

MULTI-LEVEL PERSPECTIVE ANALYSIS OF
THE AUTOMOBILITY REGIME:
OPPORTUNITY FOR NEW MOBILITY CONCEPTS



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จุฬาลงกรณ์มหาวิทยาลัย
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ระบบการขนส่งที่ใช้รถยนต์เป็นหลัก หรือ ระบบรถยนต์ (Automobility) ก่อให้เกิดความท้าทายด้านความยั่งยืนที่สำคัญ การเปลี่ยนผ่านจากการเป็นเจ้าของรถสู่การใช้บริการการเดินทาง เช่น Mobility as a Service (MaaS) เป็นสิ่งสำคัญ อย่างไรก็ตาม ประเทศกำลังพัฒนาเช่นประเทศไทย ซึ่งระบบคมนาคมยังคงพึ่งพารถยนต์ส่วนบุคคลเป็นหลัก การนำแนวคิดการเดินทางรูปแบบใหม่มาใช้อย่างแพร่หลาย จำเป็นต้องใช้การเปลี่ยนแปลงเชิงระบบด้านสังคมและเทคโนโลยี (socio-technical regimes)

การศึกษานี้พยายามที่จะลดช่องว่างดังกล่าว โดยการวิเคราะห์ระบบรถยนต์และโอกาสของแนวคิดการเดินทางรูปแบบใหม่ในเขตกรุงเทพมหานครและปริมณฑล (Bangkok Metropolitan Region – BMR) โดยออกแบบการวิจัยเชิงสำรวจด้วยแนวทางเชิงคุณภาพ การทบทวนวรรณกรรมที่เกี่ยวข้องอย่างครอบคลุม และการวิเคราะห์ข้อมูลทฤษฎีกรณีศึกษาการวิเคราะห์แก่นสาระ (Thematic Analysis) จากการสัมภาษณ์เชิงลึกของผู้มีส่วนได้ส่วนเสีย จำนวน 21 ราย เพื่อระบุพลวัตในระบบรถยนต์ที่มีอยู่ นอกจากนี้ ยังใช้การสัมภาษณ์แบบกึ่งโครงสร้างกับผู้สัญจรจำนวน 35 รายเพื่อวิเคราะห์แก่นสาระและระบุปัจจัยด้านความเชื่อที่ส่งผลต่อการตัดสินใจของผู้สัญจรเกี่ยวกับการใช้ MaaS

ผลการศึกษายกปัจจัยภายนอก (Landscape Developments) หลายประการที่สนับสนุนระบบรถยนต์ และเสริมสร้างกลไกที่รักษาเสถียรภาพของระบบดังกล่าว อย่างไรก็ตาม การศึกษายังระบุพลวัตของปัจจัยภายนอกตลอดจนกลไกบางประการ ที่ท้าทายระบบรถยนต์และอาจส่งผลต่อเสถียรภาพของระบบได้ การศึกษานี้จึงได้เสนอ การแทรกแซงทางกลไกนโยบาย เพื่อกระตุ้นให้เกิดการเปลี่ยนจากการเป็นเจ้าของรถยนต์ส่วนบุคคลไปสู่การเดินทางรูปแบบใหม่ นอกจากนี้ การศึกษายังได้ระบุความเชื่อหลักที่มีอิทธิพลต่อการใช้ MaaS เพื่อนำไปใช้ในการพัฒนาและส่งเสริมการใช้ MaaS ต่อไปในอนาคต

ทั้งนี้ เพื่อให้ประสบความสำเร็จในการพัฒนา และสามารถส่งเสริมการใช้ MaaS อย่างแพร่หลายในกรุงเทพมหานครและปริมณฑล การศึกษาจึงได้เสนอแผนที่นำทาง (Roadmap) ของการพัฒนา MaaS โดยมุ่งให้เกิดการเปลี่ยนแปลงสู่การคมนาคมที่ยั่งยืน โดยสรุปแล้ว การขับเคลื่อนการเปลี่ยนแปลงของระบบรถยนต์ ในกรุงเทพมหานครและปริมณฑล ไปสู่แนวคิดการเดินทางรูปแบบใหม่ เช่น MaaS เพื่อสร้างระบบคมนาคมที่ยั่งยืนนั้น มีทั้งโอกาสและความท้าทาย ทั้งนี้การแทรกแซงเชิงนโยบายมีความสำคัญที่จะช่วยส่งเสริมให้เกิดการเปลี่ยนแปลงดังกล่าวได้

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The car-dominated transport system, known as automobility, poses significant sustainability challenges. Shifting from car ownership to access-based services, such as Mobility as a Service (MaaS), is crucial. However, in developing countries like Thailand where car dominance prevails, achieving widespread adoption of new mobility concepts requires substantial changes in socio-technical regimes.

This study addressed these gaps by analyzing the automobility regime and adoption of new mobility concepts in the Bangkok Metropolitan Region (BMR). An exploratory research designs using qualitative approach were adopted. A comprehensive review of related literature and secondary data analysis, combined with in-depth interviews of stakeholders (N = 31), were conducted using a thematic analysis to identify dynamics in the existing regime. A semi-structure interview with commuters (N = 35) was also conducted to investigate factors that impact commuters' decision about using MaaS.

The findings indicate that certain landscape developments support the prevailing car-centric transportation system, strengthening the mechanisms that maintain the status quo. However, the study also identified landscape dynamics that challenge the existing regime, as well as mechanisms that can potentially disrupt it. The study discusses interventions to leverage these mechanisms, encouraging the shift away from private vehicle ownership and promoting new mobility concepts. These interventions include making private car usage more difficult, forming influencer partnerships, revising industry promotion policies, and prioritizing the attractiveness of public transport. Additionally, key beliefs influencing MaaS adoption were also identified and categorized into platform functions, ease of service, perceived benefits, additional factors, and social factors.

To ensure the successful and sustainable implementation of MaaS in the BMR, a comprehensive roadmap was also proposed, involving short-term initiatives such as pedestrianizing city centers and incentives for early adopters, mid-term soft launches in designated areas, and long-term campaigns to popularize MaaS. By addressing challenges and seizing opportunities, this roadmap aims to achieve a transformative shift towards sustainable transportation in the BMR.

In conclusion, there is an opportunity to drive a shift towards new mobility concepts and steer the current automobility regime towards a more sustainable transportation system. However, achieving this transition will be challenging and require significant policy interventions.

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Many years ago I was on a business trip with my boss to the ITS World Congress in Detroit, Michigan. We met many professionals in the automotive and transportation sectors from around the world. While we were exchanging name cards and networking, my boss recognized that almost all of them had the highly-renowned “PhD” lettering next to their names. He turned to me and said, “you should have that too.” At that time, I thought it was a joke so I just laughed. Sure enough, he mentioned it again a few times over the course of a year or so. Eventually, I decided to look into it and see what they had to offer for a part-time program which might coincide with my busy schedule. That’s when I discovered the EDS Program and now here I am, finishing my dissertation.

Regardless of all the stress it caused, I have to sincerely thank my boss, Mr. Nin-nart Chaithirapinyo, for inspiring me and insisting that I do this. It really helped me grow professionally and personally. I also have to thank the EDS program – especially the director, Dr. Suthirat Kittipongvises and the program coordinator, Mr. Wiwat Lertwilaisak. Both of them have been extremely supportive since my very first day at the admission interview. Also my EDS classmates, all of whom graduated long before I did. They were all very positive and never once put pressure on me despite my awkwardly slow pace.

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Chattraporn Yingsom

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CHAPTER I INTRODUCTION

1.1 General Background

The car-dependent transportation, or automobility system, is a major contributor to countless negative impacts on the environment, society, and economy. Our ability to commute depends entirely on non-renewable natural resources like fossil fuels, which inevitably generate unsafe emissions and manifold environmental effects. Climate change is posting irreparable impacts on everyday life. Traffic congestion can provoke health problems resulting from air pollution and stress, while road traffic accidents can cause considerable social and economic losses.

It is imperative that we begin moving towards a promise for sustainable mobility to make sure that our children's generation will have sufficient resources and a clean environment to live in. A modal shift in transport systems has become a rising trend and lies at the heart of thriving transport policy. Urban mobility is currently at the edge of a transition towards a new mobility concept, enabled by technological advancements and changing social and economic trends. The emergence of these innovative approaches and technologies has the potential to not only promote the use of public transportation but also drive the overall shift.

New mobility concepts refer to innovative solutions and technologies that are reshaping the way people move within urban areas. The goal is to address the challenges of congestion, pollution, and inefficient transportation systems by providing alternatives to traditional modes of transport. These concepts emphasize sustainable and efficient mobility. They highlight the importance of an integrated and multimodal transportation system that gives people various options for commuting. Examples of these new mobility concepts include shared mobility, micro-mobility, autonomous vehicles (AVs), and Mobility as a Service (MaaS).

Among these concepts, MaaS is a recent and rapidly growing concept that focuses on integrating and coordinating various transportation services into a single mobility solution. It aims to provide individuals with seamless and convenient access to different modes of transport, such as public transit, ride-sharing, bike-sharing, car-sharing, and more. This integration is facilitated through a platform or mobile

application, allowing users to easily plan, book, and manage their transportation needs.

In Thailand, MaaS is still in its early stages of development, but it has gained attention and interest from various stakeholders. Some MaaS schemes are already available, allowing users to access transportation services through a single app. The expansion of the transit network in Thailand also presents an opportunity for new mobility services to thrive. In addition, the government is actively pursuing smart city policies to enhance urban living, promote sustainability, and improve urban services. The increasing focus on digital promotion and the demand for advanced products with enhanced connectivity will help drive the implementation of MaaS in Thailand.

1.2 Problem Statement

MaaS is still a very new concept with several questions unanswered, especially regarding what extent it can replace private cars and contribute to sustainable mobility. Many studies seek to understand the dynamic process and possibility of its implementation by focusing on the technology, ecosystem, and policy developments, but neglect its evolution as a niche within the existing dominant system. Transportation is a socio-technical system, which is instituted and reinforced by a wide range of interrelated elements such as stakeholders, technologies, markets, culture, infrastructure, public policies, etc.

A successful implementation of MaaS in a society dominated by private car usage requires substantial shifts in the prevailing socio-technical regimes. It is crucial to understand the complete ecosystem of the existing car-dependent transportation system and the potential transformations that could occur with the full introduction of MaaS. However, it remains unclear which elements and interactions within the current landscape and regimes contribute to the lock-ins of private car use. It is of utmost importance to identify the necessary changes, measures, and policies that are required to overcome these lock-ins, in order to find a potential opportunity for MaaS to insert itself into the regime level.

Since MaaS is a novel and alternative practice which challenges the dominant and existing system, it is crucial to also understand the factors that make MaaS

appealing and enable it to gain momentum among users. User beliefs play a significant role in shaping the acceptance and adoption of technologies. There is a re-search gap regarding user beliefs on MaaS despite its importance in designing effective communication strategies, enhancing user experience, and informing policy decisions which can further support its implementation.

On top of that, MaaS studies are relatively limited to the context of developed countries, especially in European region. The unique characteristics of different environments will likely require MaaS development to be diverse and multifaceted. According to the United Nation Environment Program, UNEP, two-thirds of the global vehicle fleet will be in non-OECD countries in 2050. Thus, more attention should be given to developing countries where car dependency is rapidly growing, causing far worse traffic congestion and environmental problems. In order to understand to what extent MaaS can replace private cars and contribute to sustainable mobility, it will entail a more holistic comprehension of the transport system as a whole. The disruption of the current automobility system by MaaS requires not only technological advancement but also the systematic evolution of particular social factors. A study on MaaS development is thus grounded in the theory of socio-technical transition, which appears to be ignored in most research up to this point.

1.3 Objectives and Research Questions

The present study intends to fill the aforementioned gap and add knowledge in the sustainable mobility research stream by analyzing the current socio-technical regime to find the opportunity for new mobility concepts like MaaS. The aim is to provide suggestions on policy and measures to steer the change in the current automobility regime of the Bangkok Metropolitan Region (BMR) toward a more sustainable transport system and to identify how a window of opportunity for a shift toward new mobility concepts can be maximized.

In order to achieve the research aim, MaaS is conceptualized as a niche innovation, challenging the existing automobility system. The study focuses on analyzing the automobility regime to understand the dynamics within the landscape and the current regime. This analysis aims to uncover how these dynamics interact and contribute to the reinforcement of the prevailing preference for private vehicle

use. By investigating these interactions, the research intends to identify the factors that sustain the current regime, hinder the development of alternative mobility options, and impede the transition away from car dependence.

Simultaneously, the research also aims to gain a comprehensive understanding of the factors that impact commuters' decision about using MaaS. The understanding of the individual level complements the systemic and broad comprehension of the existing system. To identify an opportunity for MaaS to penetrate the regime level, it is crucial to comprehend the strengths and weaknesses of the regime, leveraging them strategically. Moreover, understanding the beliefs regarding the use of MaaS is essential to empower its potential.

This integrated approach allows for a deeper analysis of the interactions between individual decision-making and the broader system dynamics, leading to more effective strategies for promoting the adoption of new mobility services. Accordingly, the objective is two-fold, aiming to understand the potential for change at both the systemic level and individual level.

<i>Objectives</i>	<i>Research Questions</i>
<i>1. To analyze the current automobility regime of the BMR and its impacts on the window of opportunity for a shift toward new mobility concepts.</i>	1.1 What are the landscape developments that affect the current automobility regime? 1.2 What are the mechanisms behind (in)stability in the automobility regime? 1.3 Which mechanisms can be leveraged in order to discourage private vehicle ownership and set the preconditions for a shift toward new mobility concepts?
<i>To investigate factors that impact commuters' decision about using MaaS</i>	2.1 What are the salient beliefs underpinning commuters' willingness to use MaaS?

To achieve the first objectives, the multi-level perspective (MLP) framework was utilized as a lens to gain a better understanding of socio-technical transitions and the automobility regime. This framework is widely used in sustainability transition research to explore how innovations emerge and challenge existing regimes, ultimately leading to more sustainable systems. The MLP framework recognizes that

social and technological changes are non-linear processes, influenced by various pressures and the emergence of niche innovations that can disrupt and reshape the mainstream system Geels (2012).

Qualitative methods are recommended for investigating phenomena, as they allow researchers to capture in-depth knowledge and gain a deeper understanding, particularly of social contexts (Yin, 2009) To address the first three research questions, in-depth interviews (N = 21) were conducted with relevant stakeholders to gather their insights and perspectives. Thematic analysis was employed to analyze the collected data and identify key themes and patterns.

Additionally, to enhance the validity of the study and ensure data triangulation, a comprehensive literature review together with the analysis of secondary data was conducted. This approach allows for a thorough examination of existing knowledge and findings from previous studies related to the research topic. By considering a wide range of sources and data, the study can strengthen the reliability and credibility of the research findings.

To address the final research question regarding salient beliefs, a total of 35 semi-structured interviews were conducted with commuters in the BMR. The choice of interviews as the research approach was deliberate. It allows for nuanced and in-depth exploration of the topic, while also providing flexibility to explore unexpected factors and perspectives. Interviews encourage participants to discuss what matters most to them in their own words. This approach creates an open environment that encourages participants to express their views and discuss relevant topics, ensuring a comprehensive understanding of their beliefs.

Furthermore, in order to effectively capture significant aspects of human nature and understand the beliefs that influence decision-making, the theory of planned behavior or TPB was applied as a guideline for the interview design and process. TPB is an evidence-based theory grounded on a social psychological domain that soundly explains behavioral intentions. TPB has proven its effectiveness in predicting a variety of human behaviors in differing contexts.

The MLP provides a valuable framework for understanding transitions in socio-technical systems but has an aggregate nature and does not specifically focus on the agency of individual users or travelers. To complement the MLP and gain insights into the individual-level factors influencing MaaS adoption, the TPB framework was applied. While, the MLP recognizes that changes in socio-technical systems involve interactions and influences at multiple levels, including micro, meso, and macro levels. The TPB, on the other hand, focuses on individual beliefs, attitudes, and intentions that shape behavior.

In this study, the MLP provides insights into the broader socio-technical regime and landscape within which the existing system operates, including factors such as infrastructure, policies, and industry structures. The TPB was then used as a guideline to examine the individual beliefs that influence the adoption of MaaS as a niche innovation, trying to elevate into the regime level. Such a supplement allows for a deeper analysis of the interactions between individual decision-making and the broader system dynamics, leading to more effective strategies for promoting MaaS adoption.

However, it's important to note that the TPB framework is used within this context solely as a guideline to identify relevant beliefs and is not the main focus of the research. The aim is to round off the MLP by incorporating individual-level perspectives, providing a more nuanced understanding of the factors that may influence users in shifting toward MaaS.

1.4 Scope of Research

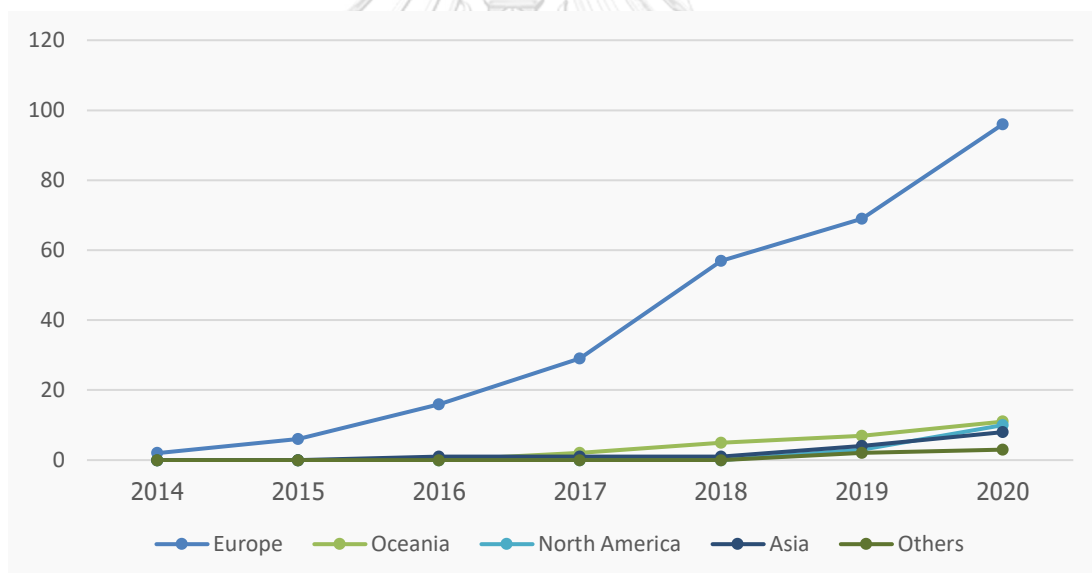
Research into MaaS has grown dramatically in the past decade. The increased publication of literature in this field reflects the rapidly growing interest in MaaS as a topic among researchers. However, most papers are affiliated with comprehension and settings in European countries.

According to the amount of literature systematically reviewed by Daniela Arias-Molinares and Juan Carlos García-Palomares (2020) and Butler, Yigitcanlar, & Paz (2020) (n = 129 after eliminating duplications), the growth of MaaS research in relation to publication year and region is shown in Figure 1 Up to 75% of the papers

are based in situations and case studies in Europe, 9% in Oceania, 8% in North America, 5% in Asia, and 4% in the rest of the world. This implies that MaaS studies are centralized and focus more on its evolution in developed world than understanding the counterpart's, which is certainly just as important. Although the number of academic papers about MaaS in other regions is growing recently, there is still a huge knowledge gap between Europe and the rest of the world.

Considering that MaaS cannot be universally applied for all regions, it is important to also investigate its potential in divergent settings, especially in South-east Asia where there are various unique characteristics of the transport systems. The Bangkok Metropolitan Region, or the BMR, in Thailand presents a unique, valuable, and captivating context of study, where the dominant mode of personal mobility is well-established, stable, and socially embedded.

Figure 1 Accumulation of academic research by year and region.



Transportation in the BMR comes with a history of road infrastructure that favors economic growth reliant upon the automotive industry. The whole system was developed with an emphasis on the country's growth and prosperity, nurturing automotive industry expansion and an upward spike in car sales. A full breadth of actors, technology, industry, markets, consumer behavior, public policy, infrastructure, and even cultural values make up and reinforce private vehicle usage, which in turn further stabilizes the automobility regime. The BMR context will reflect

how incumbent interests maintain and prolong a long-embedded regime, like car-based mobility, pulling against transition and inducing barriers to MaaS adoption.

A research study focusing on the automobility regime and MaaS in the BMR can provide valuable insights applicable to Southeast Asian and other developing cities. These cities often share common characteristics, particularly in terms of transportation agendas. They face similar transportation challenges, including rapid urbanization, traffic congestion, increasing motorization rates, a heavy reliance on private vehicles, the presence of informal transportation systems, difficulties with public transportation, air pollution, governance and policy challenges, as well as socio-economic inequalities.

By understanding the dynamics of the transportation system and the potential opportunities for MaaS implementation in the BMR, lessons can be drawn and applied to other cities in the region facing similar issues. While each city has its own unique characteristics, research conducted in the BMR can contribute to a broader understanding of automobility regimes and mobility services in Southeast Asia and developing countries.

In conclusion, a case study of BMR was selected for at least four reasons. First, as mentioned earlier, most of the previous studies on MaaS were based in Europe, which has completely different characteristics – social and economic – compared to Southeast Asian countries. Second, the potential transferability of the findings to other cities with resembling characteristics. Third, people living in density create an economy of scale for MaaS providers, which allow the possibility for implementation. Last but not least, its transportation ecosystem is more promising compared to other parts of Thailand.

The BMR had an estimated population of 10.8 million as of December 2022. It is the most densely populated area in Thailand, encompassing the capital city of Bangkok along with five neighboring provinces: Nonthaburi, Samut Prakarn, Pathum Thani, Nakhon Pathom, and Samut Sakhon as shown in Figure 2 The BMR occupies 7,761.6 km² (total) and 1,568.7 km² (urban area) with a population density of 1,452.6 and 3,762.3 people/km², respectively.

Statistics from the Office of Transport and Traffic Policy and Planning (2022) shows that, on average, commuters in the BMR travel approximately 13

kilometers, spend around 28 minutes, and 32 baht per trip. Statistics from the Department of Land Transport, Thailand (DLT) also demonstrates that there are approximately one million new vehicles registered per year in the BMR, accounting for about one third of the whole country.

This study seeks to generate findings specific to the context of the BMR. It aims to understand the automobility ecosystem and assess the potential changes that could arise with the introduction of MaaS. By comprehending the existing transportation system and its dynamics, the study can identify the challenges and opportunities associated with promoting MaaS in the BMR. The research findings will provide insights for policymakers, stakeholders, and urban planners about the necessary changes and measures required for a successful transition.

Figure 2 Map of study area – Bangkok Metropolitan Region (BMR).



Another area of research that requires clarification is the specific characteristics of MaaS being studied. MaaS is context-dependent and its implementation varies globally. Therefore, it is important to frame the nature of MaaS being focused. Generally, MaaS can be categorized as either car-centric or public transportation-centric. Car-centric MaaS integrates car-based mobility options like

ride-hailing services, car-sharing, and private car rentals into a single platform. On the other hand, public transportation-centric MaaS prioritizes the integration and optimization of public transportation modes to promote sustainable and efficient travel.

