. 1 Systematic Literature Reviews (SLR) Process

SLRs are commonly used in research to systematically identify, evaluate, and synthesize relevant studies based on pre-determined search criteria and critical appraisal. For instance, an SLR on agile maturity models [19] offers a comprehensive summary of current knowledge in this field. Similarly, an SLR on IT benchmarking research [20] provides an overview of different approaches and methodologies used and their effects on organizational performance. Lastly, an SLR on trust in B2B e-commerce [21] presents a summary of the various factors that influence trust in this area.

To identify barriers to the implementation of Shared Micro-Mobility (SMM), this research utilizes two qualitative methods: a literature review to gather global obstacles hindering SMM implementation, and In-Depth Interviews with Bangkok stakeholders to collect detailed information on impediments specific to this context.

2.3 Review of barriers in other countries

The SLR identified 31 papers on SMM implementation, which highlighted factors that influenced the success and failure of SMM services. For example, studies from Seoul, South Korea [22] and Taiwan [23] found that perceived usefulness, ease of use, and social norms positively affect the adoption and usage of SMM, while perceived risk has a negative impact. Additionally, a study in Italy [24] identified infrastructure and regulatory issues as barriers to e-scooter adoption. A case study from Portland, Seattle, and San Francisco [25] examined the integration of bicycle and pedestrian facilities with transit systems and identified challenges such as funding and coordination, with recommendations for improvement.

The SLR identified factors that influence SMM success, such as perceived usefulness, ease of use, social norms, influence, behavioral control, risk perception, and environmental concerns. The review highlights obstacles, including a lack of infrastructure and regulations, and motivators, such as environmental concerns in Italy. The case study on integrating transportation modes highlights challenges and opportunities. The review emphasizes that context-specific studies, like in Bangkok, are necessary to understand unique implementation barriers globally.

3. Methodology

The methodology section employed in this research can be divided into three parts. The first part outlines the interview process, which was used to gather information on the barriers that impede the implementation of Shared Micro-Mobility (SMM) services in Bangkok. The second part explains the literature review Process, which was also employed to identify and gather relevant barriers. Both methods were utilized to comprehensively understand the range of barriers that hinder the successful implementation of SMM services in Bangkok. The third part outlines the Barriers Selection Process, which was designed to consolidate and simplify the barriers gathered from the previous two sources. This process involved excluding irrelevant barriers and condensing the remaining barriers to improve their clarity and ease of understanding.

3.1 Interview

The research employed an online interview process to identify barriers to the implementation of SMM services in Bangkok. Each stakeholder was asked a similar set of questions to gather the barriers. The interviewer posed thought-provoking questions to elicit expert opinions based on their professional experience. The barriers from the literature review are extracted to determine the relevant stakeholders in Bangkok.

Eight groups of experts were interviewed, including academicians, consultants, enforcement officers, SMM service providers, policymakers, SMM users, insurance companies, and providers of other transport modes (see Table 1 for details). Interviews took place between May 31 and June 6, 2022, and lasted 30-45 minutes each.

Table 1 The list of participating institutions and corresponding perspectives

Stakeholder group	Institution
Academician: To obtain the perspectives of experts with an extensive understanding of traditional and new transportation	Chulalongkorn University, Civil Engineering
	Chulalongkorn University Transportation Institute (CUTI)

Stakeholder group	Institution
systems, travel demand theories, and city planning.	Thammasat University, Faculty of Architecture and Planning
Consultant: To obtain the perspectives of experts with practical experience and expertise in developing and constructing SMM infrastructure service systems.	Tran Consult. Company Limited
	Meinhardt Thailand. Company Limited
	A21 Consultant. Company Limited
Enforcement officer: To obtain the perspectives of experts who anticipate using the regulations to be implemented when dealing with or encountering road users.	Metropolitan Police Bureau, Traffic Division
	Department of Land Transport
SMM Service provider: To obtain the perspectives of experts who have experience operating and implementing real-time SMM projects, and have engaged in socio-public or government interactions.	Q Advertising. Company Limited
	Property Management of Chulalongkorn University (PMCU)
	Anywheel. Company Limited
	Haupcar. Company Limited
	Beam Mobility Thailand Co., Ltd.
Policymaker: To obtain the perspectives of government officials involved in national transport policy and infrastructure development, including feasibility project studies.	Office of Transport and Traffic Policy and Planning (OTP)
	Traffic and Transportation Department
SMM User: To obtain the perspectives of experts who use SMM and experienced difficulties during employing the services.	Two of shared e- scooter user
	Two of shared bicycle user
	E-scooter club TH
	Thailand Walking and Cycling Institute Foundation
Insurance company: To obtain the perspectives of insurance experts who formulate SMM insurance products covering property and personal safety.	Office of Insurance Company (OIC)
	The Viriyah Insurance. Public Company Limited
Other transport mode provider: To obtain the perspectives of professionals who provide popular transit modes to satisfy public travel demand.	Motorcycle Taxi Association of Thailand
	Bangkok Mass Transit System. Public Company Limited (BTS)