Since the objective of this research is to steer the change in the current automobility regime of the BMR toward a more sustainable transport system, the focus will be on public transportation-based MaaS. This approach aims to promote the use of public transportation as a sustainable and efficient mode of travel, emphasizing environmental impacts and encouraging a shift away from private car usage. In other words, this study focuses on MaaS as a tool for achieving sustainable mobility.

1.5 Significance and Contribution

To the best of the researcher's knowledge, this study is the first to use the MLP framework to systematically analyze the car-dependent system and investigate the opportunity of MaaS. It is also one of the limited number of studies that apply TPB to the analysis of user perspective regarding MaaS. The mechanisms that (de)stabilize the automobility system and the factors influencing the adoption of MaaS, which is conceptualized as a niche innovation within such transition, were highlighted. These factors will influence the transition dynamics that will either prevent or promote the emerging and unfolding of MaaS in the future.

According to a search, retrieved on October 10, 2021, using the ScienceDirect, Scopus, ResearchGate, and Chulalongkorn University online library databases – with the keywords “Mobility as a service” AND “Multi-level perspective” – only 3 documents can be found. While MLP was used by these researchers, none of these addressed the same research questions previously laid out in this proposal. One explored how shared mobility influenced MaaS development at the niche level in Madrid (Daniela Arias-Molinares & Juan Carlos García-Palomares, 2020), another investigated societal and governance implication of MaaS (Pangbourne et al., 2020), while the other focused on the dynamics between the public transport system and the development of MaaS in Amsterdam, Birmingham, and Helsinki (Hirschhorn et al., 2019).

In order to successfully introduce MaaS, it is essential to understand how the current transport system has been stabilized. This comprehension will help explain how a new mobility concept can unfold and to what extent it will proceed beyond niche spaces and move toward real disruption of the established automobility regime. MLP has the strongest potential to piece together this puzzle with a holistic view. This approach could potentially be a guide to understand the ongoing automobility regime, the emergence of MaaS, and its struggle with incumbent systems so the appropriate strategies for a successful introduction can be formulated.

Results from this study contribute to both transport research and socio-technical transition studies by providing a holistic understanding of automobility and MaaS as a cog in the machine of sustainable mobility transition. By analyzing the current automobility regime, and MaaS as a niche innovation, this study aims to fulfill the knowledge gap and provide suggestions on policy and measures to steer the change in the current automobility regime, as well as to identify how a window of opportunity for a shift toward new mobility concepts can be maximized.

Moreover, a broad comprehension on MaaS, in a setting other than western countries is also provided. This newfound knowledge is constructive for aiding further studies, especially within Southeast Asia where knowledge on MaaS is still limited. Like many cities in developing countries, Bangkok is particularly unique in terms of the current transport system due to various uncommon modes such as motorcycle taxis, boats, or motorized rickshaws that co-exist with growing public transport. This uniqueness will translate into commonalities for other researchers looking to offset the negative sides of current transport systems within their nations.

This study is also the first study about beliefs regarding MaaS adoption, so users' expectations and motivational factors influencing their intention to use MaaS were highlighted. The results will allow for a further understanding of user intention to adopt this innovative service, as well as its preferred path towards sustainable mobility promotion. By understanding user beliefs, technology developers can design user-centered solutions and address barriers to adoption. Research findings also inform policymakers about societal perceptions, enabling them to design regulations that address concerns and promote responsible technology development.

In terms of theoretical contribution, this study unfolds in multiple facets. Firstly, it contributes to the MLP by enhancing the understanding of regime dynamics and landscape developments in distinct socio-technical settings, specifically focusing on the automobility regime in the BMR. The MLP framework has primarily been applied in developed and Western contexts, and this study expands its application to the developing and Southeast Asian contexts. It provides valuable insights into the unique challenges and opportunities for sustainable mobility transitions in the BMR. Ultimately, this research adds to the existing body of knowledge by bridging the gap between the MLP framework and the context of developing and Southeast Asian countries

For the TPB, the belief study plays a crucial role in identifying the specific beliefs that are salient and influential in shaping an individual's intention towards a particular behavior. By examining beliefs related to MaaS within the context of the BMR, the study contributes to the refinement of the belief-based components of the TPB model specifically for MaaS adoption. These insights are also applicable to other cities with similar characteristics. Furthermore, the findings can serve as a foundation for developing measurement items in future TPB studies that focus on MaaS or new mobility service adoption.

In addition, the belief study uncovers new, or supplementary, factors that may influence behavioral intentions beyond the core TPB constructs. It can identify specific beliefs that are not explicitly captured in the original TPB framework but have significant impacts on individuals' intention to engage in a behavior.

Last but not least, the theoretical contribution of incorporating the MLP and the TPB lies in providing insights into the complex interplay between the structural regime and individual behaviors, shedding light on the potential for transformative change in transportation systems, and informing policy interventions to promote MaaS adoption.

CHAPTER II THEORETICAL BACKGROUND AND LITERATURE REVIEW

2.1 Mobility as a Service (MaaS)

If we observe a city from a bird's eye view, we will get to see a world in fascinating motion. Cities are full of mobility including diverse modes of transport: countless private cars stuck on the congested roads, taxis circle around and often reject customers in Bangkok (until Grab and Uber came into existence), trains carry people to and from their workplaces, trucks deliver goods and services, pedestrians roam across streets and through city blocks, motorcyclists squeeze their ways through busy traffic – all in an unbalanced ratio of course.

Mobility is the spirit of cities and the fundamental component in sustaining urban life. In all societies, regardless of their development, transportation is essential but always has critical negative consequences in the long term. There are several problems created by the extensive amount of vehicles, such as traffic congestion, emissions, and pollution. Accordingly, it has been a vision and ultimate goal of many cities that their residents no longer rely on private cars, but rather on public transport or active modes such as walking or biking.

Even though these transport modes can provide alternatives to personal vehicles in many cases, it seems that they still fail to sufficiently respond to the sustainability challenge. They will not be able to compete with private cars or meet all transport needs by themselves. As a result, during an era of a sharing economy and collaborative consumption, other innovative modes, such as car sharing, ride hailing and carpooling arise and provide significant compliments to public transport.

Having such a variety of options creates a complicated transport system where users find it burdensome to navigate through all different information sources, mobile applications, tickets and journey planning in order to smoothly commute around the city. The need for a single, user-friendly platform that integrates all services has enabled the concept of Mobility as a Service or MaaS (Daniela Arias-Molinares & Juan C García-Palomares, 2020).

2.1.1 Defining Concept and Characteristics

Suppose there is no private vehicle and people can travel to anywhere using any combination of transport modes, whether buses, trains, taxis, ride-hailing or any other kinds at the tip of their fingers – the concept of Mobility as a Service (MaaS). MaaS is an integrated transport solution, which combines different transport modes and multiple functions such as trip planning, bookings and payments in a single interface that could be accessed via either a website or an application (Loubser et al., 2021).

This concept is initiated and has been progressing mostly in the European Union, primarily Finland. Although these initiatives are characterized by public policy in order to promote public transport ridership, as well as improve productivity in the transportation sector using Information and Communication Technology (ICT), a wide range of digital solutions designed to make MaaS more efficient and attractive are being led by the private sector.

However, administrative authorities are tied into the legal system and their initiatives are vital to information distribution for the recognition of MaaS. Most notably is the European Commission which is at the forefront of the EU initiatives being used to propagandize the MaaS concept.

The key approach here aims to improve productivity and efficiency by shifting to a system that combines all different modes of transport into one platform which also includes monthly unlimited services, as opposed to single-trip payments with the same transport options. Improving convenience through the integration of itinerary planning, reservations, and payments will increase the level of convenience the user experiences, potentially matching that of private cars since both will essentially allow users to travel anywhere – at any time – with varying degrees of freedom (Sakai, 2019).

Heikkilä (2014) was one of the very first researchers to mention Mobility as a Service in her proposal on Helsinki's mobility transformation. She referred to MaaS as “a system in which a comprehensive range of mobility services are provided to customers by mobility operators.” Hietanen (2014) mentioned a more specific definition of MaaS as a distribution model which combines different transport modes and offers mobility packages to customers based on their needs through one, single

platform. This system provides users with tailor-made mobility solutions according to their preferences – putting them at the core of transport services – which are nearly similar to what they can achieve from private cars. It is an emerging transport solution that provides mobility packages and offers a new travel experience to end users in terms of access to the services and seamless trips on one single platform (Narupiti, 2019). Some captivating and intelligible definitions of MaaS are listed as follows.

Figure 3 MaaS definitions ordered by published date.

#	Author(s)	Definition
1	(Heikkilä, 2014)	A system in which a comprehensive range of mobility services are provided to customers by mobility operators.
2	(Hietanen, 2014)	A distribution model that delivers users' transport needs through one single interface of a service provider, combining different transport modes to offer tailored mobility packages.
3	(Rantasila, 2015) (Ambrosino et al., 2016) (Strömberg, Karlsson & Sochor, 2018)	An on-demand service that would incorporate all transport modes from shared mobility (including electric scooters, bikes, cars or motorcycles) to the bus, metro, tram, rail, or even flights that brings a shift of paradigm.
4	(MaaS Alliance, 2017)	The integration of various forms of transport services into one single mobility service accessible on demand.
5	(Kamargianni et al., 2018)	An ecosystem that integrate public and private operators with a MaaS Provider in the middle, managing both demand and supply by offering mobility services to end users, as well as dispatching/assigning daily trips to several operators.
6	(Kamargianni & Goulding, 2018)	A user-centric, multimodal, sustainable and intelligent mobility management and distribution system, in which a MaaS Provider brings together offerings of multiple mobility service providers (public and private) and provides end-users access to them through a digital interface, allowing them to seamlessly plan and pay for mobility.
7	(Narupiti, 2019)	A tailor-made mobility solutions that offers a new travel experience as mobility packages to end users according to their preferences, in terms of access to the services and seamless trips on one single platform.

In general, MaaS consists of these key elements: integration of different transport modes/services; multimodal transportation; on-demand, real-time and seamless solution; single platform/one-stop service to plan, book, and pay for customized mobility needs in convenient packages. The core function of MaaS is to fulfil the mobility needs of users by offering flexible, reliable and seamless door-to-door transport options to reduce congestion and pollution (Loubser et al., 2021).

The fundamental characteristics of MaaS described in extensive research are itemized in Table 2. In order to illustrate how MaaS really works in your daily life, let's say that MaaS is Netflix's model applied to urban transportation. So, the way the movie industry changes people's future choices will most likely be the same way this innovative approach changes the future behaviors of city dwellers.

Figure 4 The fundamental characteristics of MaaS.

#	Author(s)	Integration	Multimodality	User-centric design	Subscription model
1	(Hietanen, 2014)	One single interface of a services	Combination of different transport modes	Delivery of users' transport needs	Tailored mobility packages
2	(Thakuriah et al., 2016) (Docherty et al., 2017)	Integrated aggregation and payment platforms; extensive big data processing	Access to interoperable mobility services	Shift from ownership to ridership	Packages of mobility services
3	(Eckhardt et al., 2017) (Sochor et al., 2018)	Integration of planning, information, booking, payment, service offers	Multimodal and sustainable mobility services	Services that address customers' transport needs	Bundling
4	(Jittrapirom et al., 2017)	One platform; Multiple actors (operator, demanders, service suppliers)	Integrated transport modes	Need oriented; customization; personalization	Packages
5	(Kamargianni & Goulding, 2018)	Access to mobility offerings and providers (public and pri-vate) through a digital interface; seamlessly plan and payment	Multimodal mobility management; multiple mobility services	User-centric mobility management	-
6	(Narupiti, 2019)	Access to the services and seamless trips on one single platform	-	A tailor-made mobility solutions; a new travel experience offered to end users according to their preferences	Mobility packages
7	(MaaS Alliance, 2019)	Single platform/application; single payment channel; integration; single mobility service	Access to transport modes; combination of diverse forms and modes of transport	Users at the core of mobility services; solutions based on individual requirement	

There has been a lot of research, and many discussions, regarding the concept of MaaS in European countries. Many pilot projects gradually increased and have become far-reaching in recent years, with businesses and governments pursuing the implementation possibility and fundamental ecosystem readiness. MaaS is becoming a fast-rising trend reshaping how urbanites get around, especially in Finland where the very first pilot models started.

2.1.2 Recognizing Different Implementations

The rising trend of MaaS shows a potential shift in the way humans commute, and basically live their lives. Although MaaS has become increasingly popular over the past decade, there is still no clear answer or framework that constitutes what MaaS really is. Moreover, the MaaS concept has been scatteredly interpreted and developed into different initiatives and pilot projects, testing alternative strategic pathways across different geographic regions.

The central governments of European countries recognize the potential of MaaS, and its contribution to reducing car trips and enhancing public transport, so they have managed MaaS development by making it as seamless and painless as possible. Despite the same trend of strong intentions emerging from the public sector, there are still differences in developmental pathways of MaaS among European nations. In Sweden, MaaS is initially considered as a tool to promote more environmental-friendly modes and servitized transport in order to meet the ultimate goals of sustainable mobility in general, and for public transport enhancement in particular.

In Finland, MaaS is mostly, and preferably, perceived as a new transport paradigm to enhance the nation's growth based on ICT and digitalization, which have been the biggest contributors to its economy. Since the telecom giant Nokia collapsed, the Finnish government had been looking for new masterpieces to offset the economic recession. As a result, MaaS is essentially motivated by the idea that strengthening public spending on the transport sector, and encouraging cross-industry collaborations, will lead to a competitive market providing favorable conditions for economic growth. Consequently, Finnish MaaS developments have been more market-driven, compared to those in Sweden (Smith, Sochor, & Karlsson, 2018).

In North America, where the whole environment and ecosystem are divergent, the deployment is significantly different as a result. In the United States for example, local authorities have mainly been the proponents behind MaaS, with a stronger focus on car-sharing and even autonomous vehicles (Cruz & Sarmiento, 2020). This is obviously because of the lower density and popularity of public transport, as well as a stronger automobile-dependent system. The intention appears to be on providing new business models and improving the utilization of cars, rather than reducing private car usage or increasing the efficiency of public transport as a whole.

In the context of Asian countries, Japan demonstrates a distinctive scenario where the national government tries to explore a wide range of possible models and adjust them to meet different outcomes. That is why MaaS was pioneered not only by the Ministry of Land, Infrastructure, Transport, and Tourism (MLIT) but also by the Ministry of Economy, Trade, and Industry (METI). The two ministries have jointly started a project titled “Smart Mobility Challenge” to encourage the implementation of new mobility services that can either solve mobility issues, address regional challenges, or strengthen the economy (METI, 2020). Consequently, the inspiration behind the ideas for MaaS implementation in Japan is diverse and extends far beyond the typical traffic and environmental issues.

On the contrary, MaaS in Taiwan was driven mainly by the Ministry of Transportation and Communications, who initiated the strategic planning and then further developed it into national policy after the fact (Chang et al., 2019). The approach to utilize a public-private partnership for the implementation resulted in two different MaaS pilot projects initiated in Taipei and Kaohsiung Metropolitan areas, both with different integrated services and transport mode offerings (Chang et al., 2019). Taiwan possesses extensive information and communications technology, and paired it with its existing public transportation system to promote MaaS. This strategy is almost similar to European countries, where public transportation is considered the backbone of MaaS. Conversely, MaaS is used as a tool to promote public transportation in the case of Taiwan’s rollout.

In other contexts, MaaS implementations may be subject to different purposes such as social inclusion, or improved tourism experiences and sustainability

(Signorile et al., 2018). MaaS could be adopted with a focus on rural areas, where there is limited or nonexistent public transport, since the low density of population requires more subsidy for investment and operating cost. With better access to transportation, MaaS could increase an area's attractiveness and improve the quality of life, bridging the equality gap between rural and urban areas.

Given the unique characteristics of different cities and regions, creating a globally relevant MaaS model is not possible. The evolution of MaaS is dependent upon institutions, stakeholders, infrastructure, and political policies already in play. Therefore, more studies in diverse contexts are required to reflect on how MaaS should be developed in specific environments. Countries and cities involving the MaaS concept in their transport policy development need to have keen eyesight on how they intend to deploy this concept. This clarity can be used to improve collaboration among stakeholders, as well as guide them, to ensure a MaaS deployment that fits with their broader policies and goals.

2.1.3 Exploring Different Levels of MaaS in Reality

One of the goals for MaaS implementation is to offer more convenience through freedom of choice in order to encourage more sustainable travel behaviors. In essence, the potential to increase sustainable travel behavior arises from a high level of service integration. Research has already revealed that the more services that are integrated into the system, the more likely it can encourage commuters to use MaaS (Durand et al., 2018). Therefore, the reality of MaaS essentially revolves around the particular efforts to increase the level of integration incorporated in its design.

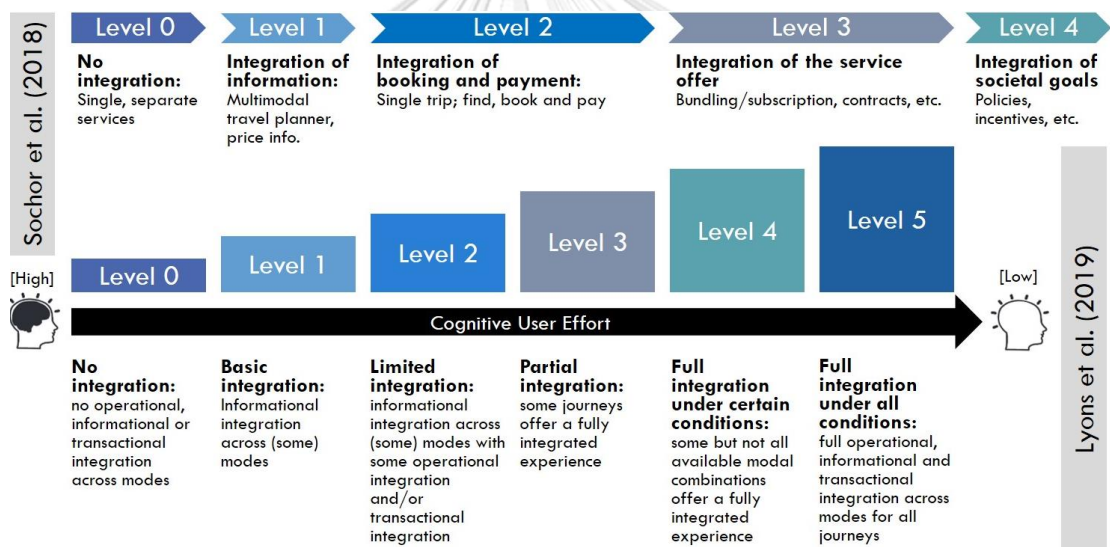
The very first topology of MaaS, which is well-accepted and broadly referred to, was introduced by Sochor et al. (2018). Its aim was to be used for comparing different schemes, as well as understanding the potential effects of MaaS. Five levels of integration were proposed, summarized in Figure 3, ranging from Level 0 (no integration), Level 1 (information integration), Level 2 (ticketing and payment integration), Level 3 (service offer integration), and Level 4 (integration of societal goals).

This typology is unique and intriguing for the way it includes social and transport policies in the highest level where incentives are implemented to reduce

private car ownership and usage, trying to deliver a more accessible and livable city. It allows the public authorities within a city, region, or even on a national level to influence the societal and ecological impacts of mobility services by incentivizing sustainable travel behaviors.

While Sochor et al. (2018) focuses on the customer, provider, and business perspectives, the six levels of MaaS integration taxonomy proposed by Lyons et al. (2019) helps elaborate and reinforce the knowledge by including operational integration and cognitive user effort – the effort of relying upon the mobility system beyond the private car to fulfill mobility goals. A more detailed explanation of the levels within the taxonomy is described in Figure 5 below.

Figure 5 **The level of MaaS integration**, modified from Sochor et al. (2018) and Lyons et al. (2019).











One of the very first examples of MaaS platforms that's still currently available in the marketplace is the well-known Whim, developed by a local start-up and introduced in Helsinki, Finland in 2016. After a six-year plan, involving governments, cities, and industry stakeholders, Whim purposefully established a mobility ecosystem which integrated public and private transport services (Casady, 2020). Its users can combine, plan, and pay, both in pay-as-you-go and monthly subscription forms, for public transport, taxi, car rental, car-sharing, and city bike trips – any mode of transport within the city – by just entering a destination and allowing the application to generate route options based on personal preferences.

Whim's impact report in 2018 showed that 63% of MaaS user trips are based on public transportation, compared to just 48% of trips made by the average citizen. They also found that 42% of all Whim city bike trips are merged with public transportation, implying that active modes are used for solving the last-mile problem (Daniela Arias-Molinares & Juan Carlos García-Palomares, 2020).

Though Whim has been recognized as one of the most notable mobility services, different MaaS platforms have been initiated and deployed worldwide. Some examples of MaaS schemes that are still operational are listed in Figure 6. Most platforms are used in developed countries, offering personalized transport solutions with flexible payments – nearly seamless journeys for travelers.



Figure 6 Examples of MaaS schemes, modified and updated from Lopez-Carreiro et al. (2020) and Hensher et al. (2020a).

Launch Year	Name	Logo	Location	Service				Modes			
				Info. & Planning	Booking	Pay per ride	Subscription	Public transport	Shared transport	Taxi	Parking
2012	Transit		North America, Europe, Australia, New Zealand	•	•	•	-	•	•	•	-
	TripGo		United States	•	-	-	-	•	-	•	•
	Grab		Singapore, Thailand, Myanmar Indonesia, Malaysia, Vietnam, Philippines, Cambodia	•	•	•	-	•	-	•	-
2014	Mobility Mixx		Netherlands	•	•	•	-	•	•	•	•
	EMMA		France	•	•	•	•	•	•	•	•
	Mein GVH (Hannovermobil)		Germany	•	-	-	•	•	•	•	-
	Qixxit		Germany	•	•	•	-	•	•	•	-
2015	myCicero		Italy	•	-	•	•	•	-	-	•
	MobiPalma		Spain	•	•	•	-	•	•	•	•
2016	Kyyti (Tuup)		Finland	•	•	•	-	•	•	•	-
	Reach Now (Moovel)		Germany	•	•	•	-	•	•	•	-
	Whim		Austria, Belgium, Finland, Japan, Switzerland	•	•	•	•	•	•	•	-
2017	NaviGoGo		Scotland	•	•	•	-	•	•	•	-
	WienMobil		Austria	•	•	•	•	•	•	•	•
	S'hail		Dubai	•	-	-	-	•	•	•	-
2018	HVV Switch		Germany	•	•	•	-	•	•	•	-

While MaaS initiative projects have been quite successful, and operations have been expanding to different cities globally, MaaS operators still struggle to gain market penetration. Sampo Hietanen, the CEO of MaaS Global Inc., notes that “users

are adopting the service well...but seamless user experience means much more than just a cool app.” There is still a lot of work to be done in delivering a user-centric service, especially in developing a business model that can fit into different settings. These are some of the challenges for MaaS’s success which will be discussed further.

2.1.4 Realizing Challenges and Uncertainties

As MaaS continues to gain increasing interest within and beyond the transport sector globally, there has also been a wide range of challenges and uncertainties casting a shadow on its capabilities. The development of MaaS is encircled with ambiguity in broader aspects including technological feasibility, future demand, and willingness to cooperate among key stakeholders. These uncertainties can prevent the concept from taking place on a larger scale (Jittrapirom et al., 2018).

An adequate amount of research has identified several challenges regarding the practical application of MaaS. Overall, the fundamental challenge of different expectations is highlighted in many studies (Audouin & Finger, 2018; Mladenović & Haavisto, 2021; Polydoropoulou, Pagoni, & Tsirimpa, 2020; Smith, Sochor, & Karlsson, 2018). Interests differ between public and private stakeholders, as the public sector is budget or cost-saving oriented, while the private sector is profit oriented. Therefore, while private operators would typically aim to maximize its revenue and prefer to provide as many profitable trips as possible, the main purpose of MaaS development for public actors would rather be social contribution by reducing trips or facilitating a modal shift from private modes to public, shared, or active modes (Sochor et al., 2016).

Another crucial challenge is the willingness to cooperate among key stakeholders (Daniela Arias-Molinares & Juan C García-Palomares, 2020; Eckhardt et al., 2018; Jittrapirom et al., 2018), either due to differences in their viewpoints according to the business domain they represent (Polydoropoulou, Pagoni, & Tsirimpa, 2020) or inevitable limitations arising from institutional barriers. Some stakeholders, such as public transport providers, tend to hold onto their current business model and may refrain from changing in order to maintain their benefits or monopoly power (Jittrapirom et al., 2020).

In some cases, even when they are willing to collaborate, laws regulate their mission and activities, making it difficult for them to pursue any innovative operations or partnering with private sectors. In addition, the collaboration is hindered by rooted differences between them, such as unenthusiastic bureaucracy and political interference that abuse public actors' agility and speed (Smith, Sochor, & Karlsson, 2018). Some private actors even point out that coordinating with public organizations can be time-consuming, bringing about unpredictable results (Narupiti, 2019).

A further challenge, notably referred to as the strongest financial barrier, regards the establishment of a sound business model (Eckhardt et al., 2018; Narupiti, 2019; Smith, Sochor, & Karlsson, 2018), especially when users tend to expect a savings in their travelling costs when using MaaS (Mladenović & Haavisto, 2021). Therefore, in order to achieve marketability with MaaS, it is extremely challenging to develop sustainable business models that offer high-value mobility services to customers, while still allowing stakeholders to capture their expected value (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020). Other difficulties of MaaS concern operational and technical issues like low ICT availability to support MaaS, unwillingness to share data, or low availability of public transport supply (Polydoropoulou, Pagoni, & Tsirimpa, 2020) which could all potentially affect the success of business models.

Amidst the above-mentioned challenges, sustainability (Alyavina et al., 2020; Sarasini et al., 2017) and future demand (Casady, 2020; Hesselgren et al., 2020; Jittrapirom et al., 2018; Smith, Sochor, & Sarasini, 2018) remain key areas of concern. These are the two specific challenges which this study contributes to: Opportunity for MaaS to disrupt the incumbent car-dependence system and user's beliefs regarding MaaS adoption.

MaaS should be developed in a way that it will truly meet people's needs, putting the user at the center of transport service providing – the so-called user-centered design or user-driven development. All of this particularly ensures its attractiveness over private vehicles, leading to other associated social and environmental merits. At the core remains the need to change people's attitudes towards private cars, reflecting more positivity on public transport and alternative mobility services. However, this attitudinal shift from car dependency is recognized

as too ambitious, consequently being a central challenge for MaaS development. In essence, MaaS's potential to deliver sustainability relies greatly upon user adoption. These two challenges are interdependent and indefinitely account for the extent of which MaaS can be successful.

2.1.5 Bridging MaaS and Sustainable Mobility

Based on its initial concept, as discussed earlier, there has been a broad expectation that MaaS will potentially increase the utilization of public transport by offering a high level of convenience, making it an alternative to private vehicles. Therefore, it is expected to become a means to overcome some of the negative impacts associated with the automobile-dependent systems by promoting sustainable mobility. MaaS is believed to have such potential because it is unique in the way that it can also offer more sustainable transport options – such as carpooling, e-scooter, bike, or car sharing – which can be combined with traditional modes of transport, offering pro-environmental multimodal trips. MaaS seems to offer a potential opportunity for a paradigm shift in the transport sector towards more sustainable mobility.

However, MaaS platforms are so perplexing that they also come with their challenges regarding such opportunities. There is no guarantee that MaaS will replace the number of cars on the roads or even reduce dependency. If MaaS cannot engage car drivers, rather than simply attract public transport riders with its on-demand services, it fails to deliver expected sustainability. Although MaaS was initiated with expectations to contribute to a more sustainable mobility system, its potential needs to be discussed and assessed prior to execution. It is important to make sure that MaaS will develop in a direction that sustainability will be promised – the replacement of private car use.

Several pilots have initially been operated in order to understand more about MaaS and its potential to deliver sustainable mobility. Most of them are based in major cities across Europe. An early field study of MaaS schemes found that participants make better choices both saving money and reducing carbon emissions in such a setup (Sochor et al., 2016). Among these, the results from the MaaS pilots called Whim in Finland and Smile in Austria seem to similarly indicate that the

introduction of MaaS contributes to an increased number of trips taken on public transport, higher use of multimodal trips in transit, and a lower number of trips taken by private car (Daniela Arias-Molinares & Juan C García-Palomares, 2020).

Sweden's UbiGo pilot analysis also shows some changes in users' travel behavior and mobility choice after users joined the program. Data was collected from both participating and non-participating households on a six-month field operational test using a mixed-methods approach. The results showed that MaaS tends to reduce private car use regardless of mode choice the participants normally use before joining the pilot test. The highest percentage decrease in private car use can be as much as 50%, and the greatest increase comes in the form of car sharing. In general, there was a shift away from private car use towards alternative modes, including car sharing, bus, and bicycle (Sochor et al., 2016).

A significant number of results, from various kinds of studies across the world, similarly demonstrated a great potential of attracting more private vehicle users to public transportation, shared mobility, or active modes through MaaS schemes (Chang et al., 2019; Harrison et al., 2020; Ho et al., 2020; Jang et al., 2021; Wright et al., 2020). For example, findings from sensitivity analysis using an activity-based approach to model demand for mobility services in Bristol, UK showed a modal shift of 2% from private vehicle to demand-responsive transport, together with a 30% increase in public transport use (Franco et al., 2020).

Additional supporting evidence from an interventional pilot study in Belgium shows that personalized mobility can be utilized to encourage healthier and pro-environmental behaviors by tweaking various options in the platform and using tailored feedback intervention. An analysis of individual travel behavior reveals that the intervention applied in a customized mobility solution triggers an individual's transition towards pro-healthy travel choices and increases active mobility with higher health benefits – such as walking and cycling – which in turn considerably decreases car dependency (Ahmed et al., 2020).

Another study by Matyas and Kamargianni (2019) also demonstrates that MaaS bundles (monthly subscription plans) have the potential to be a management tool to promote existing underutilized services such as shared mobility, further embedding sustainable travel behavior. A stated preference survey data analysis was

used to investigate overall attitudes and perceptions towards MaaS, as well as preferences of its bundles. The results are promising and show that over 60% of respondents would be willing to try new mobility services if those are included in their MaaS subscription. In essence, MaaS can be a great way to increase awareness of various transport options, and also allow interventions to promote greener mobility, shaping the way people travel to be more sustainable.

Furthermore, simulation studies, which enable large spatial scale analysis, show that MaaS's positive impacts are reassuring. A case study in Zurich found that a MaaS scheme with shared mobility could increase system efficiency in travel times and cost by up to 7%, as well as reduce energy consumption by 25%, or up to 43% if shared modes were used to substitute underused bus lines (Becker et al., 2020). Meaning, that MaaS could even potentially get rid of high-pollutant buses, if ridership is low, and replace them with shared mobility options.

Despite the anticipated positive impacts of MaaS, some previous results show that MaaS early adopters tend to be multimodal or car independent travelers who mostly use public transport already. Therefore, it is possible that by facilitating the use of other modes, such as car-sharing and ride-sharing, MaaS may induce an adverse effect (Fioreze et al., 2019). In other words, riders could veer away from public transport in favor of ride-sharing trips just to reduce the costs and hassles of car ownership (Sjöman et al., 2020). The private car could simply be replaced by new services that are still based on individual cars as has been the case in major cities utilizing Uber and Lyft (Schaller, 2018). As this may be the case, shifting more users to car-centric solutions is clearly not the way to improve sustainable transportation.

Alyavina et al. (2020) studied MaaS uptake and behavioral change through semi-structured interviews and thematic analysis conducted in London, Birmingham, and Huddersfield, UK to understand how MaaS can be sustainable. Their findings might be underwhelming because even though MaaS was considered attractive, people still prioritized their car and car-centric sharing services through the scheme. They ultimately concluded that incentivizing sustainable MaaS use to reduce car dependency and public transport is critical for its success.

Meanwhile, MaaS is also expected to bring about higher accessibility for transportation, which consequently leads to increased accessibility to different

services offered in society. It could help improve social inclusion with more mobility options for senior citizens, passengers with specific needs, or people on the outskirts of town who cannot easily reach the conventional transport system (Smith, Sochor, & Sarasini, 2018). However, many studies argued vice versa, raising concerns about the negative impact of MaaS on the social exclusion for some types of its subscriptions or packages might not be economically feasible for everyone. Another similar concern is the prioritization of MaaS on urban transport for commercial reasons, which implicitly excludes rural areas (Karlsson et al., 2016).

Notwithstanding the evidence from previous pilots, trials, and studies, a limited amount of progress has been made thus far in assessing MaaS's potential contribution to sustainable mobility. This is due to the fact that the transport system is non-monolithic and constitutes multiple interactions among multiple stakeholders. Studies of MaaS's impact on sustainability or behavior change alone aren't quite enough to bridge that missing link.

Understanding MaaS's role in sustainable mobility requires a holistic framework with interdisciplinary analyses in order to harvest the knowledge on multi-level involvement of actors, as well as institutions across different scales. There is a need to view and investigate MaaS as part of a socio-technical transition towards sustainability in the transport system. This study aims to fulfill that need by adopting a framework from transition studies to examine MaaS as a niche innovation through the analysis of the current automobility regime. While seeking to disrupt the current system, it also faces multiple factors acting as drivers of and/or barriers against such transition, which were also explored.

2.1.6 Influencing User Adoption

Technological developments have changed the way people live their lives and, consequently, the way economies work; it changes consumer preferences regarding ownership in particular. Digitization, together with environmental trends, is disrupting a wide range of industries, as well as business models. MaaS presents an extraordinary example of this movement. However, its successful development and promise to deliver sustainability are based on highly uncertain assumptions. For instance, the potential of MaaS to reduce private car dependency heavily depends on

the willingness of users to adopt the service. Otherwise, these tailored mobility solutions could even lead to more vehicles and road traffic congestion as speculated by some of the aforementioned studies.

Therefore, it is important to study users' preferences to achieve attractive mobility solutions and engage more customers, further securing the sustainability move of MaaS within transportation development. In order to accomplish this, user acceptance needs to be investigated. Understanding influencing factors behind MaaS adoption is of the highest importance for designing effective public policies, marketing tools, as well as service management.

Insights from an early pilot test by Ubigo regarding the likelihood and motivations to adopt MaaS showed promising results. The studies revealed that 78.8% of respondents would be interested in using Ubigo, 18.1% also would but under certain conditions, and only 3.1% said no (Sochor et al., 2016). Findings of a survey in Sydney, Australia also exhibited that over half of the respondents would be willing to use MaaS, but with interest levels varying across groups. Infrequent car users are the most likely to adopt the service. The study highlighted challenges of MaaS adoption in terms of the cultural shift from private vehicles and willingness to pay for subscriptions (Ho et al., 2018). Endorsing the prevalent categorization of factors influencing electric vehicles adoption (Singh et al., 2020), the study analyzed the literature on MaaS uptake and classified influential factors distributed into four major categories: demographic, situational, contextual, and psychological, as discussed below.

Demographic Factors

A study in the Netherlands explored users' preferences towards 10 designed MaaS subscription packages, using a stated choice experiment, discovered that younger people show more interest and eagerness for MaaS but they are fairly price-sensitive (Ratilainen, 2017). They are aware of environmental issues, yet a sustainable option needs to be affordable (Johansson, 2017). Other findings in Sweden add some knowledge to the younger generation's demand for MaaS in the way that their mobility preferences are also influenced by parents and vice versa (Johansson, 2017).

Willingness to use MaaS appears to be strongly correlated with age as demonstrated in many studies. The results unquestionably show that younger

generations are attached with the most favorable attitude towards MaaS, and likely to be the first group to join (Alonso-González et al., 2020; Caiati et al., 2020; Ye et al., 2020). More specific findings from extensive research programs relating to the young generation as early adopters are for example: young to middle-aged people residing in urban areas (Alonso-González et al., 2020; Durand et al., 2018), young individuals who are employed full-time, young people with high education level and membership experience (Ye et al., 2020).

Furthermore, demographic factors relating to MaaS acceptance also include higher education (Alonso-González et al., 2020; Hoerler et al., 2020; Ye et al., 2020), the fewer number of children or smaller households (Ho et al., 2020), as well as income. The results from Matyas and Kamargianni (2019) stated preference study, indicated that individuals with low household incomes are not willing to pay more for customization; they would prefer the predetermined and affordable packages, even if it might not necessarily meet their desires.

Situational Factors

Apart from individual and household factors, further key determinants towards MaaS adoption appear to be those related to technical issues such as smart functions, clear and real-time information providing, and application, as well as customization (Alyavina et al., 2020; Guidon et al., 2020; Polydoropoulou, Pagoni, & Tsirimpa, 2020). Polydoropoulou, Pagoni, Tsirimpa, et al. (2020) investigated end-users' expectations, perceptions, and concerns for MaaS using data collected via workshops, focus groups, and a survey in Budapest and Manchester. Their results found that notifying and the re-planning of journeys, as well as personalized mobility recommendations based on needs and habits, are key drivers towards MaaS adoption.

On top of technical factors, integration – either transport modes, services, functions, interoperability, or consistency of payment methods – seemed to be the most important influencers (Hesselgren et al., 2020; Kamargianni et al., 2016; Polydoropoulou, Pagoni, & Tsirimpa, 2020; Sochor et al., 2016). The more integrated the service is, the more attractive it becomes. An all-in-one service could help break existing travel habits for more sustainable ones (Alyavina et al., 2020). Guidon et al., 2020 conducted discrete choice experiments to estimate the consumers' willingness to pay for MaaS and found that consumers have a comparatively high willingness to pay

for a smartphone application that integrates more mobility services and functions like booking and paying.

After all, financial factors are of high importance as users are generally price-conscious (Alonso-González et al., 2020; Durand et al., 2018; Sochor et al., 2016; Strömberg et al., 2018). Technology will have to come with incentives, such as discounts, to guarantee a widespread uptake (Ho et al., 2020; Ratilainen, 2017). Results from a stated adaptation experiment demonstrated that it was not price per se but the combination of monthly fees and the discounts that primarily affected the use of a specific mode included in the MaaS bundle (Feneri et al., 2022).

Although people are price-sensitive, some of them also prioritize other aspects including those related to sustainability. Findings from previous pilots and studies showed that participants see MaaS as a sustainable alternative and they are attracted to MaaS by environmental concerns and health benefits (Alonso-González et al., 2020; Fioreze et al., 2019; Sochor et al., 2016). As such, pro-environmental attitudes, as well as announcements of future consumer-addressing policy measures, would increase openness to use such services (Hoerler et al., 2020).

Contextual Factors

Government policies are the main influencing mechanism among contextual factors. Findings from an empirical analysis of a corporate MaaS pilot showed that many regulations regarding tax or the use of public spaces (such as spaces for electric bike pool stations) inconvenienced employees and encouraged them to use MaaS. Hence, regulations must be reformed to favor sustainable options instead of discouraging them (Hesselgren et al., 2020).

Other factors concern MaaS publicity, which consequently impacts users' knowledge of the service. Lack of understanding, particularly in the usability of the app has been found to be a significant barrier to the adoption of shared and demand-driven mobility services (Casadó et al., 2020; Sochor et al., 2016). Likewise, some other studies also found that social visibility and acknowledgment of the innovation is also one of the influencing factors towards adoption. Jang et al. (2021) analyzed people's preferences of MaaS bundles using a stated portfolio choice experiment and found that respondents are not inclined to subscribe to the new service in large numbers due to lack of acknowledgment. The result implied that more publicity is

required to help users recognize and understand the service in order to increase its adoption rate.

Psychological Factors

Studies have consistently displayed that psychological factors (e.g., experiences, perceived usefulness, performance expectancy, user characteristics, perceived risk, and symbols) are significant influencing factors for MaaS adoption. Experience includes membership, car sharing, and public transport experiences. Alonso-González et al., 2020 conducted the exploratory factor analysis and latent class cluster analysis to identify factors relevant for MaaS adoption based on a survey comprised of over a thousand respondents in the Netherlands. Their experimental results showed that respondents with membership experience, and those who predominantly use public transport for traveling, are more likely to become potential users. Similarly, previous experience with car-sharing also significantly increased openness to using MaaS (Fioreze et al., 2019).

In terms of perceived usefulness and performance expectancy, flexibility seems to be the most common influencing factor (Casadó et al., 2020; Polydoropoulou, Pagoni, Tsirimpa, et al., 2020; Strömberg et al., 2018) and the second most recognized is convenience (Sochor et al., 2016). Findings from an online survey conducted by Hoerler et al. (2020) in Switzerland revealed that those who plan to reduce their car usage could be motivated to switch to a seamless travel service if it is sufficiently flexible and fast. Comparatively, (Ye et al., 2020) applied a questionnaire and the Unified Theory of Acceptance and Use Technology model to identify the key variables that affect user acceptance and user's requirements. From the results of performance expectations, the strongest demand is convenience, even greater than the impact of time and cost.

User characteristics including digital lifestyle, innovativeness, multimodality, and curiosity are the other key influencing variables regarding psychological aspects. Early adopters are those who rely on travel information for their transport mode choices instead of solely considering their preferred or habitual mode of transport. Consequently, multimodal individuals are known to have more complex strategies to choose transport modes and, in turn, facilitate the adoption of

MaaS (Alonso-González et al., 2020; Guidon et al., 2020; Hoerler et al., 2020; Jang et al., 2021; Matyas & Kamargianni, 2019; Ye et al., 2020).

Furthermore, perceived risk is prone to be another significant variable. Psychological precautions about the services reduce the willingness to use MaaS. From the perspective of observed variables in Ye et al., 2020's study, users are most worried that the MaaS process would be complicated and inconsistent with the user's appeal for convenience. In addition, users are also ambivalent around trust and privacy in the use of their data (Casadó et al., 2020; Polydoropoulou, Pagoni, Tsirimpa, et al., 2020), as well as the reliability and technological security of the service (Polydoropoulou, Pagoni, Tsirimpa, et al., 2020; Strömberg et al., 2018).

Overall, the psychological aspects appear to be more complex than demographic, situational, and contextual. However, few studies have attempted to directly explore psychological factors that influence the users' intention of using MaaS. The effective and widespread adoption of MaaS platforms requires the recognition of psychological needs, which are highly important for product/service design and development, especially those user-centric ones. Electric vehicle adoption presents a very sound example since a wide range of studies revealed that psychological factors have a positive impact in predicting consumer's adoption, purchase, and behavior intention. Additionally, recent works have emphasized the importance of the explicit treatment of psychological factors as they have been proven to significantly influence the individual decision-making process (Singh et al., 2020). Therefore, identifying the psychological aspects that influence MaaS is highly recommended for future research.

2.1.7 Understanding the Situation of MaaS in Thailand

In Thailand, MaaS is still in its early stages of development. However, the concept has gained attention and is being explored by various stakeholders - both government agencies and private companies. In Bangkok and its vicinity, several startups and public transport providers have started offering mobility platforms, allowing users to access transportation services through a single app. There are some MaaS schemes available at the initial level of integration.

Examples of MaaS schemes with separate and individual services include Grab, Haupcar, Muvmi, BTS, and MRT. On the other hand, there are also MaaS schemes that offer integration of information for multimodal travel planning, such as Namtang, ViaBus, BKK Rail, and Bangkok Metro. Some examples of MaaS schemes in the BMR are listed by launch year in Figure 7 The classification of level for each scheme is based on the degree of integration within MaaS, combined from Sochor et al. (2018) and Lyons et al. (2019).



Figure 7 Examples of MaaS schemes in the BMR, gathered from launching campaigns and news (2023).

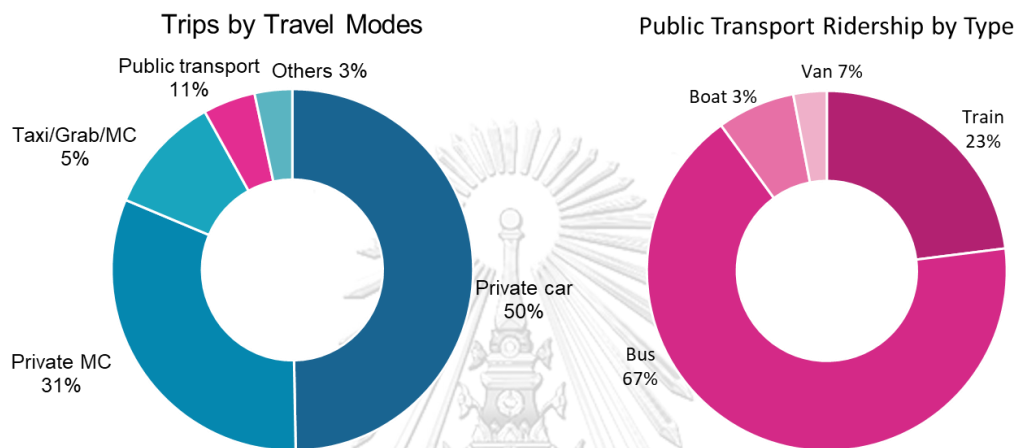
Launch Year	Name	Logo	Service				Modes				Level
			Info. & Planning	Booking	Pay per ride	Subscription	Public transport	Shared transport	Taxi	Parking	
2011	Google Map		•	-	-	-	•	-	-	-	L1
2013	Bangkok MRT		•	-	-	-	•	-	-	-	L0
	Grab		•	•	•	-	-	-	•	-	L0
2017	Hauptcar		•	•	•	•	-	•	-	•	L0
	ViaBus		•	-	-	-	•	-	-	-	L1
2018	BTS SkyTrain		•	-	-	-	•	-	-	-	L0
2019	Namtang		•	-	-	-	•	-	-	-	L1
	BKK Rail		•	-	-	-	•	-	-	-	L1
	MuvMi		•	•	•	-	-	•	•	-	L0
2020	Bolt		•	•	•	-	-	-	•	-	L0

These MaaS schemes available in the BMR can also be categorized based on the transportation type, distinguishing between those with a public transport base and those with a private transport base. Generally, the first group primarily offers information and planning functions that span across different public transport modes. On the other hand, the schemes with a private transport base are less integrated but provide more comprehensive features - including planning, booking, and payment - all within a single platform. In order to promote sustainable mobility by increasing public transport ridership, there is a need to enhance the public transport-based side of MaaS.

According to the Office of Transport and Traffic Policy and Planning, private cars make up 50% of the total trips in the BMR, while motorcycles account for 31%, and public transport represents 11%. MaaS has the potential to help promote public transport use by integrating different modes into a single platform or

application, simplifying ticketing and payment, providing real-time information, enhancing accessibility, offering incentives and rewards, and enabling integrated trip planning. These features make public transport more accessible, convenient, and user-friendly, encouraging individuals to choose sustainable modes of transportation and reducing reliance on private cars.