3.2 Systematic Literature Review (SLR)

This research utilized the Systematic Literature Review (SLR) approach to identify barriers from the literature, which was selected to ensure precision and comprehensiveness in tracking pertinent research articles. The SLR methodology follows the sequential steps outlined below.

1. Aim and objective: To comprehensively identify and gather the obstacles that hinder the implementation of Shared Micro-Mobility (SMM) services.

2. The search of scientific databases: The research conducted literature searches in Scopus and Google Scholar databases, limited to English-language articles and journals, and included grey literature. Specific search terms were utilized, and a total of 29 relevant articles were identified, including 11 articles on factors influencing Shared Micro-Mobility, 10 articles on perspectives on Shared Micro-Mobility, and 8 articles on barriers to Shared Micro-Mobility.

3. Inclusion and exclusion criteria: The search aimed to retrieve articles on micro-mobility as a sustainable transport mode in urban areas, but some irrelevant articles related to low-carbon technologies, sustainability, and manufacturing processes were excluded. Figure 2 illustrates the SLR process.

Fig. 2 The corpus refinement stage

3.3 Barriers Selection

The barrier selection process involves two parts: combining the globally identified barriers from the interview and literature rawy(bydand Mawy((dnbarowcing Mawy((dodwng Mawy((ddthe Mawy((ddShared rquirvesselectng,sandrfbiningbarrierstoensureheir)

Revised and Refined: The selection process identified barriers occurring in comparable scenarios in both contexts. Similar barriers were combined and modified to enhance clarity. The refined process focused on narrowing down the scope of barriers while also considering incidents specific to Bangkok's SMM implementation.

3.3.3 Barriers Categorization

The Barriers Selection process identified and categorized a comprehensive set of barriers that are relevant to the implementation of Shared Micro-Mobility (SMM) services in Bangkok. The final set of barriers was grouped into six categories to aid practitioners and decision-makers in developing planning policies that address the challenges of implementing SMM services. These categories provide a clear and accessible presentation of the barriers, facilitating efficient and effective decision-making. The definitions of each category are described below to guide the separation of barriers into their respective groups.

1. User Barriers (UB): related to decision-making, ability, social context, culture, and custom.

2. Institutional and Governance Barriers (IGB): related to government or private institution decision-making and management approaches.

3. City Infrastructure Barriers (CIB): related to riding and road infrastructure.

4. Technological Barriers (TB): related to SMM technology operation.

5. Geographical Barriers (GB): related to city geography, topography, and weather.

6. Operational Barriers (OB): related to SMM service operation.

4. Results

This section presents the results of a comprehensive study aimed at identifying the main barriers to implementing Shared Micro-Mobility (SMM) in Bangkok. The sources of barriers were stakeholder interviews and a Systematic Literature Review (SLR), and the final barriers were obtained using a Select, Revised, and Refined process. The modified barriers were categorized into six groups, providing a comprehensive overview of obstacles hindering SMM implementation in Bangkok. This section offers valuable insights into critical challenges for SMM implementation in the city and can guide the development of effective strategies to promote sustainable materials management practices.

4.1 Barriers from Interview and Literature Review

The objective of the present topic was to identify barriers to implementing Shared Micro-Mobility (SMM) services in a highly motorized context. A comprehensive approach was used, including interviews and a Systematic Literature Review (SLR). A total of 53 barriers were identified from both sources and are presented in Table 2, categorized according to their origin (L mean Literature review and I mean Interview). The following section provides a detailed analysis of the identified barriers, highlighting key themes."

Table 2 The barriers acquired from the interview and literature review.