Figure 8 Trip in the BMR by Travel Modes of Transport
Office of Transport and Traffic Policy and Planning³ Ministry of Transport (2023).



At present, public transportation system in the BMR encompasses various modes, such as buses, rail, boats, public vans, paratransit vehicles (Songthaew¹, Silorlek²), taxis, tricycles (Tuk-Tuks), and motorcycle taxis. Among these various public transport modes available, buses are the most frequently utilized, followed by trains, vans, and boats. The bus has gained popularity as a mode of transport due to its extensive coverage area and affordability. Buses in Bangkok are operated by the Bangkok Mass Transit Authority (BMTA) and private contractors. Financial challenges have led to a decrease in the number and quality of buses, and bus fares are regulated by the Department of Land Transport (DLT) (Narupiti, 2019).

Boat services operate on the city's rivers and canals, while public vans provide point-to-point shuttle services. Paratransit vehicles and taxis are also available, with fixed fares and various regulations. Tricycles (Tuk-Tuks) and motorcycle taxis offer alternative transportation options, with negotiation-based fares.

¹ A modified pick-up truck equipped with an overhead cage and two rows of seats in the back. These vehicles are capable of accommodating up to 18 passengers or more.

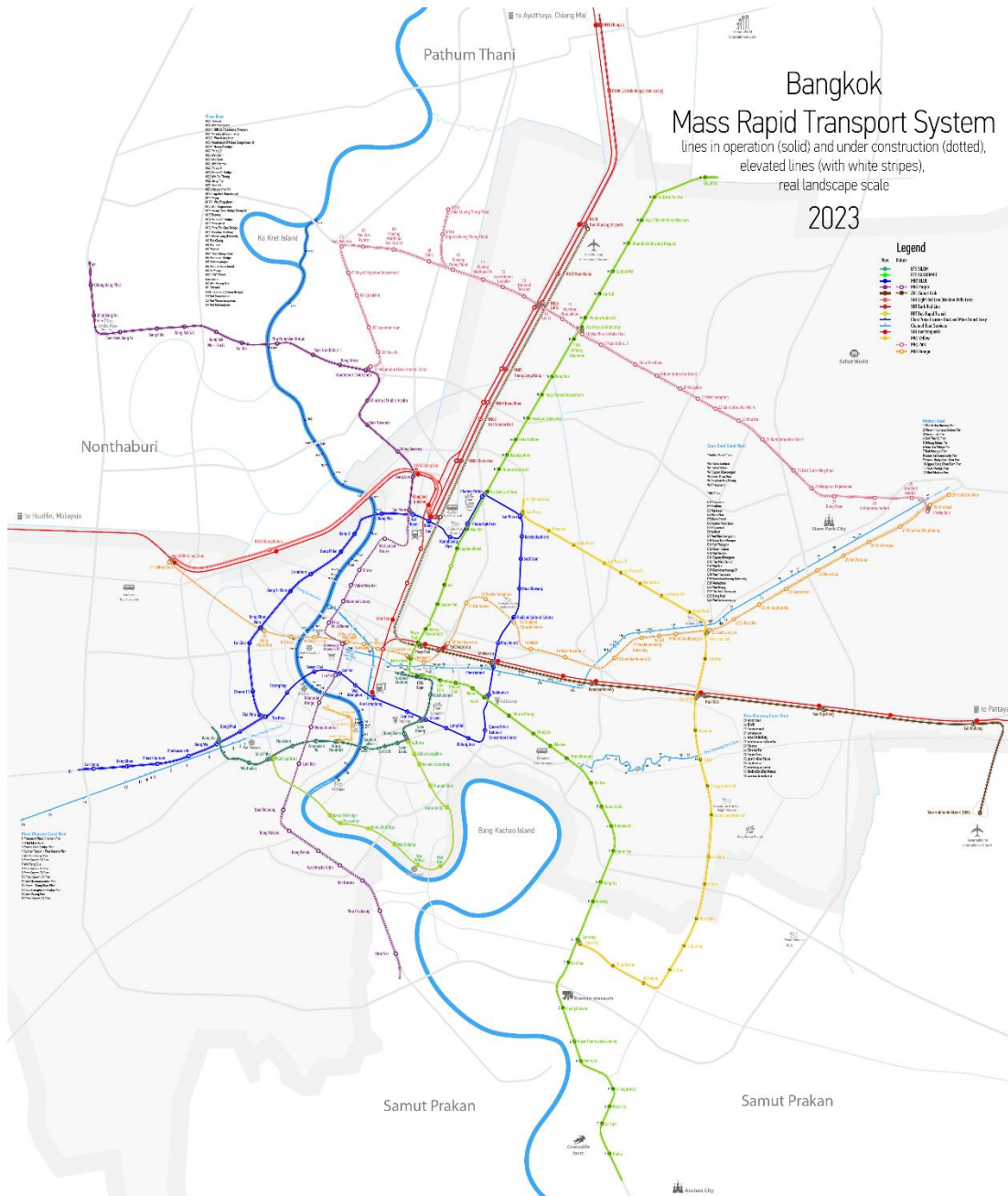
² A modified Daihatsu or Suzuki small pickup equipped with an overhead cage and two rows of seats in the back. These vehicles are capable of accommodating up to 6-11 passenger seats.

Mass rapid transit, including subways (MRT), SkyTrain (BTS), and the Airport Rail Link (ARL), is expected to be a major transportation backbone in the BMR. These rail systems are managed by different organizations and have their own fare structures and ticketing systems. Currently, the mass rapid transit network in the BMR comprises 12 lines, spanning a total length of 282.3 kilometers. Future plans involve expanding the network to 14 lines, covering a distance of 553.41 kilometers by 2029. Figure 8 shows the Mass Rapid Transit Master Plan in Bangkok Metropolitan Region or M-Map, including both current and future lines of mass rapid transit in the BMR.

This expansion will enhance connectivity and accessibility across different areas, resulting in a more robust transportation infrastructure. Moreover, it will create opportunities for the integration and collaboration of various new mobility services with the existing transit network. This development presents a favorable environment for MaaS to thrive and provide seamless transportation options to commuters.

The government has also implemented some policies and initiatives to support and regulate mobility services in the country. One significant aspect is the regulations governing ride-hailing services, which ensure passenger safety and service quality. These regulations encompass driver registration, vehicle inspections, and insurance coverage.

Furthermore, the government has actively pursued the development and implementation of smart city policies aimed at enhancing urban living and addressing urban challenges. The objective of these smart city initiatives is to leverage technology and innovation to improve quality of life, promote sustainable development, and enhance the efficiency of urban services. The increasing emphasis on digital promotion, alongside a growing demand for advanced products offering enhanced connectivity and performance, will serve as drivers for the implementation of MaaS.



2.2 Transition Towards Sustainable Mobility

As a result of manifold externalities, a variety of initiatives and policy solutions are being undertaken to tackle persistent issues such as traffic congestion, air pollution, and excessive energy consumption arising from the automobility system.

Sustainable mobility is an approach that advocates transportation development with a focus on socio-economic welfare without further harming the environment or depleting Earth's limited natural resources. The World Business Council for Sustainable Development, or WBCSD, particularly defined sustainable mobility as “the ability to meet the needs of society to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values today or in the future” (Development, 2004).

So far, tremendous efforts have been made to foster more sustainable mobility by focusing on infrastructure and technological improvements, as well as by influencing individual travel decisions. However, limited progress has been achieved compared to the rising demand for mobility according to continuing economic growth. As a consequence, there has been a broad argument that rather than incremental changes, a ‘transition’ of radical systemic innovation is required to encourage modal shift and bring about a fundamental move towards sustainable mobility regimes (Kemp & Rotmans, 2004).

Such a transition entails a wide-breadth reconstruction process between systems (Geels, 2012). In other words, a transition is a process of change that encompasses interactions of all concerning elements, including technology and innovations, policy and regulations, even interpersonal networks (Smith et al., 2010). Studies involving sustainable mobility transitions have highlighted the importance of change in social and technical domains in order to shift away from the current automobility regime and move towards a more sustainable solution.

Various innovations are considered promising in achieving a sustainable mobility transition such as alternative energy vehicles – including biofuels, hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs), and fuel cell electric vehicles (FCEVs) – autonomous vehicles, shared mobility, as well as customized mobility like MaaS. However, questions remain as to the potential pathway for each individual innovation (Sopjani et al., 2019).

The socio-technical transitions theory, which has come forth in the innovation research field, has made a huge impact on sustainability transition investigations in the past decade. The theory was initially proved and clarified

through numerous case studies in various fields, especially energy and transportation, either to understand historical transitions or to unfold, as well as forecast, those of the future (Nykqvist & Whitmarsh, 2008; Sopjani et al., 2019).

One of the broadly accepted and most used frameworks is the multi-level perspective (MLP), which conceptualizes overall dynamic patterns in socio-technical transitions. It is usually applied as an analytical lens to understand the interaction of actors, environments, and innovations in order to explain how system innovations or transitions occur. Therefore, this framework can be properly applied to depict the holistic view and analyze the entire process of transition towards sustainable mobility.

2.2.1 Multi-Level Perspective Framework (MLP)

The multi-level perspective framework was elaborated upon and refined by Frank Geels and Johan Schot (Geels, 2004, 2012) from the groundwork of socio-technical transitions research. MLP is fundamentally constituted from evolutionary economics, sociology of technology, and neo-institutional theory (Geels, 2004). The basic concept is that system innovations or transitions cannot be influenced simply by some independent drivers. Instead, they are non-linear processes resulting from multi-dimensional struggles among numerous dependent variables. Therefore, in order to understand transitions, MLP distinguishes three analytical and heuristic levels including macro level, meso level, and micro level as shown in Figure 9

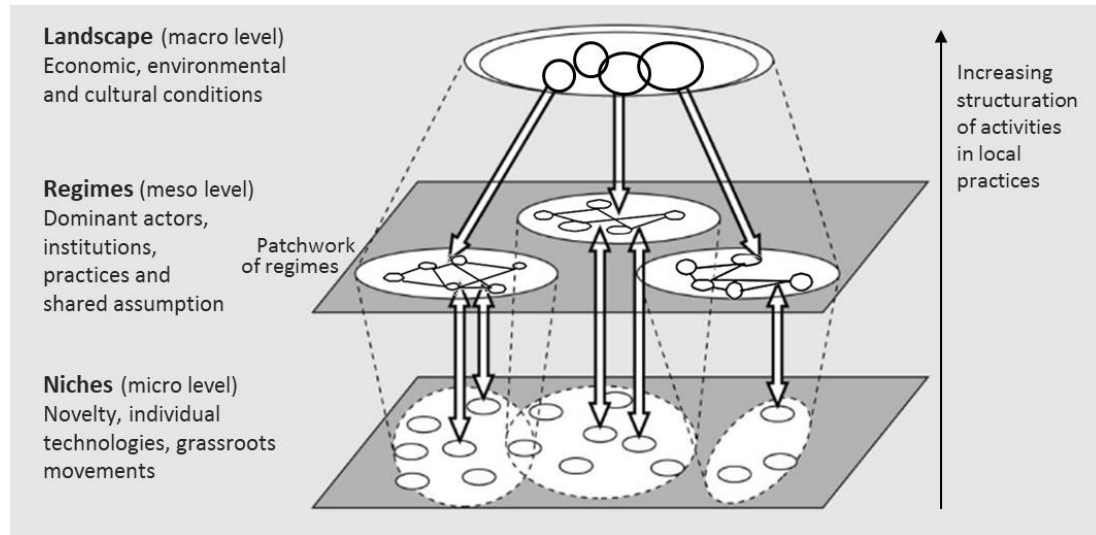
Macro Level (Socio-technical Landscape)

At the macro level, there exists the socio-technical landscape that forms an exogenous structure, or interactive conditions, and dynamics of socio-technical regimes, operating within meso level. The landscape includes economic trends, ecological conditions, physical environment and infrastructures, culture, social values, and concerns, which are all inconstant (Geels, 2012). For example, the landscape can be globalization, economic growth, political order, wars, cultural norms, environmental issues, and most recently – pandemics, in which the regime may be more or less accommodated.

As this landscape evolves, the regime may be challenged, facing pressures putting stress on the system. If it fails to adapt, niches at micro level will gain the opportunity to evolve. The elements within the socio-technical landscape dominate

whether and how particular changes will occur (Geels, 2004). Landscapes are difficult and slow to change as they cannot be influenced directly by actors (Geels, 2012).

Figure 10 Three analytical and heuristic levels of MLP, modified from Geels, 2002 and Rotmans et al., 2001.



Meso Level (Socio-technical Regimes)

The meso level is formed by the socio-technical regime, which refers to the rules that enable and constrain multiple actors and institutions, whose interplays construct, transform and reproduce incumbent systems. Shortly, the regime has been described as the dominant culture, practices, or shared assumptions in a particular social unit. Geels (2002) explicated fundamental elements that make up and constitute socio-technical regime including technology, regulation, user practices and markets, cultural meaning, infrastructure, maintenance networks, and supply networks. These components are subsequently categorized into three interrelated clusters: a network of actors and social groups, the set of formal and informal rules, and the material and technical elements (Geels, 2004).

Although the descriptions vary and evolve from time to time, the core substance of the regime remains the same. Socio-technical systems, such as those associated with energy, food, or transportation, are actively established, maintained, and incrementally improved by actors, such as firms, engineers, users, policy-makers and regulators, and special-interest groups within the regime (Geels, 2019). While each of those social groups has relative autonomy within its own distinguished space and functions, they are also interdependent with each other through various

coordinated activities (Geels & Schot, 2007) s. These alignments and interactions then stabilize the socio-technical regime, blocking system innovation, or radical change. But, this stability is also dynamic, meaning that innovations still occur at micro level, pushing forwards the transition process.

Micro Level (Niches)

The micro level is where novelties or radical innovations emerge in small technological niches at the periphery of existing systems, through initiatives or pilot projects pioneered by any groups of people such as academics, entrepreneurs, start-ups, practitioners, or relative activists. The whole idea of niche development is to address the pain points of existing regimes. Actors would support niche innovations, expecting that novelties will eventually be adopted in the regime or even replace it (Geels, 2004). Niches can include new technologies, institutions, lifestyles, and cultural elements developed by actors and institution networks. (Kemp & Rotmans, 2004).

Since the existing regime is embedded institutionally, organizationally, economically, or even culturally, its stability suppresses most niche innovations to remain within micro level. However, some of them might earn enough supports from actors and receive enough resources to evolve and gain momentum beyond niche level. As soon as such innovations are adopted, the journey from niche to regime starts. The level of radical change depends on how much they can disrupt the existing system (Geels, 2019).

Although the chance of breakthrough is rare and most innovations couldn't make it, niches are very substantial for system innovations. They provide spaces for learning processes in many dimensions such as technology, market demand, regulation, symbolic meaning, infrastructure, and production systems. Moreover, they also allow concerning actors to build the stakeholder networks which support innovations such as supply chains and user-producer relationships (Geels, 2004). In other words, niches supply and nurture the seeds for the transition towards more desired systems.

Therefore, niche development is at the heart of the socio-technological transition. Its success is manifested not only in niches organized around a specific technology but the whole system dynamics within all three levels. For transition

pathway towards sustainable mobility, niches might include a wide range of emerging technologies and innovations that can be grouped based on objective including alternative fuel vehicles, modal shift (to greener modes), and mobility demand management. Particularly, technologies associated with important behavioral and institutional changes.

This study applied MLP to conceptualize MaaS as a niche innovation and analyze the current automobility regime to determine MaaS' potential to emerge and unfold. Factors that destabilize the automobility regime, as well as hinder niche adoption, were identified. This realization unveiled windows of opportunity where MaaS can move beyond the niche level.

Transition Dynamics and Pathways

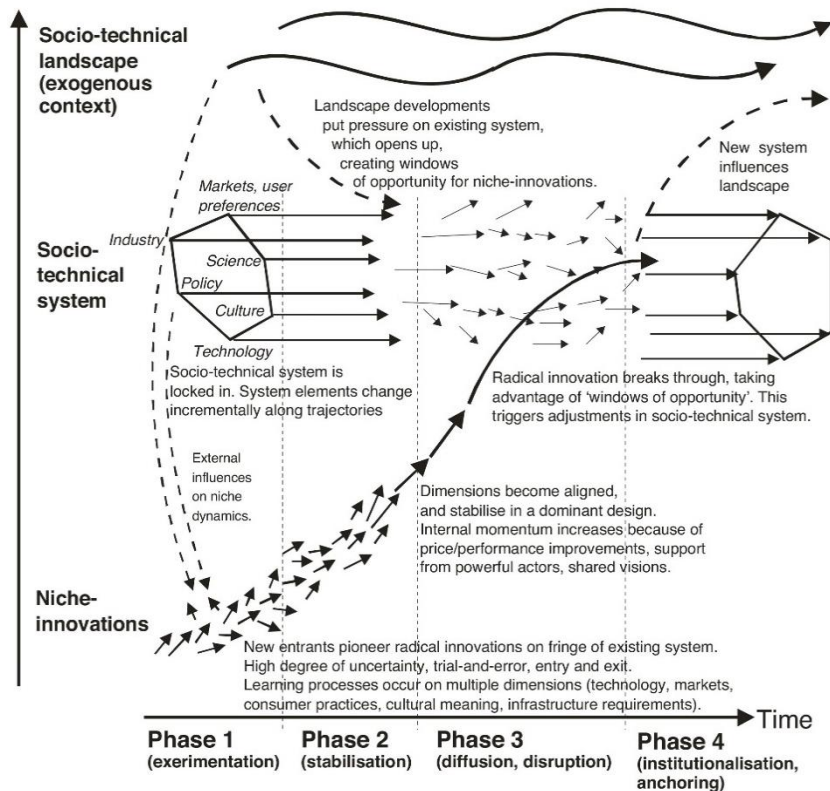
By distinguishing the systems into three analytical levels, as discussed earlier, MLP provides a framework to understand the transition process as non-linear, developing through dynamic interplay at those levels. (Geels, 2002; Geels & Schot, 2007; Smith et al., 2010). Precisely, transitions occur as a result of interactions among multiple social groups such as firms, consumers, social movements, policymakers, researchers, media, and investors through various activities such as exploration, learning, debate, negotiation, power struggle, conflict, investment, and goal-setting in the context of rules and institutions (Geels, 2019), cooperation, as well as experiment – seen with the recently popularized term “sandbox”.

Transition pathways demonstrate (those in the past) and forecast (those in the future) how technological innovations are constructed, cultivated and developed by different social actors. Ultimately, one way or another, these innovations contribute to the paradigm shift of the current regimes to more preferable ones – or the more sustainable one in the case of the transport sector – in order to heal the regime cracks influenced by different pressures from the socio-technical landscape. Different types of interactions between different levels of MLP lead to different transition pathways (Geels, 2002; Geels & Schot, 2007).

Although transition pathways vary among diverse areas (countries, regions, etc.) and sectors (energy, transport, agriculture, etc.), the dynamics that occur through transition processes typically include: (1) niche innovations steadily build inner momentum, (2) landscape changes, together with niche innovation development,

create pressure on the system and regime, and (3) destabilization of the regime creates windows of opportunity for niche innovations, which then diffuse and disrupt the existing system. Please see Figure 11

Figure 11 A dynamic multi-level perspective on system innovations (Geels, 2019).



Rules embedded in the socio-technical regime facilitate coordination and dependency among actors, stabilizing the incumbent system, as well as fostering lock-in and resistance to change. Meanwhile, the regime also accommodates actors to optimize the current system through challenges and incremental changes with the capabilities and resources of dominant players. Transitions, therefore, are restrained and take time to complete, often decades or more, and some are never achievable (Geels, 2004).

2.2.2 Rationale and Suitability of MLP

This study seeks to understand the holistic perspective of MaaS regarding how it can disrupt the automobility regime and promote a transition towards sustainable mobility, focusing not only on the technology itself but also on other aspects like user perspective. MLP provides a broader analysis of innovation,

stretching beyond isolated products or services, by covering all dynamics of ongoing change processes. The framework focuses on the co-evolution of technology and society involving multiple dimensions in both supply and demand sides, such as policy and infrastructure, as well as patterns of use and consumption.

In this regard, MLP can be applied to best frame the investigation of MaaS. Being a very new concept, it is full of challenges and uncertainties, especially regarding its potential to deliver sustainable mobility as expected. MLP can provide guidance to identify the dynamics of the transition process that affect the current mobility practices, as well as MaaS development, within such transitions - and vice versa.

Given that integration is fundamental to MaaS justifies another reason for the application of MLP; it is an actor-based approach, taking into account the interplay among different groups of stakeholders. It provides an in-depth perspective on socio-technical changes, which makes it a practical and fruitful analytical tool for understanding phenomena involving diverse stakeholder groups like MaaS development.

In pursuit of the mobility integration platform, collaborations among different actors from different domains, both within and outside transportation, are strongly required. These actors, however, are attached with their own agendas and expectations based on the interests they represent, making MaaS development a complex negotiation process. MLP is highly applicable since it analyzes societal systems by recognizing them as complex dynamics, instead of linear causalities or simple drivers.

Most importantly, MaaS is expected to improve transport systems by ultimately replacing private vehicle use and disrupting the car-dependent transport system – the automobility system. Multiple lock-in mechanisms such as public policy, infrastructure, manufacturing, and consumer behaviors constitute this regime and foster its stable state, making it nearly impossible for any innovation to compete with. MLP can help elaborate on this process as it covers stability (lock-in and resistance to change) on one hand, and pressures driving radical change on the other (Geels, 2012), helping identify the most probable pathway for MaaS within the transition to sustainable mobility.

2.2.3 Critique and Justification of MLP

Be that as it may, like any other approach, MLP has also been criticized for certain points which should be discussed as they relate to this study. Whitmarsh (2012) and Geels (2019) reviewed a significant amount of debates on MLP limitation and found that a common issue is about biases within the framework. Some scholars argued that MLP prioritizes the technology dimension and ignores the importance of politics, power, or cultural meaning. In other words, the framework lacks analysis of the social context at the cost of understanding the technological side.

For example, Shove and Walker (2007), criticized that MLP still falls into the supply-side focus trap like typical socio-technical transition literature. Despite the key concept of socio-technical co-evolution, there is still inadequate reference to demand patterns or individual behaviors beyond technology consumers. Social aspects of the framework focus excessively on functionalities rather than the agency of actors, which is of high importance (Smith et al., 2005).

In this regard, Geels (2019), explained that although MLP seeks to understand radical societal change deriving from the emergence of innovations, the framework is in fact multifaceted. It involves various actors and struggles beyond the technological dimension. Attention given to the technology and innovation movement is because it functions as an ingredient of transition dynamics rather than the core substance of the analytical framework. Such criticism, therefore, is misleading for at least two reasons. First of all, it undermines the fact that technology is a fruitful entrance point for studying society as an ongoing process of change. Secondly, it misunderstands or disregards the social innovation studies of MLP (Geels, 2019).

In addition, socio-technical transition is associated with the evolution of technologies and innovations over time, from invention to diffusion, societal embedding, and most importantly user/consumer adoption. It is impossible to investigate and comprehend this progression using a supply-driven analytical approach. MLP has proven its effectiveness in analyzing both historical and unfolding transitions regarding sustainability in various case studies revolving around energy (e.g. electricity, biomass), alternative fuel vehicles, bike-sharing, urban mobility, food networks, telework to agro-ecology and farming (Geels, 2019).

Lacking empirical grounding, as well as interconnection between local initiatives and large-scale transformation, is another misleading judgment of MLP. This framework has indeed been broadly applied in numerous case studies, especially during the recent years, because it is evidently underpinned by an empirical evidence base both vertically and horizontally. MLP has been repeatedly tested and refined through several dozen historical case studies with empirical examples of successful large-scale transformations of socio-ecological systems towards sustainability (Geels, 2019).

Applying MLP to investigate MaaS's potential pathways within the transition dynamics of Thailand's automobility regime likewise contributes more empirical grounding to MLP studies. Furthermore, this approach is built upon evolutionary economics which fixate on radical change and waves of creative destruction. Such founding knowledge orients MLP towards understanding the process of change no matter how large the scale of transition grows (Geels, 2019). Likewise, MaaS was locally initiated by a researcher but became a widespread trend across different contexts, stretching far beyond transportation, after inspiring stakeholders such as policymakers and practitioners. This innovation presents an excellent opportunity to construct a linkage between local initiatives and large-scale transformations. Applying MLP consequently bridges the accusatory gap associated with the ideologies of localities and their pertinence to a broader scheme.

Another critique concerns limited attention to behavioral perspective. Whitmarsh, 2012 reflected that a sustainable transport system cannot be achieved purely by technical measures but also by commuter behaviors, which are amongst the most difficult things to change. It is critical for the MLP research to analyze tensions between niche and regime actors in the context of behavioral change.

In her review, habits were mentioned as an example of behavioral lock-in and could jeopardize the effectiveness of transport policy. But, that is exactly what socio-technical transitions are and MLP provides a clear framework to investigate the dynamics of these driving and resisting forces pushing towards and pulling against radical changes. With this clear strength of MLP, this study can conceptualize MaaS as one of those niches, exploiting cracks within the automobility regime and trying to ingrain itself in the future regime.

Since another objective of this study is to uncover and understand individuals' beliefs on MaaS adoption, the theory of planned behavior (TPB) was also applied as a guideline for semi-structure interviews with commuters. Salient beliefs underpinning commuters' willingness to use MaaS were identified. The results from this part can also be further analyzed through the MLP lens and enhance knowledge on behavioral change within the socio-technical transition field.

So far, MLP has been useful for identifying and engaging with diverse groups of actors, but it's still underutilized in investigating the variety of alternative futures (Vähäkari et al., 2020). It is an integrative approach that provides a prominent and broader perspective to sustainability transition studies. By accommodating multiple actors and dimensions to describe how innovations emerge and breakthrough the incumbent regime to reach sustainability, MLP has a great potential to piece together the comprehension puzzle of a brand-new innovation like MaaS. This framework holds great promise to contribute to future research, and provide a clearer understanding of the transition dynamics towards sustainability (Vähäkari et al., 2020).

2.2.4 MLP in Transport Studies

The contributions that MLP has provided to transport research are evident as highlighted in many previous studies. Whitmarsh, 2012 reflected on the strengths and limitations of MLP in sustainability transition research. She concluded that MLP has made significant contributions by providing a more integrated and broader theoretical framework for socio-technical change in transport domain, based on historical and contemporary case studies and theoretical literature. MLP can even be further developed into a systemic futures study tool for transition process analysis and planning, especially when it is applied together with other theories (Vähäkari et al., 2020).

Nykvist and Whitmarsh (2008), for example, applied MLP to analyze current mobility systems and niche developments within the UK and Sweden, focusing on three main areas of innovations: transport technologies, modal shift, and demand management. The study demonstrated empirical evidence, together with qualitative and quantitative indications of ongoing niche development, by

investigating the co-evolution processes, divergence, and tension within and between those niches. Their findings showed that transport technologies obtain higher marketability and have greater potential compared to modal shift or demand management schemes. However, the levels of success vary depending upon technologies and areas.

Their results are considered very useful for this study on MaaS as they also discovered a significant relationship between the development of vehicle/fuel technologies and mobility services provided. Additionally, information technology appeared to be a key driver in all three areas of innovation. Therefore, they concluded that future innovation in transport depends on diversity, hybridization, and co-evolution of niches. Since MaaS is still an emerging innovation, it is very important to understand its feasibility and potential pathway within the mainstream of sustainable mobility transition. With such knowledge and clarification, we would be able to determine whether MaaS has the potential to be imprinted in the future mobility system, and how we should foster that potential.

A more recent and fashionable study using MLP in the transport sector was about the impacts of the COVID-19 pandemic on sustainability transitions, focusing on electricity and mobility in Finland and Sweden (Kanda & Kivimaa, 2020). The outbreak is conceptualized as a major and rare landscape shock that causes pervasive effects across socio-technical systems. Their findings showed that although COVID-19 is a global crisis that rapidly expands and widely impacts people's livelihoods, it may also present a small window of opportunity to accelerate sustainability transitions and enable societies to become more resilient to different kinds of risks.

In terms of sustainable mobility, the pandemic has led to a permanent disruption in lives, work, and of course commuting. Mobility needs, as well as overall fossil-energy consumption, are obviously decreased as daily activities are digitalized. This trend is supported by empirical data from Thailand. According to the Intelligent Traffic Information Center (iTIC)'s database, mobility volume and number of road traffic accidents are reduced by 40% and 43% consecutively during the COVID-19 situation.

From their analysis, Kanda and Kivimaa (2020) concluded that the once promising MaaS niche appears to be impacted not only by the decrease in overall

travel demand, but also in public transport by directing personal preferences to individual mobility. Thus, they identified at least two important research streams: changing of patterns and instability of practices due to COVID-19, and the impacts of the pandemic as an abrupt but gradually developing landscape influence on mobility transitions.

A study of this nature reveals an intriguing direction to nurture the knowledge of sustainable mobility transition, particularly the evolution of niches throughout different landscape changes. In most cases so far, if not all, landscape dynamics have been literally depicted as exogenous factors putting pressure on the incumbent regime, driving for radical changes towards sustainability. For almost the first time, landscape changes seem to generate a shift away from sustainability. Accordingly, this is a unique opportunity to include the pandemic into account and analyze the sustainable mobility transition dynamics, as well as the alteration of MaaS's potential as a result of these circumstances.

However, there are two sides to the coin. In different contexts like developing countries, the outbreak could present an alternative impact on MaaS's pathway. While people might prefer private modes over public transport (Abdullah et al., 2021; Bhaduri et al., 2020) which can discourage MaaS, they are also becoming increasingly digitalized, which instead encourages familiarity and behavior in favor of MaaS.

In the case of Thailand, for example, it is not only social distancing and lockdowns that force people to adapt to online platforms and digital lifestyles, but also the government countermeasures toward the pandemic. Thanks to money transfer stimulus programs and the pandemic accelerating cashless preference, the average transactions per day in 2020 stood at 15.6 million, an increase of 62% from 2019, according to Bank of Thailand data. This situation presents a unique case study of how dynamics within and among the three analytical levels of MLP interrelate and affect each other peculiarly.

Although MLP has been widely discussed and applied by social scientists and researchers, the approach has received insufficient attention in developing countries. For that reason, Wu et al., 2021 conducted an Asia-centric study using MLP to illustrate the interaction of three MLP levels (landscape, regime, and niche) to

project future paths for the transition from fossil fuel-based vehicles to new energy vehicles (NEVs) in China. Secondary data, as well as information, were mainly collected and analyzed based upon: (1) NEVs-related national development plans (2) statistics, reports, and yearbooks relating to automotive production and sales volumes, and (3) news and information reported by different media. All data was compared and verified for accuracy and reliability using source material from private and government sectors.

The study depicted the transition dynamics under double pressures, meaning that while manifold factors are rocking the stability of the incumbent regime, the socio-technical system of traditional vehicles is also being preserved and adjusted as they navigate challenges and instabilities. They concluded that although the exogenous context is nurturing emerging innovations and impeding the development of traditional fuel vehicles, the socio-technical regime of NEVs is still in the early stage and cannot meet the consumers' needs just yet. By grasping the whole picture, the study was able to identify challenges for system change, governance implications, and the actors involved in each NEVs socio-technical transition phase. The Chinese government can, therefore, still play an essential role in pushing the transition forward by implementing public policy related to electric power, technological innovation, and industrial coordination.

In addition, their analysis also showed that the automotive industry is facing tremendous changes. With the development of society and the change of user needs, car dependency can be lessened but only with more cooperation, attributes, and supply chain restructuring. While bottom-up innovations like autonomous vehicles and MaaS are the stimulus, top-down motions such as government measures are the prerequisite and main force to promote the successful transition of the NEVs' system.

China demonstrates a similar condition where economic growth, as well as national development, still rely considerably upon industrial production. According to the International Organization of Motor Vehicle Manufacturers or OICA's (Organisation Internationale des Constructeurs d'Automobiles) statistics, China ranked first in global vehicle production, while Thailand ranked eleventh in 2020. Therefore, the findings from the NEV study in China are of great value for the study on MaaS in developing countries, particularly car manufacturing countries such as

Thailand. The study clearly depicted how the incumbent system has been deeply stabilized through a strong network with the industrial chain due to the value it produces. Contrariwise, in the European context, where MaaS was initiated and relatively advanced, the automotive industry might not be as embedded so the evolution might not face these same variables. Therefore, MaaS's potential pathway in the context of Thailand's automotive-based productions is likely to be different and needs to be clarified early.

2.3 Technology Adoption

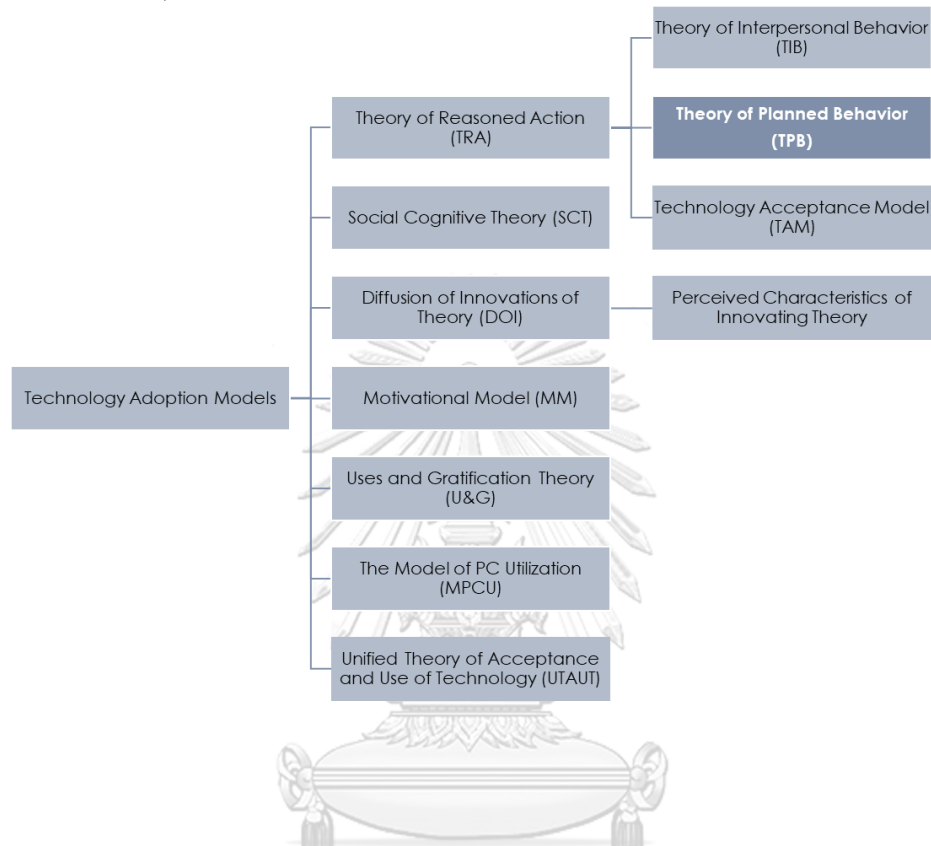
One of the common issues every business has to address at the beginning stages of any product or service is realizing the customers' expectations and willingness to adopt whatever they have to offer. Therefore, it is imperative to understand the driving factors that affect user acceptance, especially those concerning new technologies or behaviors. This comprehension helps guide future development and, for the most part, induce market penetration.

In order to effectively grasp significant aspects of human behavior, and understand influencing factors in their decision-making, a number of theoretical frameworks and models have been developed around psychological and sociological theories. It appears that these models can truly nurture the knowledge on user or consumer adoption of new technologies and innovations. How fast they can be accepted usually depends on a large number of factors, such as availability of technology, convenience, preference, security, social value, economic value, and so on. These models have been continually introducing and verifying different factors that can affect user acceptance, their intention to use, and ultimately their behavioral change.

So far, the theories that have been proposed are, but not limited to, the Theory of Reasonable Action (Fishbein & Ajzen, 2005), the Technology Acceptance Model (TAM by Davis, Bagozzi and Warshaw, 1989), the Motivational Model (by Davis, Bagozzi, and Warshaw, 1992), the Theory of Diffusion of Innovations (DOI by Rogers, 1995), and the Unified Theory of Acceptance and Use of Technology (UTAUT by Venkatesh, Morris, Davis and Davis, 2003) as shown in Figure 12 Many studies have later applied these classic frameworks to conduct their research (Lai,

2017); some of them even further combined or extended factors to develop them into customized models specifically for their research areas.

Figure 12 Different technology adoption models, modified from Lai, 2017.



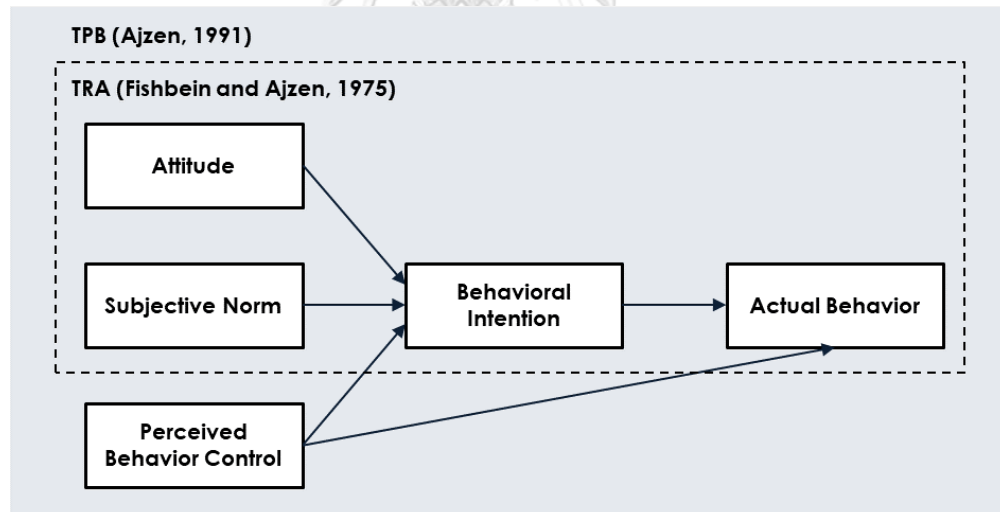
This study has thoughtfully selected the theory of planned behavior or TPB (Ajzen, 1991) in order to investigate motivational or fundamentals factors that influence users' intention to adopt MaaS. TPB is built on a socio-psychological foundation, seeking to explain human behavior. It is notable for being a mainstream theory in technology adoption and user acceptance research with a solid base of empirical support. Numerous meta-analysis and systematic reviews of various literature were conducted to evaluate its predictive power.

A large number of studies have successfully applied TPB to predict intentions and behaviors across various fields of research ranging from health related behaviors, business and technology sector, human resources and employment (See Tolliver, 2016), suicide behavior, education, smoking cessation, green consumerism, online retailing, tourism (See Ulker-Demirel and Ciftci (2020), and food safety (Lin & Roberts, 2020).

2.3.1 Theory of Planned Behavior (TPB)

Icek Ajzen further developed his work on the Theory of Reasoned Action, or TRA, to create a more precise model using the same groundwork. He explained that behavior is planned; hence, the model he proposed predicts deliberate behavior and is called the theory of planned behavior or TPB. Though both theories share the core substance that behavior is the result of a conscious decision to act in a certain way, there is still a significant difference between them. While TRA identifies attitudes and social norms as influencing factors towards an intention to perform a specific behavior, TPB includes not only attitudes and subjective norms but also perceived behavioral control to predict such intention as described in Figure 13

Figure 13 Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB).



Ajzen (1991) argued that TRA only focuses on variables under an individual's control, assuming that people have volitional control over the behavior of interest so they are capable of performing the behavior as long as they desire to. It was later discovered that behavior is not completely voluntary and that an individual doesn't have full control over it. A person, instead, must possess adequate resources, opportunities, and support to perform a specific behavior. Perceived behavioral

control (PBC) was then taken into account as external factors beyond an individual's control may affect the individual's intention. As a result, TPB can help investigate individual motivational factors and predict intention, as well as behavior, in differing contexts with greater accuracy than previous models.

According to TPB, the actual behavior is directly determined by behavioral intention, which usually reflects an individual's motivation to perform the specific behavior. Intention signifies how much a person is willing to try or put in effort to perform the target behavior (Ajzen, 1991). In short, the stronger a person intends to engage in a behavior, the more likely the behavior will be performed. While behavioral intention determines actual behavior, it is also formed by three factors as mentioned earlier. The more positive attitudes, subjective norms, and perceived behavioral control a person has, the stronger the intention to perform the given behavior.

Attitude is defined as an individual's favorable or unfavorable evaluation of a given behavior, developed based on his/her personal beliefs about it. These behavioral beliefs are subjective and vary according to perceived consequences associated with that behavior. It is usually built upon personal experience, information sources, and inferences. These salient beliefs must be easily accessible in memory, such as if it will be (un)beneficial, (un)pleasant, or (un)enjoyable (Ajzen, 1991). For example, commuters may have a positive attitude towards MaaS because they believe that it is helpful, convenient, or time-saving.

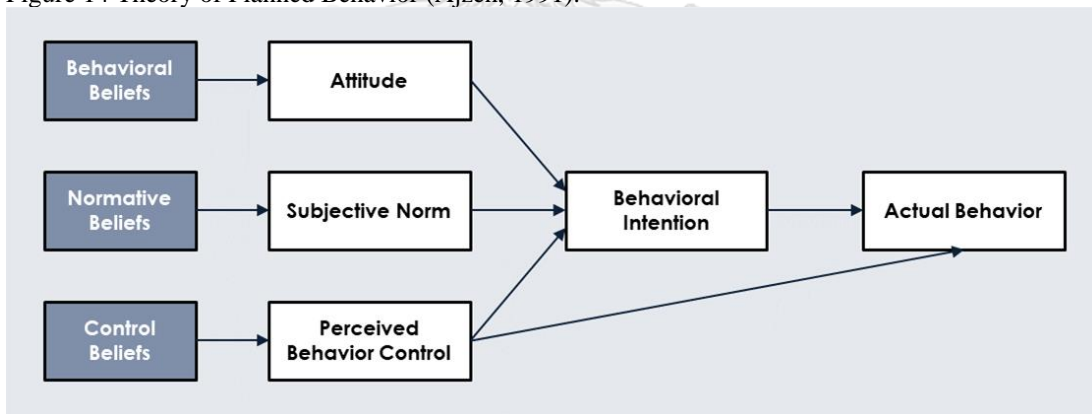
Subjective norm relates to perceived social pressures about whether or not an individual should conduct a given behavior. It is normally influenced by normative beliefs concerning expectations, approval, or actions of significant groups of people. Specifically, a normative belief is dependent upon an individual's motivation to comply with the social norm (Ajzen, 1991). For example, individuals who presume people around them would expect or encourage them to use MaaS may feel social pressure to adopt it, especially if they value being accepted and taking part in a trend.

Perceived behavioral control refers to an individual's perception of their capability to perform a given behavior, such as perceived ease or the difficulty of performing that behavior. It is assumed this reflects past experience, as well as anticipated physical support and obstacles. Perceived behavioral control is determined

by a person's belief as to whether or not they are provided with necessary assistance or facilitation to conduct a given behavior (Ajzen, 1991). For example, commuters who believe that they have control over mobile phones and/or the internet might become potential MaaS users because they are certain they have enough skills and resources to make use of the service.

In conclusion, any action people takes is basically steered by the beliefs they hold regarding the probable consequences of that action (behavioral beliefs), the social pressure or expectations of other people (normative beliefs), and the presence of factors that may facilitate or obstruct their performance (control beliefs) as described in Figure 14. Although, these beliefs reflect the perception or knowledge people have concerning target behavior, the correction of such perception is inconsequential. Beliefs could be egocentric, disguised, biased, or even irrational because they are based on incomplete information a person obtains. What matters according to TPB is whether the beliefs people hold encourage or discourage performance of the behavior. Human beings are not assumed to be rational but their intentions and behaviors follow reasonably from their beliefs (Ajzen, 2020).

Figure 14 Theory of Planned Behavior (Ajzen, 1991).



2.3.2 Predictive Power of Beliefs

The salient beliefs are the prevailing determinants of a person's intentions and actions because these beliefs are accessible in memory and will create the principal considerations that guide human behaviors (Fishbein & Ajzen, 2011). It is important to discover beliefs that spontaneously come to the participants' minds when they think about a specific behavior.

However, most TPB studies seem to give less attention to such established knowledge. There is very limited study on salient beliefs. In most TPB research, beliefs behind each component are simply designed based on the researchers' own intuition, literature reviews, or directly imported from previous studies that are assumed applicable to different behaviors or populations. In fact, beliefs vary from behavior to behavior and are dependent upon demographics so it is imperative to identify beliefs of different behaviors among different target population (Fishbein & Ajzen, 2011).

Some TPB meta-analyses and comprehensive reviews even critically suggested that main methodological concern for understanding intention and behavior is the limited use of studies about beliefs. In comparison, the effect size of results from those with beliefs studies were significantly larger. The beliefs could significantly explain up to 56% of the variance in attitude, subjective norm, and perceived behavioral control. Studies on beliefs are clearly an effective mechanism for understanding and explaining the psychosocial and cognitive determinants of people's intention and behavior (Downs & Hausenblas, 2005) that appear to be overlooked.

By understanding beliefs behind each constructs, TPB can also suggest behavioral interventions instead of just being an explanatory predictive model of human behavior. Several studies have applied TPB to depict a causal relation and understand about intervention on behavioral, normative, and control beliefs in or to produce positive intentions among participants who previously did not or were less likely to perform the behavior (Fishbein & Ajzen, 2005). Those studies have involved, such as, physical activity participation, car speeding reduction, helmets use among cyclists, designated walking tracks usage (Curtis et al., 2010).

Understanding the belief factors that affect users' preferences is essential for effective and persuasive intervention in order to influence their decision-making processes. Moreover, comprehension about beliefs can allow researchers to reveal additional factors, that can impact decision making of the population of interest, especially in diverse settings (Fishbein & Ajzen, 2005). It is even more important when studying about an innovative service like MaaS since it tends to bring new

behavior, which is not comparable to other ones in the past, and therefore impossible to simply bring in salient beliefs from previous studies.

2.3.3 Significance of TPB and Beliefs in MaaS Adoption

Overall, TPB with its theoretical perspective on beliefs has shown the robustness in understanding transport behavior, but no recent study of this nature has been applied to MaaS adoption. Most importantly, none has investigated about salient beliefs behind human's decision making. Ye et al. (2020) applied the Unified Theory of Acceptance and Use Technology model, or UTAUT, to identify the key influencing factors on user intention in Shanghai, China where data from 600 samples were analyzed by structural equation analysis. All six constructs from the UTAUT model (performance expectation, social influence, facilitating condition, individual innovation, perceived risk, effort expectation) were tested significantly regarding user intention to use MaaS.