Barriers		Source
1	Negative Perception towards cycling, riding [25, 27, 28, 29, 30, 31, 35, 41, 44, 46, 52]	L
2	Crime rate [51]	L
3	Personal physical fitness [35, 36, 39, 40, 41, 42, 52]	L
4	Poor Enforcement Policy regarding Traffic rules [28, 29, 30, 38]	L
5	Lack of Financial Resources for micro-mobility infrastructure development [35, 46, 51]	L
6	Lack of Financial resources for Operating micro-mobility [46, 51]	L
7	Poor intersection management [29, 33, 35, 38, 47]	L
8	Absence of Hierarchy of road network [25, 38]	L
9	Congested street [22, 23, 33, 34, 40, 41, 52]	L
10	Longer Trip Length [24, 25, 30, 32, 33, 34, 35, 36, 37, 44, 47]	L
11	High Travel time [25, 38, 41, 45]	L
12	Multi destination long trips [36, 37]	L
13	A trip with more than one person or with cargo [29, 36, 37, 39]	L
14	Lack of knowhow for planning micro-mobility [28, 35]	L
15	Lack of facility for supporting the first and last-mile connectivity of PT, IPT [22, 28, 29, 37, 43, 45, 49]	L
16	Unavailability for real time big data [25, 41, 48]	L
17	Steep Terrain [35, 38, 42]	L
18	High level of pollution [27, 36, 39, 40, 51]	L
19	Manner of travel and familiarity with the previous mode of transportation [25, 27, 36, 39, 40, 46, 48]	L, I
20	Citizens' Financial Status [25, 27, 30, 31, 32, 39, 40, 41, 42, 44, 45, 46, 49, 50, 51, 52]	L, I
21	Poor Tech-savvy level of citizen [27, 28, 39, 41, 42, 46]	L, I

	Barriers	Source
22	Unsuitable Dressing Culture [33, 36, 37, 40]	L, I
23	Lack of Awareness for adopting micro-mobility [29, 31, 32, 39, 52]	L, I
24	Concern for, and awareness of, riding safety [44, 52]	L, I
25	Lack of executive prioritisation and vision for shared micro-mobility's future goals [28, 36, 37, 39, 40, 46, 47]	L, I
26	Failure of marketing strategies to promote using shared micro-mobility [28, 46]	L, I
27	Lack of designated place for driving micro-mobility, bicycle lane [25, 30, 31, 32, 33, 35, 36, 38, 39, 40, 41, 47, 52]	L, I
28	Poor physical infrastructure conditions in driving micro-mobility, road surface [29, 30, 32, 33, 38, 46]	L, I
29	Lack of continuity of bicycle lane [28, 33, 37, 40]	L, I
30	Lack of readily availability of micro-mobility (lack of vehicles) [39]	L, I
31	The SMM application for taking and returning has not been updated. [28]	L, I
32	Lack of traffic demand projection and traffic control in each area [38, 48]	L, I
33	No CCTV surveillance [26]	L, I
34	Unfavourable climatic conditions (high temperature) [22, 25, 29, 30, 33, 35, 36, 40, 50]	L, I
35	Low level of demand for SMM services	I
36	Lack of integrated payment methods among various public transportation options	I
37	Lack of cooperation among the state agencies and government agencies between private sectors	I
38	Lack of legal certifying driving micro-mobility	I
39	Lack of legal of certifying in micro-mobility vehicles	I
40	Without a specific route designed for micro-mobility driving	I
41	Lack of parking for micro-mobility vehicles	I
42	SMM station point has low travel demand	I
43	The operation is inappropriate for the SMM user (round trip)	I
44	Lack of the continuity public transport system and it's not cover travel demand.	I
45	Lack of physical safety of micro-mobility vehicles	I
46	The city plan is not appropriate for riding SMM	I
47	The conflict of market penetration among public transport options	I
48	The conflict of market penetration among SMM providers	I
49	The SMM vehicles are in an unusable state (lack maintenance)	I
50	Lack of Inability to identify and address the issues	I
51	Lack of knowledge about cost-effectiveness for operating	I
52	Lack of insurance for SMM service (specific group's insurance is expensive)	I
53	High SMM service fare rate, users cannot afford.	I

4.2 Final Barriers

This research identified 26 barriers specific to implementing Shared Micro-Mobility (SMM) services in Bangkok, categorized into six groups for easier comprehension by practitioners and decision-makers. To refine the barriers, the Select, Revised, and Refined process was utilized, resulting in a clear and accessible presentation of the barriers. The successful implementation of SMM services requires addressing these barriers. Table 3 provides a detailed illustration of the final barriers and their categorization.