This study has assuredly contributed to the MaaS adoption research stream, as discussed in section 2.1.5, but UTAUT doesn't include individual characteristics such as attitude, which has been proven to be of top priority in influencing factors towards behavioral intentions and usage behaviors regarding information system (IS) and information technology (IT) innovations (Dwivedi et al., 2019). Karlsson et al. (2020) also empirically and in-depth investigated enablers and barriers to the implementation of MaaS and discovered that people's attitudes were recognized as important factors to be considered.

Besides, UTAUT has been revealed as less powerful in predicting behavioral intentions concerning transport technology adoption. TPB performed better than UTAUT in the context of driver acceptance of Advanced Driver Assistance Systems or ADAS (Rahman et al., 2017). Similar results were found in the context of intentions to use highly automated cars. While TPB constructs accounted for 57.9%–74.1% of the variance in intentions, the UTAUT only added up another 3–6% of the variance (Kaye et al., 2020). This study, therefore, intends to adopt TPB to fill this gap and nurture knowledge on influencing factors, particularly underlying beliefs with regards to MaaS.

There may be some critiques about investigating people's beliefs towards a brand-new service barely available in the market, like MaaS. Without direct experience, individuals may face psychological distance – the degree to which people feel disconnected with a phenomenon. And that might limit the validity of conclusions about future intention and behavior extracted from their responses.

In common with this study, research on EV adoption has mainly been based on behavioral intention instead of actual behavior, which is understandable due to the current low market shares of EVs, similar to that of MaaS. As a result, some studies sought to conduct research with participants who were given direct experience of BEVs, to reduce psychological distance. Among those studies, many ended up unfavorably having sample biases, of which the most common is to include samples of potential early adopters or those who are already especially interested in EVs. These samples cannot represent the majority of consumers and it is not rational to generalize the results deduced from their responses either (Rezvani et al., 2015).

Although MaaS is not a service that is widely available yet, it is the combination of various transport modes and services that people are already familiar with, either public transport or new mobility solutions like car sharing and ride hailing, or new services like e-payment, routing, and navigation. Therefore, it is possible to investigate users' beliefs regarding intention to use MaaS, which indeed can be applied to further predict actual behavior with a considerable degree of accuracy (Fishbein & Ajzen, 2011).

In conclusion, the central premise of TPB is grounded on the fact that the flow of influence passing from personal beliefs to intention to behavior is a rational process. It reflects human cognition which we systematically involve in gaining information, considering, processing and utilizing available knowledge to reach a behavioral decision. This approach successfully assists countless researchers to carry out copious studies in a wide range of fields. The prominence of TPB lies in its potential for developing successful educational or behavioral interventions, focusing on the most influential factors in order to shape preferable behavior in every conceivable way.



CHAPTER III

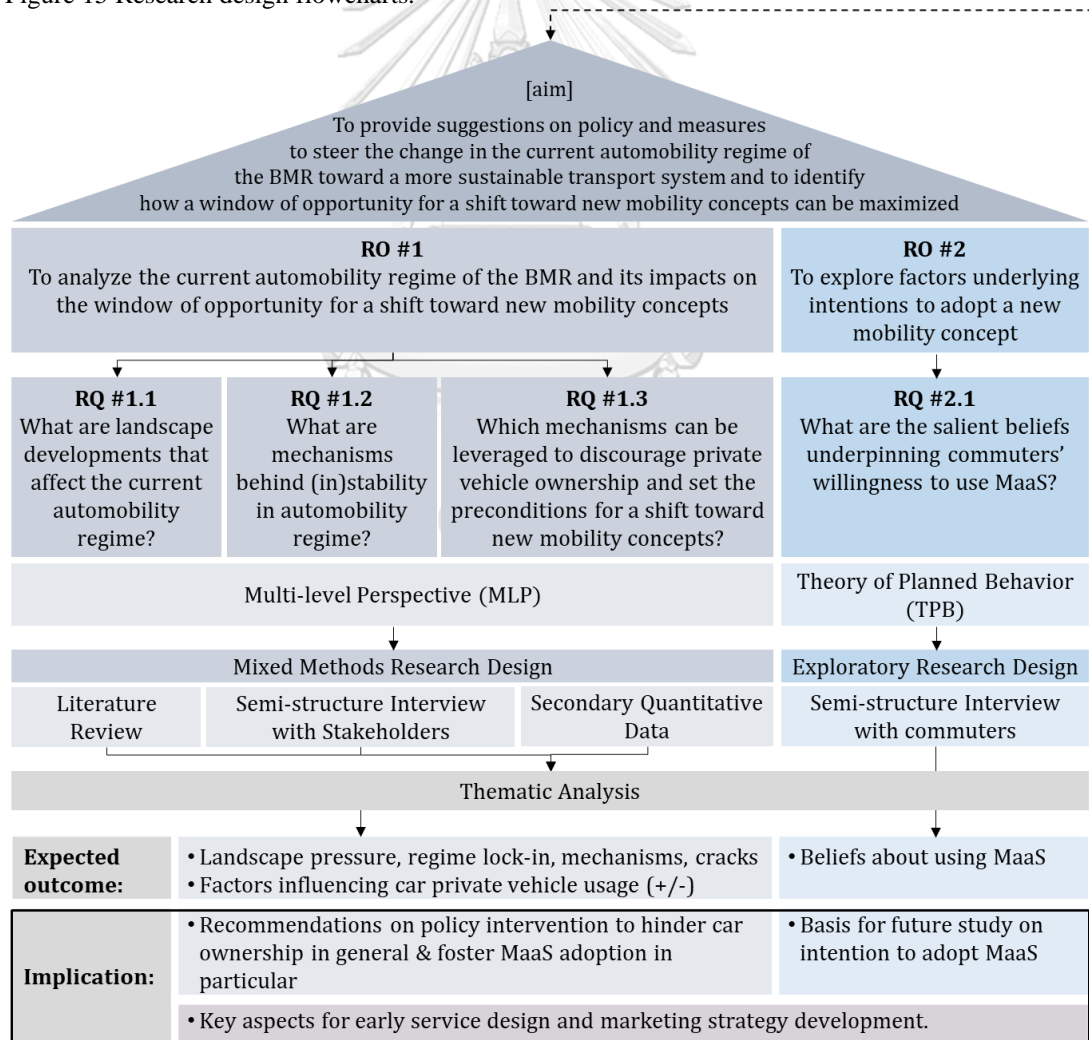
Methodology

3.1 Research Design

This section describes the research design, data collection, and analysis methods that are carried out within this study. The overall aim of this study is to provide suggestions on policy and measures to steer the change in the current

automobility regime of the Bangkok Metropolitan Region (BMR) toward a more sustainable transport system and to identify how a window of opportunity for a shift toward new mobility concepts can be maximized. In order to achieve such aim, the research is divided into two individual but interrelated objectives as depicted below.

Figure 15 Research design flowcharts.



Transport research has predominantly relied on quantitative approaches such as cost-benefit analysis, choice modeling, and simulation. While these methods offer accurate results, they often lack the depth and detailed information required to address complex issues. This study fills a crucial gap in the literature by employing qualitative methods to conduct research in the transport domain. By adopting qualitative approaches, the study aims to provide a more comprehensive and nuanced understanding of the current dynamics and interactions within the existing automobility regime.

Qualitative approach recognizes the need for in-depth exploration, capturing diverse perspectives, and uncovering underlying factors that quantitative methods may overlook. Through qualitative research, the study aims to contribute to a more holistic understanding of transport-related issues and inform policy and decision-making processes in the field. It is promising because it significantly enhances the understanding of target phenomena by providing a more comprehensive picture. (Grosvenor, 2000). The approach is considered valuable and has recently gained momentum in new research fields, especially social and behavioral sciences which are more complicated and require interdisciplinary comprehension.

This research, therefore, adopted an exploratory research design using qualitative approach. The first part of the study (RQ 1.1 - 1.3) involved semi-structured interviews with stakeholders, as well as a comprehensive literature review and analysis of secondary data. Based on the MLP framework, the dynamics within the automobility system in the BMR were analyzed. The mechanisms behind both stability and cracks, if any, were identified accordingly. This comprehension explains how windows of opportunity for a niche innovation like MaaS can be created.

The second part of the study, focusing on salient beliefs underpinning commuters' willingness to use MaaS, involved conducting semi-structured interviews with commuters. This allowed for a deeper exploration of the participants' perspectives and insights regarding their intentions towards adopting MaaS. The TPB was utilized in this part as a framework to guide the design of semi-structured interviews. The aim was to investigate the key beliefs that influence commuters' inclination to adopt MaaS.

The interview questions were thoughtfully designed following the TPB guidelines to collect relevant data regarding the last research questions (RQ 2.1). The results from both parts can demonstrate how MaaS can disrupt the automobility regime and promote the transition towards sustainable mobility.

Overall, the utilization of semi-structured interviews enables a comprehensive and detailed investigation of the subject matter, while also allowing for the exploration of unexpected factors and perspectives. By engaging participants in open and authentic discussions, interviews provide an environment where individuals can freely express their perspectives and focus on what is most significant in their viewpoints.

3.2 Part I – The Analysis of Automobility Regime

Qualitative methodology has been considerably applied to a wide range of social sciences, such as education, linguistics, political science, sociology, and psychology. It is especially useful to examine new topics since responses are not limited by any sets of questions or answers, allowing the discovery of some elements that the researcher may not anticipate (Grosvenor, 2000).

Although the qualitative approach has proven its efficiency across different research fields, it is less popular in the transport domain where the majority of studies are centered around a quantitative-based approach. Emerging as a centerpiece of transport technology, MaaS studies also inherit that lack of qualitative method application (Matyas, 2020) despite its potential to analyze and explain substantial grounds of new topics. Moreover, these methods require a strong foundation of theoretical frameworks with a thoughtful research design of data collection and analysis, which is coincidentally suitable for a complex socio-technical system like transportation and automobility in particular. Therefore, secondary research and semi-structured interviews are adopted as described further in this section.

3.2.1 Data Collection and Sampling

Given the aims of this research, it is important to start with identifying the dynamics regarding user perspective at both macro and meso levels: (de)stabilizing factors derived from landscape changes and lock-in mechanisms of current user

practices within the automobility regime. These dynamics are identified through exploratory and inductive research using in-depth interviews of automobility regime stakeholders with COREQ checklist. Empirical secondary data in relation to the discussion was also elicited to enrich and verify the collected data from interviews.

The regime is constituted and stabilized by many interactions among multiple actors including users/consumers; therefore, the rich data sources from individuals are extremely significant. In-depth interviews with the current regime actors, prioritizing automobility stakeholders, were conducted to obtain primary data and a concise understanding (online or face-to-face if the situation cooperates³) regarding user preferences and influencing factors that provide the social embeddedness of private cars dependency.

This method allows researchers to place an emphasis on contextual and situational issues that underline complex social phenomena. There is no reality beyond the perceptions or beliefs of the individuals so it is essential to carefully pay attention to the informants in order to comprehend and interpret their reality.

This research uses a purposive sample to select the informants with a high possibility to provide accurate knowledge regarding landscape pressures and the (de)stability of the automobility regime. Based on secondary research of scientific literature and national documents, the main stakeholder groups among transport planners, car manufacturers, and civil society were determined as viable options. These stakeholders represent the six elements of transport systems including technology, policy, markets, consumer practices, infrastructure, cultural meaning, and scientific knowledge as shown in Table 3. Specific interviewees were selected from these groups to share their viewpoints regarding the research questions. Thus, 21 individuals were interviewed – 16 online, 3 in person, and 2 by questionnaires, to discuss the automobility regimes and their dynamics.

Semi-structured interviews were conducted following a loose guideline to allow new questions based on informants' answers that the researcher might not have considered before. Probing questions were utilized to get more information about answers and ensure consistency and clarification across the interviews. The questions focused on significant factors that influence the automobility system development in

³ This study was carried during the worldwide pandemic of coronavirus disease 2019 (COVID-19).

the present and coming future. The role of political, social, institutional, regulatory, economic, environmental factors on the future of private car dependency were discussed.

The objective is to analyze the current automobility regime and its impacts on the window of opportunity for a shift toward new mobility concepts. The questions, for example, concern opinions and knowledge of trends, developments, conditions, factors that affect the automobility system, their roles in the automobility system, challenges that their organizations are facing, factors that support new mobility adoption, and of policies therein, to investigate landscape pressure, regime lock-in mechanisms or cracks, as well as factors influencing private vehicle dependence.

The semi-structured questionnaire comprises of two sections: (1) general information of informants, and (2) open-ended and descriptive questions, which are derived from literature review and preliminary interviews (see Appendix A).

The interviews began with an introduction and some clarification from the interviewer for ice breaking purposes; e.g., introduction to research topic and objectives, data protection declarations, request for audio/video recording, the use of anonymous citations for reporting, definitions of some research terms, etc.

These introductions were designed to open up the conversation on the topic. Although all interviews were recorded and transcribed, memos were still taken during and after each interview. This was useful for developing questions in current or future interviews, as some interviewees pointed out information that needed to be provided by other stakeholders.

In order to gain the multi-stakeholder perspectives, representatives from each stakeholder group were included. Apart from taking into account their knowledge and expertise, factors such as willingness to participate and the ability to effectively communicate their experiences and opinions are considered. Most of all, their charisma of critical thinking was prioritized during the sampling selection process.

Figure 16 Stakeholder groups and representations in Thailand.

<i>Dimensions</i>	<i>Groups</i>	<i>Roles</i>	<i>Organizations</i>
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<i>Dimensions</i>	<i>Groups</i>	<i>Roles</i>	<i>Organizations</i>
<i>Industry structure</i>	Car manufacturers, suppliers	Vehicles and parts producing	<ul style="list-style-type: none"> • Thai Auto-Parts Manufactures Association • Thai Automotive Industry Association
	New mobility service provider	Car sharing provider Car subscription service provider	<ul style="list-style-type: none"> • Haupcar • Toyota Leasing (Kinto)
<i>Regulations and policy</i>	Government authority	Industrial development policy making Investment promoting	<ul style="list-style-type: none"> • Office of Industrial Economics, Ministry of Industry • Office of the Board of Investment
		National economic and social planning	<ul style="list-style-type: none"> • Office of the National Economic and Social Development Council
<i>Markets and user practices</i>	Financial Institutions	Market Financing	<ul style="list-style-type: none"> • Thai Hire-Purchase Association
	Marketing Agency	Automotive news and motor show provider	<ul style="list-style-type: none"> • Grand Prix International
<i>Distribution network and maintenance</i>	Car dealership	Vehicle and parts selling, maintenance	<ul style="list-style-type: none"> • TOYOTA Bara Windsor
	Car insurance	Financial protection	<ul style="list-style-type: none"> • Aioi Bangkok Insurance
<i>Infrastructure</i>	Government authority	Transport planning and policy making	<ul style="list-style-type: none"> • Office of Transport and Traffic Policy and Planning, Ministry of Transport
		Traffic management	<ul style="list-style-type: none"> • Traffic and Transportation Department, Bangkok Metropolitan Administration (BMA)
	Fuel providers	Mass rapid transit system providing Digital promotor	<ul style="list-style-type: none"> • Mass Rapid Transit Authority of Thailand
	Digital infrastructure	Energy providing ITS technology promoting	<ul style="list-style-type: none"> • Digital Economy Promotion Agency, • PTT Oil and Retail Business • Thai Intelligent Transport Systems Association (ITS Thailand)
<i>Scientific knowledge</i>	Academia	Transport researching Public policy researching Automotive industry research and development	<ul style="list-style-type: none"> • Thailand Development Research Institute • Thailand Future Foundation • Thailand Automotive Institute
<i>Cultural meaning</i>	Civil Society	Urban commuter and urban transport experts	<ul style="list-style-type: none"> • Urban Design and Development Center

Interviews were conducted by the researcher at the interviewees' workplace and/or online using virtual meeting platforms – either Microsoft Teams or Zoom according to the interviewees' convenience. All interviewees were informed of the purpose of the interview at least one week in advance. All the interviews were conducted between April and June 2023. The interviews were recorded, lasting an average of 47 minutes each. The individual interviewees comprised decision-makers at both the national and local levels (5), executives in the private sector (6), individuals at the management level (8), and individuals at the operational level (2) in both the public and private sectors.

The interviews were transcribed directly from these recordings, in which irrelevant parts of the conversation were left out from the transcription. The interviews were conducted and transcribed in Thai, as well as analyzed in Thai, to avoid translation errors. This approach helps capture linguistic nuances because languages often have unique structures, vocabulary, or idiomatic expressions that can convey specific meanings. Overall, analyzing interview data in the native language improves the depth of understanding, accuracy of the interpretation, and overall quality of the research findings.

3.2.2 Data Analysis

This part of the study adopted thematic analysis to identify factors affecting the current automobility system in the BMR. Mechanisms behind (in)stability in the regime are thematized using both inductive and deductive approaches. Thematic analysis is a qualitative method, which is best used for identifying, analyzing, and providing insights into patterns of themes across several elements within collected data (Braun & Clarke, 2006). This research technique involves the systematic coding and data analyzing in order to link it to broader concepts.

This study analyzed the data from in-depth interview following the six-step of thematic analysis as elaborated in Table 4. The ultimate theme of the analysis is to answer the three research questions of what factors that have impacts on automobility regime and which factors can be leveraged in order to discourage private vehicle dependence and set the preconditions for a shift toward MaaS. Data matrix using Microsoft Excel was designed and developed based on thematic analysis process, as

well as the 32-checklist of COREQ to gather all the required data and conduct the analysis.

Figure 17 Phases of thematic analysis (Braun & Clarke, 2006).

Phase	Description of the process
(1) Familiarizing yourself with your data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
(2) Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
(3) Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
(4) Reviewing themes	Checking if the themes work in relation to the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
(5) Defining and naming themes:	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
(6) Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis.

The research question is linked to the theoretical background that is based on transition studies and the MLP framework. The broader themes were developed accordingly. The coding and theme identification processes in this study were driven by the data itself to minimize biases influenced by the researcher. The themes and sub-themes were incorporated into the theoretical framework after the analysis was completed, rather than predetermined.

Although manual coding is time-consuming, it helps streamline the overall analysis process. Manual coding and analysis were chosen in this study to mitigate language limitations that may exist in data analysis software, as coding and analysis involve subjective interpretation and understanding of the data. Table 5 shows coding examples of the data analysis. I developed data matrix using Microsoft Excel to gather all the required data and conduct the analysis.

In order to ensure the rigor of the qualitative analysis and interpretations, recommended techniques based on literature review were employed. Triangulation is

one such technique. The secondary data from multiple sources were used to confirm the interpretations and validate findings. Member checking was also applied during the interview process to confirm the researcher's understanding of the answers provided by participants. It involves an iterative process of feedback and clarification between the researcher and the participant to enhance the validity and credibility of the analysis.

Since the analysis was primarily conducted in parallel with the interview, some data and initial finding were also cross-checked with different participants to obtain feedback and ensure accuracy. Peer debriefing was also adopted to strengthen the validity of the researcher's analysis. Few colleagues, who also work in automobility and transportation field, were asked to review the coding process and theme searching to make sure they are rationale to different analysts and to provide alternative perspectives to the researcher's interpretations. Saturation is reached when no new information emerges, indicating thorough exploration. Most importantly, all documents, materials, and data were registered in detail throughout the analytical process, including decisions made, coding schemes, and interpretations. This transparent documentation allows for scrutiny and evaluation by peers or other researchers, reducing the potential impact of personal biases.

Figure 18 Coding examples

Research questions	Theme	Preliminary codes	Anchor examples
RQ1.1: Landscape developments that affect the current automobility regime?	Urban design and planning	urban, planning, urban sprawl, city structure, housing, zoning, community, location, urban expansion and development	<ul style="list-style-type: none"> • “There is still a lack of proper <i>urban planning</i> without integration with public transport planning” – Interviewee 11. • “Without job and <i>housing</i> balance, the high cost of living forces people to move away to more affordable areas. But, they still need to commute to the city center for work” – Interviewee 16.
	Public transport system	public transport, mass transit, bus, van, common ticket, train, BTS, MRT, rail, canal, boat, metro, infrastructure, station, public facility, M/C taxi	<ul style="list-style-type: none"> • “The readiness and quality of our <i>public transport</i> are still pretty poor. Our mass transit service coverage is not enough” – Interviewee 15. • “Using public transport requires multiple <i>connections</i>, which are neither smooth nor affordable” – Interviewee 05.
	Infrastructure for active modes	walking, cycling, bike, walkway, footpath, crossing, traffic light	<ul style="list-style-type: none"> • “<i>Crossings</i> are extremely dangerous, which makes people feel unsafe and hesitant to use them, especially at night when there are no lights” – Interviewee 13.
	Investment promotion policy	investment, economic development, economy, neighboring country, growth	<ul style="list-style-type: none"> • “We need to benchmark with Indonesia to create attractive policies that will attract foreign <i>investment</i>” – Interviewee 18.
	Health concerns	health, pollution, PM2.5, dust	<ul style="list-style-type: none"> • “When the environment is poor, people prefer to use cars because they don’t want to walk on dusty streets and inhale <i>PM2.5</i>” – Interviewee 08.
	Global economic order	production base, hub, parent company, global economy	<ul style="list-style-type: none"> • “Thailand has been global <i>production base</i> for a long time” – Interviewee 04. • “When Japan was affected by the Plaza Accord, the resulting strong yen led to Japanese <i>mother companies</i> flowing into Thailand, establishing it as a <i>hub</i> for car manufacturing” – Interviewee 08.
	Concentration of economic growth and prosperity	concentration, economic growth, prosperity, migration	<ul style="list-style-type: none"> • “The BMR has higher growth, leading to <i>migration</i> for jobs” – Interviewee 01.
	Politics	politics, politician, house of representative, representatives, political will, corruption, conflict of interest, authority,	<ul style="list-style-type: none"> • “The <i>government</i> needs to show that they support using public transportation by sending a clear message in that direction” – Interviewee 07. • “<i>Politics</i> plays a crucial role as <i>representatives</i> often prioritize the interests of their local voters rather than considering the broader system as a whole” – Interviewee 15.

Research questions	Theme	Preliminary codes	Anchor examples
		government, national agenda, voters	
Environmental issues	Environment, pollution, natural resources depletion, sustainability, CO ₂	<ul style="list-style-type: none"> • “The environment has become a prominent concern due to pollution, making it crucial for individuals to be encouraged to decrease their reliance on private cars” – Interviewee 04. • “In the case of natural resources, it is crucial to utilize them with maximum efficiency or with minimum usage to preserve them and reduce CO₂ emissions” – Interviewee 06. 	
Commitment to international goals	SDG, MDG, net zero, carbon neutrality, commitment, international, global	<ul style="list-style-type: none"> • “The government has embraced global goals and commitments such as the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs)” – Interviewee 05. • “Thailand has made a commitment to combat climate change, with the goal of achieving carbon neutrality by 2050 and reaching net zero emissions by 2065” – Interviewee 16. 	
Shift in policy direction towards environmental and social	policy, direction, measure, national plan, government plan	<ul style="list-style-type: none"> • “The policy direction has turned to focus on environment and social issues more than in the past” – Interviewee 08. 	
Digital trend and promotion	digital, smart, technology, connected, autonomous, shared, promotion	<ul style="list-style-type: none"> • “In alignment with the global trend, the government has started promoting digital technology, focusing on efficiency, sustainability, and safety” – Interviewee 09. 	
Technology development	technology, IT development, advancement	<ul style="list-style-type: none"> • “The advancement of technology has provided businesses with greater opportunities to provide innovative services and solutions to customers” – Interviewee 14. 	
Changes in values among young gen.	social value, young, generation, youth	<ul style="list-style-type: none"> • “The young generation tends to use cars only occasionally, indicating a shift in their preferences and behavior” – Interviewee 01. 	
Economic slowdown	economy, GDP, purchasing power, debt	<ul style="list-style-type: none"> • “Currently, economic growth is unfavorable, and high levels of household debt are definitely hurting purchasing power” – Interviewee 10. • “Economic factor is influencing people’s decision and behavior” – Interviewee 12. 	