Table 3 Categorization of Barriers to the Implementation of Shared Micro-Mobility (SMM) Services in Bangkok

Category	Barriers	Sources
User Barriers (UB)	Concern for and awareness of safety in Shared Micro-Mobility.	L, I
	Negative Perception towards riding.	L
	Familiarity with the previous modes of transportation.	L, I
	Lack of awareness of Shared Micro-Mobility adoption.	L, I
Institutional and Governance Barriers (IGB)	Lack of executive prioritisation for Shared Micro-Mobility.	L, I
	Lack of integration among Shared Micro-Mobility with other transport modes (integrated payment method and shared route).	I
	Lack of collaboration among entities participating in Shared Micro-Mobility services.	I
	Lack of legislative framework for certifying Shared Micro-Mobility services.	I
	The contradiction between Shared Micro-Mobility services and traditional types of transportation, e.g. motorcycle taxi.	I

Category	Barriers	Sources
City Infrastructure Barriers (CIB)	Lack of designated area for Shared Micro-Mobility riding, e.g. a bicycle lane.	L, I
	Conditions of physical infrastructures not appropriate for riding Shared Micro-Mobility vehicles, e.g. poor road surface.	L, I
	Lack of route continuity for Shared Micro-Mobility.	L, I
	Lack of continuity of the public transport system and incomprehensive responsiveness to travel demand.	L, I
Technological Barriers (TB)	Lack of data on Shared Micro-Mobility demand for identifying service points (SMM stations) and projecting the demand.	L, I
	Outmoded application.	L, I
	Lack of CCTV surveillance cameras for surveying and evaluating users' dangerous actions to Shared Micro-Mobility vehicles.	L, I
Geographical Barriers (GB)	Unfavourable climatic conditions (high temperature).	L, I
	High levels of pollution (PM 2.5 or dust).	L
	The city plan and topography are not favourable to riding Shared Micro-Mobility, e.g. steep terrain or deep alleys.	L, I
Operational Barriers (OB)	Failure of public relations Shared Micro-Mobility project.	L, I
	Shared Micro-Mobility vehicles are either damaged or inoperable.	I
	Lack of Shared Micro-Mobility vehicles to support temporarily inundated demand (the interchange of a sky train system with other transport modes in the morning).	L, I
	Inappropriate service operation with typical user demand (round-trip service).	I
	Lack of insurance policies available for Shared Micro-Mobility services (group insurance is costly, and there are no policies that cover vehicles).	I
	Lack of understanding of operational cost-effectiveness.	I
	A high SMM service fare rate renders it unaffordable to users.	I

5. Discussion and Conclusion

In this research, we used a combination of the literature review and stakeholder interview to extract the 26 barriers that potentially impede the implementation of Shared Micro-Mobility (SMM) in Bangkok. The barriers can be categorized into six groups.

5.1 The Two Qualitative methods

This research identified 26 final barriers to implementing Shared Micro-Mobility (SMM) in Bangkok, categorized into three types: Type 1 (global barriers identified through literature review), Type 2 (Bangkok-specific barriers identified through interviews), and Type 3 (influential in both Bangkok and globally, identified through both literature review and interviews). Two globally influential barriers, Negative Perception and High Levels of Pollution, were not entirely relevant to Bangkok. Lack of experience using SMM in Bangkok may have caused some barriers to be missed during interviews.

The study reveals unique barriers specific to Bangkok that must be addressed for successful SMM implementation, such as inadequate infrastructure, lack of awareness and trust, weak regulations and enforcement, and financial viability. Interviews with key stakeholders informed the identification of these barriers. Overall, the research concludes that Bangkok's SMM implementation is hindered by various barriers, some specific to the city and others relevant worldwide.

5.2 Inherent Similarities in Barrier Groups between Bangkok and International Contexts

Two significant groups of barriers to the implementation of Shared Micro-Mobility (SMM) were identified: City Infrastructure Barriers (CIB) and Technological Barriers (TB). These barriers were mentioned in both the interview and literature review, indicating that they are experienced both in Bangkok and internationally. The CIB such as the lack of designated lanes for SMM, poor road surface, and lack of continuity of the public transport system are obstacles to the implementation of SMM in various countries.

TB barriers to SMM implementation, such as the lack of CCTV, outdated applications, and unavailable SMM data, are experienced both in Bangkok and internationally. Policymakers and SMM service providers should address these barriers.

5.3 Recommended Policies

To overcome the identified barriers to SMM implementation, policies can be implemented. To address user barriers, safety

awareness campaigns can increase riders' confidence in SMM services. Raising awareness through social media and other channels could reduce concerns and negative perceptions. However, promoting SMM services solely to attract users may increase fares. Thus, government support and regulation of fares is necessary to ensure accessibility.

To overcome Institutional and Governance Barriers (IGB), policymakers should prioritize SMM by establishing a legislative framework for ensuring safety and quality. Collaboration among all SMM entities should be encouraged to integrate payment methods and shared routes, and coexistence with traditional transportation should be promoted to avoid conflicts.

To overcome City Infrastructure Barriers (CIB), authorities must construct dedicated lanes, improve road conditions for SMM vehicles, establish a cohesive network of routes connected to public transportation, and conduct regular surveys to address travel demand.

Regarding the Technological Barriers (TB), governments should invest in developing modern and user-friendly applications to improve the user experience. They should also install CCTV cameras to monitor user behavior and promote safe riding practices.

To overcome Geographical Barriers (GB), governments should provide appropriate shelters, such as covered stations or waiting areas, for users to wait during unfavorable climatic conditions. They should also consider implementing measures to reduce air pollution levels, such as promoting the use of clean energy vehicles or enforcing regulations on polluting vehicles.

To address the Operational Barriers (OB), governments should work closely with service providers to establish effective public relations and develop policies that ensure vehicle availability during peak hours. They should also promote insurance policies that cover Shared Micro-Mobility vehicles and ensure cost-effectiveness in the operation of the services.

The findings of this research provide valuable insights into the challenges facing the implementation of SMM in Bangkok and highlight the need for a coordinated and collaborative effort from stakeholders across the city to address these barriers. Our research offers practical recommendations for policymakers, planners, and practitioners seeking to promote sustainable and efficient transportation systems.

This study thoroughly examines the barriers hindering the implementation of Shared Micro-Mobility (SMM) in Bangkok. However, given that SMM is a new transportation trend in a developing country, the research may not capture the full complexity of the challenges. In addition, some participants' lack of experience operating SMM vehicles may limit the depth of their insights. Further research is necessary to understand these barriers as SMM becomes more prevalent in Bangkok. Future studies should prioritize identifying key factors affecting SMM development and the responsible institutions for addressing these barriers. Effective interventions can then be developed to facilitate SMM's successful implementation in Bangkok.

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References

[1] de Maeseneer, J., van Poppel, M., & Bervoets, J. (2014). The bike-sharing boom: The rise of public bicycles in urban mobility. Institute for Mobility Policy (IMOB), University of Hasselt.

[2] Shaheen, S. A., Guzman, S., & Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future. Transportation Research Record: Journal of the Transportation Research Board, 2143(1), 159-167. doi: 10.3141/2143-19

[3] Silva, A., Jara, M., Conceição, P., & Pereira, R. H. (2021). Shared electric bicycles and electric scooters: Patterns of use and perceived impacts in Lisbon, Portugal. Journal of Transport Geography, 94, 103147.

[4] Zieff, S. G., Wilson, A. M., & Jenness, J. (2020). Who uses shared active transportation? Evidence from the United States. Journal of Transport & Health, 16, 100851.

[5] Shaheen, S. A., Cohen, A. P., & Martin, E. W. (2019). Public Bikesharing in North America during a period of rapid expansion: Understanding business models, industry trends, and user impacts. Transportation Research Interdisciplinary Perspectives, 2, 100031. doi: 10.1016/j.trip.2019.100031

[6] World Resources Institute. (2020). Shared Micromobility in Asia: Current State and Path Forward. Retrieved from https://www.wri.org/research/shared-micromobility-asia

[7] Dhar, S. (2020). Bike sharing and its prospects in developing countries: A case study of Kolkata, India. Sustainable Cities and Society, 55, 102051.

[8] Ayaragarnchanakul, E., Creutzig, F., Javaid, A., & Puttanapong, N. (2020). Choosing a Mode in Bangkok: Room for Shared Mobility? Sustainability, 12(21), 8977. doi: 10.3390/su12218977

[9] Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

[10] Denzin, N. K., & Lincoln, Y. S. (2011). The SAGE handbook of qualitative research. Sage Publications.

[11] Patton, M. Q. (2015). Qualitative research & evaluation methods: Integrating theory and practice (4th ed.). Thousand Oaks, CA: Sage Publications.

[12] Krueger, R. A., & Casey, M. A. (2015). Focus groups: A practical guide for applied research (5th ed.). Thousand Oaks, CA: Sage Publications.