Research questions	Theme	Preliminary codes	Anchor examples
RQ1.2: Mechanisms behind (in)stability of the automobility regime?	Social Values	status, progress, image, success, achievement, dignity, character, show-off, social context, culture, wealth, lifestyle, social standard	<ul style="list-style-type: none"> • “Driving a car is often seen as a symbol of <i>social status</i> and can be associated with your personality or <i>character</i>” – Interviewee 03. • “Having or driving a car is often associated with a sense of <i>dignity and success</i>. It symbolizes <i>achievement</i> and <i>wealth</i>” – Interviewee 15.
	Provision of car ecosystem and strong actor network	car, road, car navigator, car ecosystem, value chain, car infrastructure, tollway, expressway, free public parking, car activity & lifestyle, sales & maintenance	<ul style="list-style-type: none"> • “We have a route calculator specifically designed for <i>car navigation</i>, but unfortunately, public transport options are not prioritized as most customers prefer using cars” – Interviewee 02. • “The city puts <i>cars</i> first in almost everything, leaving little attention to other transportation options” – Interviewee 16. • “We built a lot of <i>roads</i> and then built <i>expressway</i> on top of it, making driving convenient” – Interviewee 17.
	Car-oriented transport policy and knowledge	expertise and knowhow, road authority, road expansion, road technology, road construction, traffic volume, traffic, road management, traffic release	<ul style="list-style-type: none"> • “The infrastructure favors cars due to our road <i>technology knowhow</i>, as we made the decision in the past to prioritize the construction of expressways rather than investing in a rail system” – Interviewee 09. • “Thai contractors have high <i>expertise</i> in building roads because they have done it for so long. It is also simpler, compared to other infrastructures.” – Interviewee 02.
	Automotive industry promotion policy	automotive, automobile, industry, promotion, policy, first-car buyer, EV, subsidy	<ul style="list-style-type: none"> • “<i>Automotive industry</i> is a major industry. There are many <i>policies</i> that supported it, such as the first car buyer policy” – Interviewee 05. • “EVs <i>subsidy</i> can encourage people to drive more because the cost of energy is lower than that of gasoline” – Interviewee 09.
	Automotive industry strengths	advocate, association, government relationship, common interest, competitiveness, strong network	<ul style="list-style-type: none"> • “The industry always <i>advocates</i> for maintaining a strong <i>relationship</i> with the government to discuss policies” – Interviewee 01. • “Our agencies are designated to promote the <i>competitiveness</i> of the automotive manufacturing industry” – Interviewee 18.
	Car attractiveness	privacy, multi-purpose, personal safety, family trip, freedom, door-to-door, on-demand	<ul style="list-style-type: none"> • “Cars provide <i>privacy</i> and <i>freedom</i>, allowing you to go anywhere without relying on anyone else” – Interview 03. • “It offers <i>on-demand</i> transportation and provides <i>personal safety</i>, especially for girls” – Interviewee 13.
	Product development	car technology, autonomous,	<ul style="list-style-type: none"> • “Nowadays, cars come equipped with <i>high-tech</i> functions that <i>assist</i> you, making

Research questions	Theme	Preliminary codes	Anchor examples
	of car	driving assistant, high-tech	the driving experience much easier and more convenient” – Interviewee 04. <ul style="list-style-type: none"> • “Cars have been developed to serve <i>multiple purposes</i>, allowing them to be used for personal trips as well as small business needs” – Interviewee 10.
	Low cost of private car use	cost, expense, out-of-pocket	<ul style="list-style-type: none"> • “The <i>cost</i> of using a private car in our country is also affordable compared to foreign countries” – Interviewee 05.
	Lack of knowledge for car management	data, information, research, knowledge, car management	<ul style="list-style-type: none"> • “Lack of <i>information</i> and <i>knowledge</i> makes it difficult to formulate a policy to limit car usage” – Interviewee 07.
	Habitual behavior	convenience, comfort, familiarity, perceived time savings	<ul style="list-style-type: none"> • “People prefer using cars due to <i>familiarity</i> and <i>convenience</i>. It doesn’t need extensive planning” – Interviewee 03.
	Social and environmental awareness	environment, pollution, efficiency, social impact	<ul style="list-style-type: none"> • “It has huge impact on the <i>environment</i>, especially <i>pollution</i>” – Interviewee 07.
	Tighten law and regulation	law, regulation, standard	<ul style="list-style-type: none"> • “Due to increasing environmental concerns, the government has imposed stricter <i>standards</i> such as Euro 5 and Euro 6 – Interviewee 04.”
	Stakeholder conflict of interest	conflict of interest, compromise, common stance, agenda, disagreement	<ul style="list-style-type: none"> • “Each party has its own <i>agenda</i> and often fails to consider the overall perspective or the bigger picture” – Interviewee 11.
	Uncertainty of policy	policy, change, uncertain	<ul style="list-style-type: none"> • “Government policy and direction <i>change</i> all the time” – Interviewee 04.
	Oil price	oil/ gasoline/ energy price	<ul style="list-style-type: none"> • “<i>Oil price</i> has been increasing” – Interviewee 20.
	Traffic congestion	traffic, congestion, jams	<ul style="list-style-type: none"> • “<i>Traffic jams</i> is really bad especially at mass transit construction” – Interviewee 20.
	Lack of parking space	parking	<ul style="list-style-type: none"> • “It is very difficult to find <i>parking</i> and takes so much time” – Interviewee 17.
	Burden of ownership	space, time, security, expense	<ul style="list-style-type: none"> • “Annual <i>expense</i> i.e. tax, registration, insurance, maintenance” – Interviewee 14.
	Safety concern	accident, safety, road discipline	<ul style="list-style-type: none"> • “High rate of road <i>accidents</i>” – Interviewee 13.

3.3 Part II – Beliefs Regarding MaaS adoption

Understanding the factors that impact commuters' decision about using MaaS is essential to formulate persuasive communication intervention that can effectively influence individuals' decision-making processes. User beliefs are vital in determining the acceptance and adoption of technologies. These beliefs strongly influence users' perceptions and decisions. Uncovering and understanding individuals' beliefs underpinning commuters' willingness to use MaaS can help understand the user intention and can be used as a basis to construct the measurement items in the future study.

The salient beliefs are the prevailing determinants of a person's intentions and actions because these beliefs are accessible in memory and will create the principal considerations that guide human behaviors (Fishbein & Ajzen, 2005). It is important to discover beliefs that spontaneously come to the participants' minds when they think about a specific behavior. Therefore, studies to extract the salient beliefs regarding an interested behavior among target populations in a specific context are recommended.

The purpose is to identify the behavioral, normative, and control beliefs of a population, as well as to obtain in-depth insight about cognitive foundation behind people's behavior (see Figure 9 in Chapter 2). Inducing and analyzing these beliefs can guarantee the significant factors that provide the basis for intentions to perform interested behavior (Fishbein & Ajzen, 2005).

Moreover, MaaS is a unique and innovative service that has not yet been widely introduced. As a result, adopting only direct indicators and a TPB questionnaire typically used in other studies might not be suitable to assess each of the theory's constructs. Those measurement items may not represent the real influencing factors towards using MaaS. It is of high importance to identify the underlying behavioral, normative, and control beliefs that provide the basis for the TPB variables in order to design effective behavior change intervention.

3.3.1 Rationale and Significance of Salient Beliefs

Despite theoretical recommendation, most TPB studies seem to give less attention to such established knowledge. There is very limited use of salient belief

studies, especially prior to the main TPB research. Beliefs behind each component are simply designed based on the researchers' own intuition, literature reviews, or directly imported from previous studies that are assumed applicable to different behaviors or populations. In fact, beliefs vary from behavior to behavior and are dependent upon demographics so it is imperative that elicitation research be carried out whenever the TPB is applied (Fishbein & Ajzen, 2005).

In order to examine beliefs in a target population, qualitative studies are necessary for understanding the determinants of a specified behavior. People's thoughts and feelings towards commuting are not only linked to personal experiences, but also influenced by social norms. Family and friends, as well as new positive and negative experiences, can either further shape or help dissipate beliefs (Fishbein & Ajzen, 2015). Elicitation studies provide researchers with valuable data by analyzing the cognitive determinants of an individualized behavior. Singling out the strongest factors in determining attitude, subjective norm, and perceived control can lead to the understanding necessary for establishing valid predictions.

Some TPB meta-analyses and comprehensive reviews even critically suggested that main methodological concern for understanding intention and behavior is the limited use of salient beliefs studies. In comparison, the effect size of results from those with salient beliefs studies were significantly larger. The beliefs could significantly explain up to 56% of the variance in attitude, subjective norm, and perceived behavioral control. Salient beliefs studies are clearly an effective mechanism for understanding and explaining the psychosocial and cognitive determinants of people's intention and behavior (Downs & Hausenblas, 2005) that appear to be overlooked.

Moreover, salient beliefs study can allow researchers to reveal additional factors, that can impact decision making of the population of interest and strengthen the predictive power of TPB, especially in diverse settings (Fishbein & Ajzen, 2011). It is even more important when applying with an innovative service like MaaS since it tends to bring new behavior, which is not comparable to other ones in the past, and therefore impossible to simply bring in salient beliefs from previous studies.

3.3.2 Data Collection and Analysis

A qualitative approach using semi-structured interviews was applied to gain in-depth insight into the salient beliefs underpinning commuters' willingness to use Mobility as a Service (MaaS). This approach provides a holistic understanding of the phenomenon and uncovers the underlying reasons, values, and motivations behind commuters' mobility choices. By capturing the richness and diversity of user experiences, qualitative research offers the opportunity to generate new insights and perspectives.

In addition, qualitative methods enable an in-depth understanding of users' beliefs by exploring the complexities and contextual factors that influence their decision-making processes. This approach captures subjective experiences and provides insights into how beliefs are formed, maintained, or changed. The participant-centered nature of qualitative research ensures that the study reflects the lived experiences and perspectives of the users themselves, thereby enriching the understanding of user motivations and decision-making related to MaaS adoption.

To strengthen the methodology and address the limitations of the qualitative approach, several techniques were applied, as described in section 3.2.2. Additionally, to enhance the rigor of the analysis, the Theory of Planned Behavior (TPB) was adopted as a guideline for designing, conducting, and analyzing semi-structured interviews.

Applying a theoretical framework helps increase rigor by providing a structured and organized framework for conceptual clarity. Theoretical frameworks offer an interpretive lens for analyzing and interpreting data, enabling the identification of patterns, themes, and relationships within the data. This facilitates a deeper understanding of the research phenomenon and promotes systematic and consistent analysis. Furthermore, theoretical frameworks guide the data collection and analysis process by specifying the aspects of the phenomenon that should be observed.

Semi-structured interviews were selected over focus groups to avoid the motivation to conform socially, especially in Thai people's nature of being modest and passive. They would feel more comfortable sharing their own thoughts and

opinions individually rather than in a group discussion where they might defer to others in order to avoid confrontation, disagreement, or embarrassment. Interview questions were probed based on the TPB guidelines presented by Ajzen (1991) to elicit behavioral beliefs, normative beliefs, control beliefs, as well as other beliefs that might introduce additional constructs beyond the TPB model as shown in Table 6

Figure 19 Interview questions to assess participants' beliefs towards using MaaS.

Constructs	Questions
General Questions	<ul style="list-style-type: none"> • What is the first thing that comes to your mind when you know about MaaS?
Behavioral Beliefs	<ul style="list-style-type: none"> • What do you see as benefits or advantages that would occur from using MaaS? • What do you see as concerns or disadvantages that could occur from using MaaS?
Normative Beliefs	<ul style="list-style-type: none"> • Who do you think would support or approve you to use MaaS? • Who do you think would object or disapprove you to use MaaS?
Control Beliefs	<ul style="list-style-type: none"> • What would motivate or make it easy for you to use MaaS? • What would prevent or make it difficult for you to use MaaS?
Other Beliefs	<ul style="list-style-type: none"> • Are there any additional factors that would affect your decision to use MaaS?

Due to theoretical saturation – the point where additional data collection provides little further information – a small convenience sample within the target population is appropriate, as long as it captures a comprehensive range of salient beliefs (Ajzen, 1980). The purposeful sampling strategy in this study targeted individuals aged between 18 and 65 years who reside in the Bangkok Metropolitan Region (BMR) and engage in daily commuting. The participants were not incentivized in any way to take part in this study.

Due to the COVID-19 pandemic, semi-structured individual interviews were conducted with study participants through virtual meeting platforms including Zoom, Microsoft Teams, or Line based on participants' convenience from August 2021 through September 2021.

Before starting the interview, a conceptual description of MaaS based on a common definition (see Chapter 2) was provided verbally. Each respondent was also asked to watch a two-minute video demonstrating an example of the MaaS application in Denmark (available at <https://www.youtube.com/watch?v=x60CCM28X8E>)

together with the researcher narrating a sequence of the video in the native language. The use of visual materials such as pictures or videos is commonly incorporated in the research process of qualitative research because an individual's memory can be imperfect and biased, and the color, motion, and sound from visual materials such as videos, can trigger a broader spectrum of brain processing and is an effective way to prompt memory and stimulate accurate recall (Jarrett & Liu, 2018). Video can also be an effective way to prompt discussion, or provide a basis for self-reflection on present and future actions.

Moreover, a respective mobile app mockup developed by Surangsrirat et al., 2020 was also presented through a web-based vector graphics editor and prototyping tool called Figma (see Appendix B) to depict what the MaaS app in Thailand could possibly look like. The respondents were well aware that the application was not available in Thailand yet. They could also ask questions to ensure they understood all potential features and functionalities, as well as the overall offering. The researcher took field notes during each interview, which were also audiotaped or videotaped upon participants' permission and ranged from 20 to 40 minutes.

Verbatim transcriptions of audio or video recordings were made, and a data matrix was used to code the participants' responses regarding the use of MaaS. The responses were grouped according to the relevant beliefs associated with the underlying TPB model. The most frequently mentioned beliefs were identified and mapped based on recurring themes. Each of these beliefs is discussed alongside supporting statements, which are presented as quotes from the participants.

The data were analyzed manually using thematic analysis with both inductive and deductive coding to identify specific beliefs that play a significant role in shaping attitudes, subjective norms, and perceived behavioral control, leading to a deeper understanding of the TPB constructs and potential modifications or additions to the framework (Bryman, 2016). The analysis involves a structured matrix development whereby all data are reviewed for content and coded for correspondence to the identified categories. This process was performed twice at different timing and cross-checked with a research assistant in order to assure the reliability of the codes.

CHAPTER IV

THE CURRENT AUTOMOBILITY REGIME OF THE BMR

4.1 Landscape Developments Affecting the Automobility Regime

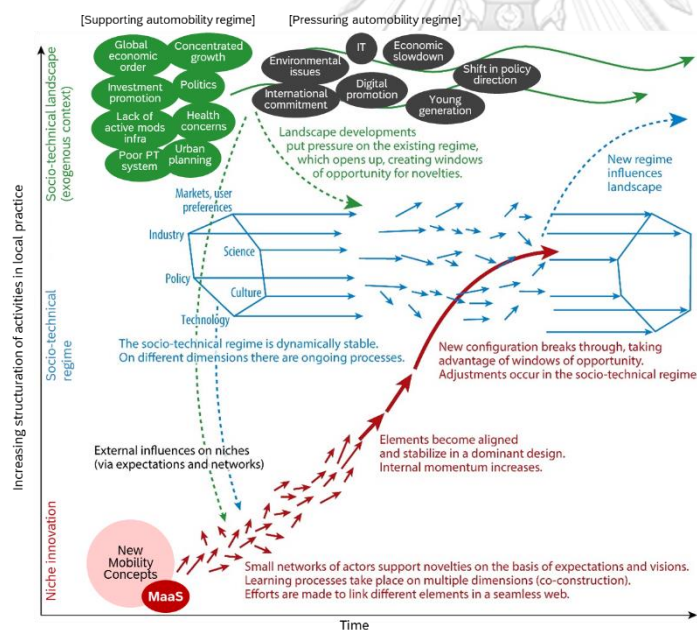
According MLP, landscape developments that influence the automobility system refer to broader societal changes, trends, and factors that shape the context in which the system operates. Landscape changes, occurring at a slower pace compared to regime changes, but play a significant role in the stabilization and destabilization of regimes. These gradual landscape shifts create pressure on the existing regime, causing “cracks” to emerge and prompting the realignment of specific elements within it (Geels, 2004). Understanding landscape dynamics is crucial in comprehending how broader societal developments impact the evolution or potential breakdown of prospective regimes.

This section presents the results from the qualitative data analysis of the semi-structured interviews conducted with stakeholders regarding the landscape dynamics that impact the automobility regime in the BMR. Table 7 and 15 illustrate the observed dynamics at the landscape level. The results indicate that there are currently landscape developments that both support and pressure the existing automobility regime. Some landscapes resemble those identified in different contexts from the literature review, while others are specifically observed within the context of the BMR.

Figure 20 Landscape developments affecting the automobility regime.

Supporting automobility regime	Pressuring automobility regime
<ul style="list-style-type: none"> • Health concern • Urban design and planning • Lack of proper infrastructure for active modes i.e. walking, cycling • Investment promotion policy • Poor public transport system i.e. unsafe, limited interconnectivity/ coverage/ integration, high expense • Global economic order • Concentration of growth and prosperity • Politics i.e. no political will, corruption, conflict of interest, inconsistency, failure to keep up with technology 	<ul style="list-style-type: none"> • Environmental issues i.e. pollution, natural resources, sustainability • Commitment to international goals • Shift in national policy direction towards environmental and social focus • Changes in social values among the young generation • Digital trend and promotion • Technology development • Economic slowdown

Figure 21 Landscape developments affecting the automobility regime, results from interviews, graphic modified from Geels, 2002 and Aruni et al., 2019.



- Landscape developments supporting automobility regime -

The analysis of interview data about landscape dynamics revealed that the developments contributing to reinforcing the dominance of private vehicle use and maintaining the stability of the automobility regime are the following:

4.1.1 Urban Design and Planning

Almost all participants mentioned about the lack of effective urban planning that leads to more urban sprawl, making it challenging to address and eventually resulting in car-centric development that promotes car ownership and dependency. Many stakeholders compared the BMR's situation with other countries such as European countries or Japan. In Europe, where cities are clustered and interconnected, it is obvious that the development of public transportation is much easier. In term of transportation, urban sprawl increases distances between residential areas, commercial centers, and workplaces, making public transport more difficult, less convenient and time-consuming. Lower population densities in sprawling suburban areas result in reduced demand for public transport services, making it economically challenging to provide frequent and high-quality services.

Many interviewees have highlighted the persistent issue of dead-end or deep alleys as a significant problem related to urban planning in the BMR. These alleys pose various challenges to the use of public transport such as the lack of direct connections to main roads or public transport stops. As a result, residents in these alleys need to walk longer distances to reach the nearest public transport stop or get less frequent transport service, particularly in areas with low population density. Some interviewees mentioned their willingness to use public transport to avoid traffic congestion, but they highlighted the lack of options from their house located on a dead-end alley.

“For instance, my house is located about 1.6 kilometer from the Ngamwongwan road and there is no option to get out except for motorcycle taxi, which is dangerous” – Interviewee 02.

Zoning is another matter of city planning mentioned frequently during the interviews. Stakeholders believe that zoning have a significant impact on public transport management as they can shape land use patterns and enable efficient transportation networks. The stakeholders explained that in the BMR, where job opportunities are predominantly located in the city center, the high cost of housing significantly forces people to purchase homes in the suburbs, where public transport access is limited or expensive. These individuals not only face longer travel times but

also bear the burden of expensive fares. As a result, they are left with no choice but to rely on private vehicles for their daily commute. This is why we observe the presence of slums in city centers, as they provide affordable housing options that help relieve the financial burden of commuting expenses.

“These individuals have already made sacrifices by choosing to reside far away from the city center, yet the transportation system imposes a financial burden on them through distance-based charges for travel expenses” – Interviewee 11.

Based on insights from the interview data, stakeholders expressed the view that the lack of zoning presents challenges in traveling within the BMR, particularly by public transport. They emphasized that zoning plays a crucial role in promoting the development of mixed land use, which can effectively reduce the need for long-distance travel. By allowing a mixture of residential, commercial, and recreational activities in close proximity, zoning can create livable and self-reliable neighborhoods where people can access essential services, employment, and recreational amenities without relying heavily on private vehicles. This, in turn, incentivizes individuals to utilize public transport for their daily commuting needs, reducing reliance on private vehicles and alleviating congestion and pollution.

Stakeholders also highlighted the lack of integration between urban planning and transportation planning as another issue stemming from the inadequate urban design and planning. They emphasized that successful cities with efficient mass transit systems often adopt a sub-city concept, enabling residents to easily connect with the city through these transportation networks. This integration of housing and transportation planning would contribute to the creation of well-connected communities and facilitate convenient access to transportation networks. Stakeholders think that the integration is crucial because without it, individuals are left with limited choices and often tend to rely heavily on private cars, thereby strengthening the dominance of the automobility regime.

4.1.2 Poor Public Transport System

During the interviews, stakeholders frequently discussed landscape developments that favor the dominance of the automobility regime, particularly highlighting the challenges posed by poor public transport in the BMR. They

expressed concerns regarding numerous limitations and significant shortcomings of the public transport system, leading to inconvenience for commuters. Stakeholders emphasized issues such as insufficient coverage, limited interconnectivity, and a lack of integration or proper infrastructure for non-motorized modes. Furthermore, they pointed out that public transport in the BMR can be relatively expensive compared to other daily expenses for commuters and, in some cases, even more costly than using a private car. These conditions collectively contribute to the poor state of public transport in the BMR.

Almost all of the interviewees discussed the limited coverage of public transport. The public transport network in the BMR does not adequately cover all areas, leaving certain regions underserved or with limited access to transportation options. People may have to drive to the stations but finding parking can be challenging. Park-and-ride facilities are not generally available, and the parking spots are outdoor, which is not convenient. Taking public transport can be tiring, and when considering the overall cost, it becomes comparable to using a private car with a higher level of convenience.

Many participants drew comparisons between the situation in the BMR and the highly organized and accommodating public transportation system they witnessed in Japan. They highlighted Japan's extensive rail network, which effectively connects various regions across the country, ensuring seamless travel for commuters. Additionally, participants mentioned the availability of buses, taxis, and other transportation options that facilitate transit to remote or less frequented areas where rail access may be limited.