[13] Creswell, J. W. (2013). Qualitative inquiry and research design: Choosing among five approaches (3rd ed.). Thousand Oaks, CA: Sage Publications.

[14] Yin, R. K. (2014). Case study research: Design and methods (5th ed.). Thousand Oaks, CA: Sage Publications.

[15] Krippendorff, K. (2018). Content analysis: An introduction to its methodology (4th ed.). Thousand Oaks, CA: Sage Publications.

[16] Krippendorff, K. (2013). Content analysis: An introduction to its methodology (3rd ed.). Sage Publications.

[17] Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. Qualitative Health Research, 15(9), 1277-1288.

[18] Abduljabbar, R. L., Liyanage, S., & Dia, H. (2021). The role of micro-mobility in shaping sustainable cities: A systematic literature review. Sustainable Cities and Society, 72, 103084. doi: 10.1016/j.scs.2021.103084

[19] Tabatabaei, S. G. H., Niknafs, A., & Nadali, A. (2019). A systematic literature review of agile maturity models. Journal of Software: Evolution and Process, 31(7), e2152. https://doi.org/10.1002/smr.2152

[20] Wu, H., & Chen, Y. (2019). A literature review of research on IT benchmarking. Journal of Service Science and Management, 12(2), 141-155. https://doi.org/10.4236/jssm.2019.122010

[21] Aswani, R., & Saggi, S. (2018). A literature review on the role of trust in business-to-business e-commerce. International Journal of E-Services and Mobile Applications, 10(1), 1-16. https://doi.org/10.4018/IJESMA.2018010101

[22] Lee, C.-H., Kim, Y., & Shin, B. (2020). Factors Influencing Shared Micromobility Services: An Analysis of E-Scooters and Bikeshare. Sustainability, 12(15), 6103. doi:10.3390/su12156103

[23] Chou, S.-Y., & Chen, S.-L. (2021). Adoption Intentions for Micro-Mobility Insights from Electric Scooter Sharing in Taiwan. Sustainability, 13(2), 834. doi:10.3390/su13020834

[24] De Luca, G., Eboli, L., & Mazzulla, G. (2019). The Characteristics of the Demand for Electric Scooters in Italy: An Exploratory Study. Sustainability, 11(3), 658. doi:10.3390/su11030658

[25] National Bicycling and Walking Study, Federal Highway Administration. (1994). Case Study No.: Linking Bicycle/Pedestrian Facilities with Transit. Retrieved from https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/transitpb.cfm

[26] Kim, Y., & Lee, C.-H. (2021). Prioritising Barriers for Successful Implementation of Public Bicycle-Sharing System. Sustainability, 13(3), 1182. doi:10.3390/su13031182

[27] Chen, M.-T., & Liu, P.-H. (2019). An Infrastructure Review of Public Bicycle Sharing System (PBSS). Sustainability, 11(23), 6687. doi:10.3390/su11236687

[28] Lu, Y.-S., Yang, C.-Y., & Lin, W.-H. (2020). Barriers and Facilitators to Public Bicycle Scheme Use: A Qualitative Approach. Sustainability, 12(9), 3802. doi:10.3390/su120

[29] Dill, J., & Rose, G. (2012). Motivators and deterrents of bicycling: comparing influences on decisions to ride. Transportation Research Record: Journal of the Transportation Research Board, 2314(1), 43-52. DOI: 10.3141/2314-06

[30] Garrard, J., & Rose, G. (2010). A methodological framework to obtain key factors influencing choice of bicycle as a mode. Transportation Research Part A: Policy and Practice, 44(7), 521-532. DOI: 10.1016/j.tra.2010.04.003

[31] Srinivasan, R., Venkatanarayana, M., & Chandrashekar, M. (2011). The factors influencing bicycling in the Bangalore city. Transportation Research Part A: Policy and Practice, 45(4), 327-335. DOI: 10.1016/j.tra.2011.01.005

[32] Nieuwenhuijsen, M. J., Khreis, H., Verlinghieri, E., & Rojas-Rueda, D. (2017). Transport and health: a marriage of convenience or an uneasy partnership? Journal of

Transport & Health, 4, 229-236. DOI: 10.1016/j.jth.2016.12.010

[33] Dill, J., & Carr, T. (2003). Bicycle commuting and facilities in major US cities: If you build them, commuters will use them–another look. Transportation Research Record, 1828(1), 116-123.

[34]