In contrast, participants expressed their perception that the public transport system in the BMR does not resemble the same level of convenience. While we have a major transport system like arteries in the middle (backbone network), the peripheral areas lack adequate connectivity. It is crucial to bridge this gap and ensure that the public transport network reaches these underserved areas, resembling the capillary blood vessels that complete the circulatory system (backhaul network).

“It often seems ironic that mass rapid transits are built along roads where buses already operate, instead of expanding public transport service coverage to other

areas. This approach also implies the public transport policy trap that focus on road traffic reduction” – Interviewee 11.

During the analysis of the interviews, another challenge that emerged repeatedly was the limited physical connectivity between different modes of transport. Stakeholders expressed concerns about situations where bus stops or train stations lacked direct access to each other or to other modes of transport. These missing links often forced passengers to walk longer distances or rely on informal connections, which can be particularly challenging given the hot weather and frequent rain in the BMR. The lack of seamless connections added additional discomfort and difficulty to the overall travel experience. This issue was supported by the study on seamlessness of the public transport system in the BMR using modified quantitative gap analysis and found that the lack of seamless connections adds additional discomfort and difficulty to the travel experience, emphasizing the need for improved physical connectivity and coordination between transport modes (Permana and Petchsasithon 2019).

Some also mentioned that public transport is also often not on time. There is no real-time and reliable schedule for it. Some buses still lack air conditioning, which is unsuitable for hot weather conditions like in the BMR. Safety is another issue, as there is limited connecting facilities between modes, and sometimes, there is none at all. People don't feel safe using them, especially at night time.

The discussions also revealed that the BMR experiences a shortage of bus stops or stations that provide shelter from the rain when getting on or off the bus. Participants cited examples of stations lacking sufficient roofing or underground facilities, contrasting them with the amenities found in some buildings in Hong Kong. They mentioned that in certain locations, buses have the convenience of dropping off passengers directly inside buildings where train stations are situated. These facilities significantly contribute to the attractiveness and convenience of active modes of transportation, which are crucial for promoting the use of public transportation. Figure 22 shows pictures and number of bus stops in the BMR.

Figure 22 Bus stops in the Bangkok Metropolitan Region, 2020.



Throughout the interview process, one of the prominent issues discussed extensively was the absence of a common ticketing system that enables passengers to conveniently transfer between different modes of transport using a single ticket or card. Participants mentioned the inconvenience caused by the lack of an integrated ticketing system. While there have been efforts to introduce common ticketing systems, the main challenge seems to be about conflict of interest among operators. The single fare for the mass rapid transit systems in Bangkok, such as the BTS Skytrain and MRT subway, still vary based on the distance traveled.

Another issue raised by participants is the importance of accurate and timely information regarding routes, schedules, fare systems, and service. They emphasized that having access to such information is crucial for commuters to effectively plan their journeys. Inadequate coordination among different transport operators was also identified as a contributing factor to confusion and inconvenience for commuters.

The high expense of public transport compared to private car use was consistently highlighted during the interviews. Participants noted that the high cost makes it more economical for commuters to travel on a motorcycle instead. Not only is it a cheaper alternative, but it also offers a faster mode of transportation compared to taking the bus. Some interviewee mentioned that the cost of using the BTS Skytrain, compared to income, is arguably one of the highest in the world. The issue was confirmed by the study on factors affecting travel in the BMR that transportation costs accounted for 36.24% of commuters' monthly living expenses (Satranarakun & Kraiwanit, 2022).

Stakeholders highlighted that when the fares are too expensive, people tend to avoid using it. Some participant gave an example that if an individual travels by the Purple Line⁴, its fares is actually higher than driving a car, especially for families with four members.

“If you take the Skytrain for one day, it averagely costs 30 Baht per trip. If you travel in a group of three, that’s 90 Baht. Additionally, you would need to pay for motorcycle taxis at 15 baht each, resulting in 45 baht per person per trip, which equals 90 baht per person per round trip or 270 baht in total” – Interviewee 11.

Based on the interview data, it was revealed that due to the nature of our city plan, which consists of super blocks, paratransit becomes necessary for first/last mile connectivity. However, participants raised concerns about the high cost of the Skytrain system, which is further worsen by the prohibitively expensive nature of motorcycle taxis. They also highlighted that in other countries, the small blocks are feasible to walk to the bus stop and rail stations. Unfortunately, in the BMR, the motorcycle taxi price remains high as there is no regulator or integration into the broader transportation system. This makes accessing mass transit difficult.

While public transport is a fundamental service that should be accessible to everyone, relatively-high fares on rapid transit systems in the BMR contrarily shut out lower-income people from the service.

4.1.3 Lack of Proper Infrastructure for Active Modes

Based on the insights gained from the interviews, participants highlighted the difficulties and challenges associated with active modes or non-motorized transport, such as walking or cycling. They emphasized that these modes face particular obstacles due to the absence of a dedicated agency responsible for this link of public transport. In a hot climate like the BMR, it becomes crucial to have shaded areas or trees along walkways to make walking a feasible and comfortable option. A study about choosing a mode in the BMR found that these amenities are often lacking,

⁴ The MRT Purple Line, also known as the MRT Chalong Ratchatham Line, is the fifth rapid transit line in Bangkok. Its distance is 23 kilometers and serves the northwestern region of the city, running from Tao Poon to Klong Bang Phai in Nonthaburi Province.

resulting in an average comfortable walking distance for commuters of only about 700-800 meters (Ayaragarnchanakul et al., 2022).

Stakeholders expressed the view that walking becomes significantly more inconvenient, particularly during hot and rainy weather, making it less practical to rely on public transportation. They contrasted this with countries like Japan, where the weather is not as hot, and walking remains a more practical option. In the context of the BMR, the dilemma arises when facing rainy conditions after leaving home. Additionally, the need to carry belongings to work and back home further increase the challenges associated with walking as a mode of transportation.

During the interviews, an example was given regarding the seamless connectivity between a dock and other modes of transportation, such as the Skytrain, when traveling by boat. To ensure this connectivity, stakeholders emphasized the necessity of constructing a roof or shelter. However, the absence of a roof creates difficulties for people, particularly during hot weather or the rainy season. The lack of proper infrastructure for active modes has resulted in missing links between different modes of transportation.

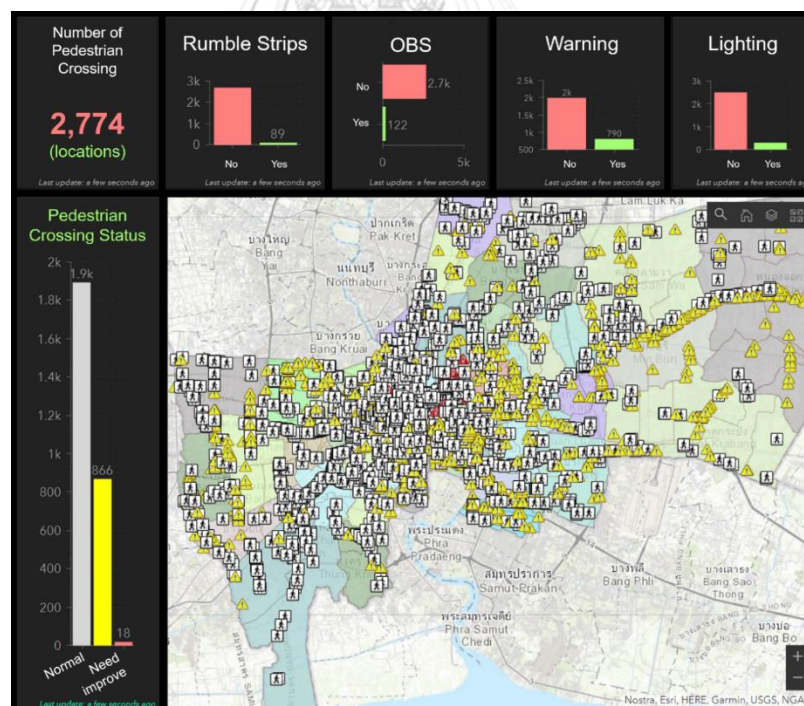
It was noted that although efforts have been made to improve pedestrian infrastructure in the BMR, there are still many areas lacking proper sidewalks, pedestrian crossings, or footbridges. These insufficiencies unavoidably force pedestrians to share the road with vehicles, increasing the risk of accidents. Figure 23 is an example of the pedestrian crossing status in Bangkok, showing that most of them still lack of standard safety features such as rumble strip, warning, or lighting system. More than 30% of them also need physical improvement.

During the interviews, participants emphasized the need for research and infrastructure development tailored to the walking behavior specific to each city and country. They pointed out that when designing pedestrian crossings, it is important to consider the presence of both fast and slow walkers. Taking into account the width of the road, crossing it can consume a significant amount of time, requiring pedestrians to have sufficient time and not feel rushed when the lights are already flashing. Unfortunately, there is a lack of dedicated research and provision focused on pedestrians in these aspects.

Another example discussed was the challenge of crossing a road at a traffic light intersection. In some countries, there are designated waiting spaces in the middle of the road for pedestrians. However, in the BMR, the narrowness of the infrastructure often discourages walking and creates inconvenience for pedestrians. This highlights the significance of addressing infrastructure issues to promote walking as a mode of transportation.

An improvement project conducted by the Thailand Future Foundation was mentioned, which involved installing pedestrian crossing lighting and enhancing the lighting system for nighttime use. The project found that such initiatives could encourage more people to walk and cross the road instead of relying solely on motorcycle taxis. These insights underscore the utmost importance of improving infrastructure for non-motorized modes of transport, such as walking, to create a safer and more pedestrian-friendly environment.

Figure 23 Pedestrian Crossing Status in Bangkok, Traffic and Transportation Department, Bangkok Metropolitan Administration (2023).



4.1.4 Global Economic Order and Investment Promotion Policy

Stakeholders emphasized that the fact that Thailand serves as an automobile production base has a significant influence on car dependency in the BMR. Given Thailand's robust network and investment in the automotive industry, the BMR serves

as the first market to provide cars to. As the capital and central region, the BMR benefits from the country's transportation infrastructure, including well-maintained road networks, highways, and expressways. This infrastructure facilitates the distribution and availability of cars in the BMR, allowing residents to have easier access to purchasing and owning vehicles.

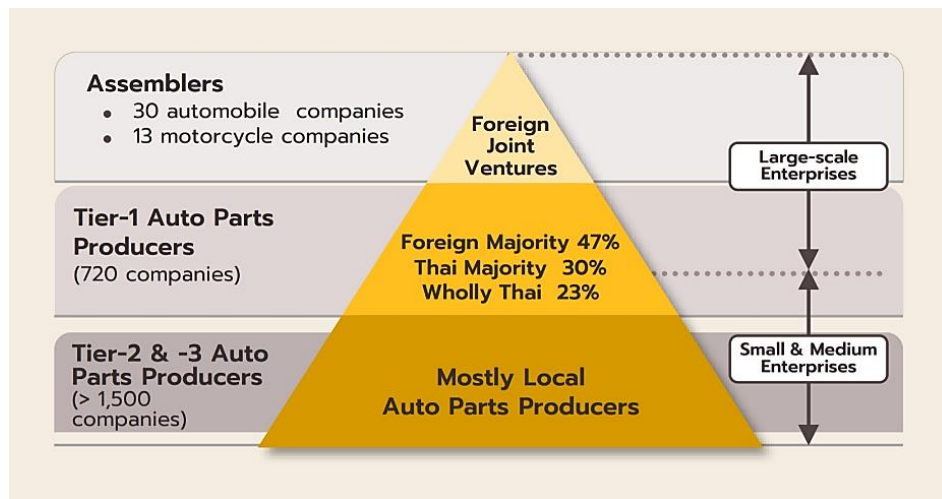
Moreover, the BMR's high population density and economic prosperity make it an attractive market for automotive manufacturers and dealerships. The region's strong purchasing power and demand for private transportation contribute to the prominence of the BMR as the primary market for car sales in Thailand.

Based on insights from the interviews, it was revealed that Thailand has been designated as an automobile production base by mother companies, the majority of which are Japanese. The participants shared that Japanese businesses relocated their production to Southeast Asia to mitigate business deficits resulting from the yen appreciation caused by the Plaza Accord⁵ in 1985. Consequently, Japanese investment flowed into Thailand, positioning the country as Japan's hub for automobile production in ASEAN. This, in turn, encouraged the establishment of more parts manufacturers, either through partnerships with Thai entrepreneurs or by Thai individuals involved in parts supplier network. Figure 24 shows the structure of Thai automotive industry.

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Figure 24 Structure of Thai Automotive Industry, Thailand Automotive Institute (2023).

⁵ The Plaza Accord was an agreement among the finance ministers and central bank governors of the United States, Japan, West Germany, France, and the United Kingdom. Its purpose was to address global economic imbalances, specifically the appreciation of the Japanese yen and trade imbalances between the United States and Japan. The main provisions of the accord involved currency exchange rate adjustments, policy coordination to stimulate domestic demand, market intervention to weaken the yen's value, and ongoing monitoring of progress. While it helped address trade imbalances, it also had unintended consequences, such as an asset bubble and economic downturn in Japan.



During the interviews, it was revealed that the Thai government actively sought Japanese investment and supported the domestic car assembly industry as a result. Participants shared that government policies aimed at supporting the industry, such as Import Substitution Industrialization (ISI) and Export-Oriented Industrialization (EOI), as well as liberalization through free trade agreements, were driven by international financial organizations like the World Bank, International Monetary Fund (IMF), and Asian Development Bank (ADB). These organizations shaped the development policies through their financing conditions, helping capitalists establish an international division of labor where each developing country specialized in producing specific goods for the global market (Cox, 2006).

These dynamics have led to a situation where the majority of Thai entrepreneurs heavily rely on contract manufacturing and have limited involvement in the development and design stages of products. Participants highlighted that despite the availability of production technology, its expansion is hindered by copyright restrictions. Consequently, Thai companies primarily operate within a manufacturing landscape centered around contract manufacturing, with limited participation in research and development. According to stakeholders, especially those in the automotive sector, the current structure emphasizes the need for government policies that promote and sustain the industry, preventing foreign investors from relocating to neighboring countries.

Likewise, stakeholder from investment promotion arena discussed that Thailand has placed significant emphasis on the economy, with investment promotion

policies playing a crucial role in attracting investors. The ultimate goal is to encourage as much investment as possible, as it is seen as vital for driving economic growth. Stakeholders mentioned the underlying belief that by improving the economy, many problems can be addressed. Investments lead to job creation, which enhances the overall economic well-being of the population. Furthermore, when foreign investors bring their technology and knowledge to Thailand, it promotes the transfer of technology and enhances the country's technological capabilities. This transfer can have a positive impact on various sectors, stimulating innovation and improving productivity. Figure 25 and 26 illustrates the annual amount of foreign direct investment flowing into Thailand during 2006 – 2022.

Figure 25 Foreign Direct Investment by Business Sector, data adopted from of Bank of Thailand.

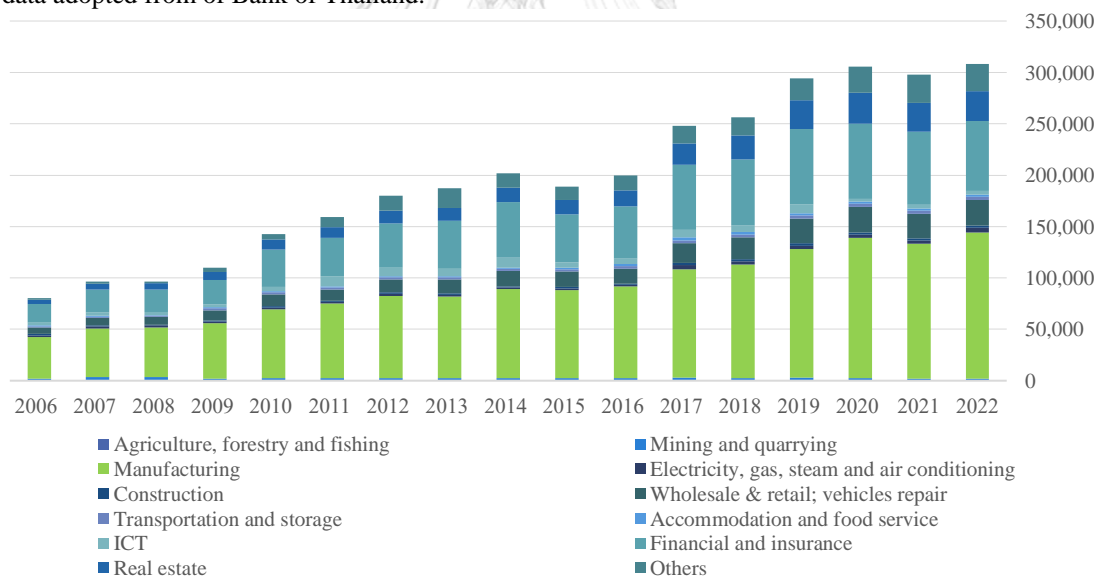
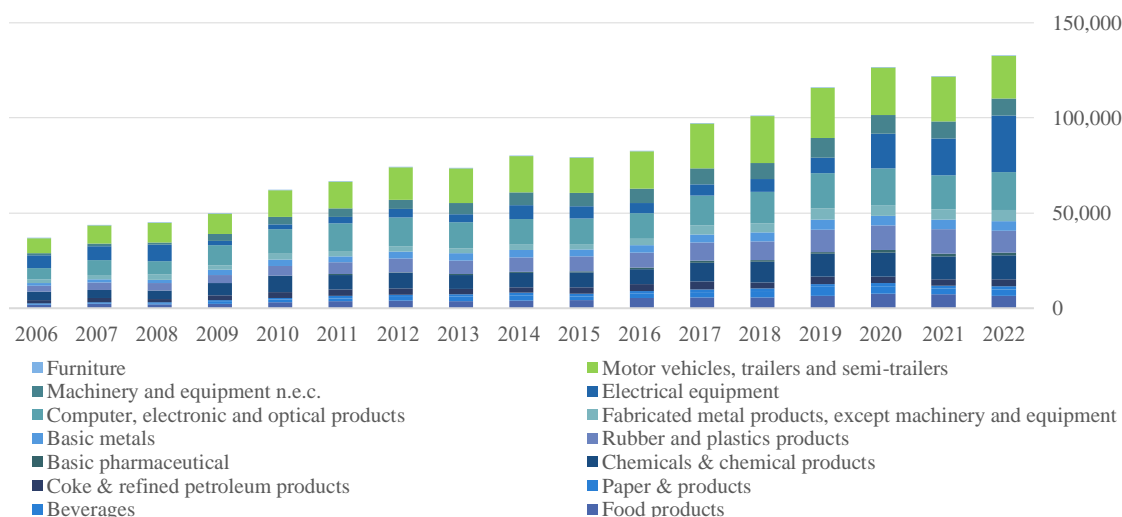


Figure 26 Foreign Direct Investment in Manufacturing Sector by Industry, data adopted from of Bank of Thailand.



4.1.5 Concentration of Economic Growth and Prosperity

Stakeholders also highlighted concentration of economic growth and Prosperity as supporting factors towards car dependency. Thailand lacks the equitable distribution of prosperity across the country. It is undeniable that the BMR is the economic, social, and political center of Thailand. Throughout its development process, opportunities and resources have rarely been distributed elsewhere. The region experiences a higher concentration of wealth and development compared to other urban areas in the country.

There has been a migration of people from outside to the urban areas. Interviewees pointed out that when people from other provinces move to the BMR, they use cars to travel back to their home provinces. This then becomes a factor that leads them to use cars for commuting and daily life. Previous research highlights that car ownership is associated with an investment trap into a purchased commodity, which does not encourage the user to use other travel modes (Mladenović & Haavisto, 2021). People own cars for specific trip purposes that public transport cannot fulfill, but since they have already invested in the car, it leads them to utilize it for other purposes as well.

4.1.6 Politics

Stakeholders consistently noted that politics play a crucial role in shaping policies, as it determines the direction and focus of governmental actions. In the context of transportation, political choices are detrimental in determining whether the

country should prioritize a transportation system that relies more on public modes, or one that leans towards private car usage. Politics hold a crucial position in transport systems as it encompasses the investments and policies involved in constructing the groundwork. It will shape the development of infrastructure, allocation of resources, and implementation of regulations. Decisions related to public transportation networks, road construction, parking facilities, and sustainable transport options all stem from political choices.

Therefore, it is essential for policymakers to carefully consider the long-term implications of their transportation policies, taking into account factors such as environmental impact, congestion, accessibility, and public needs. Nearly all interviewees agreed that politician's and government's commitment to promoting public transportation as a means to reduce dependence on private cars is still lacking. Promoting public transport requires huge collaboration among stakeholders, which is a challenging task in the context of Thai society. Clear political determination is crucial in this regard.

Specific to the BMR, interviewees showed consensus on the structuring of authority and the confusion it causes. In the BMR, there is currently no unified agency or centralized authority responsible for overseeing the entire public transport journey from start to finish. Instead, different agencies handle specific aspects of the journey. Local authorities are responsible for managing footpaths, local roads, local feeder services, and bus stops. On the other hand, national authorities, such as the Ministry of Transport, oversee buses and mass rapid transit systems. Additionally, the Thai Traffic Police manage traffic lights, crossings, and traffic law enforcement. It was well-stated by stakeholders that this silo approach creates a lack of seamless coordination in the overall public transport experience.

Some interviewees shared their observations that the executives in this country, who have never relied on public transportation themselves, may not fully comprehend the difficulties faced by commuters. Comparatively, in the Netherlands, the efforts made to promote bicycles were actually led by the Interior Minister. His personal experience of biking to work on a daily basis gave him valuable insights into the necessary improvements to make commuting by bicycle more efficient and enjoyable.

Another frequently mentioned issue by respondents was politics, particularly corruption and conflicts of interest among those in political power. Despite our attempts to replicate a system from abroad, the presence of corruption and conflicts of interest has hindered its full implementation. It is a firm belief that the planning of roads and public transport should be well-organized, with a focus on user-friendliness and ensuring seamless trip completion. Instead, our urban development is heavily influenced by negotiations and conflicting interests. The current system structure is in discord, and many felt the design of streets seems to prioritize the interest of stakeholders rather than a cohesive and efficient transportation network.

Furthermore, concerns were raised by interviewees since certain projects are not always aligned with the best interests of the communities but rather prioritize the interests of specific groups. For instance, there is an effort to establish a connection between the Yellow Line and the Green Line. However, it was revealed in an interview that the Blue Line, operated by a separate entity, raised concerns that this integration will lead to a decrease in their own passenger numbers. In such circumstances, it becomes necessary for the government to intervene and ensure that as more lines are connected, and the convenience and accessibility for passengers are prioritized.

Integration and collaboration are significantly challenging. Several stakeholders noted that each ministry has its own agenda and focuses on its individual goals rather than considering the overall picture. It was even pointed out that every project aims to be completed rapidly within a limited timeframe, often resulting in trade-offs and compromises. While academic principles, such as land reform, exist to ensure the optimal use of land, powerful decision-makers often resist implementing them to save time and deliver the public construction projects in their political terms.

Other issues mentioned by interviewees regarding politics include political inconsistency and incapability to keep up with the technology. Stakeholders feel that the politics in Thailand often lack continuity, with policies frequently changing as different ministers come and go. This inconsistency hinders the implementation of sustained policies, leaving many people affected. It is also believed that political bodies struggle to keep pace with rapidly advancing technology. Many feel it is

essential to embrace new technologies, even if it requires the involvement of private sector or younger generations who are more adept at handling them.

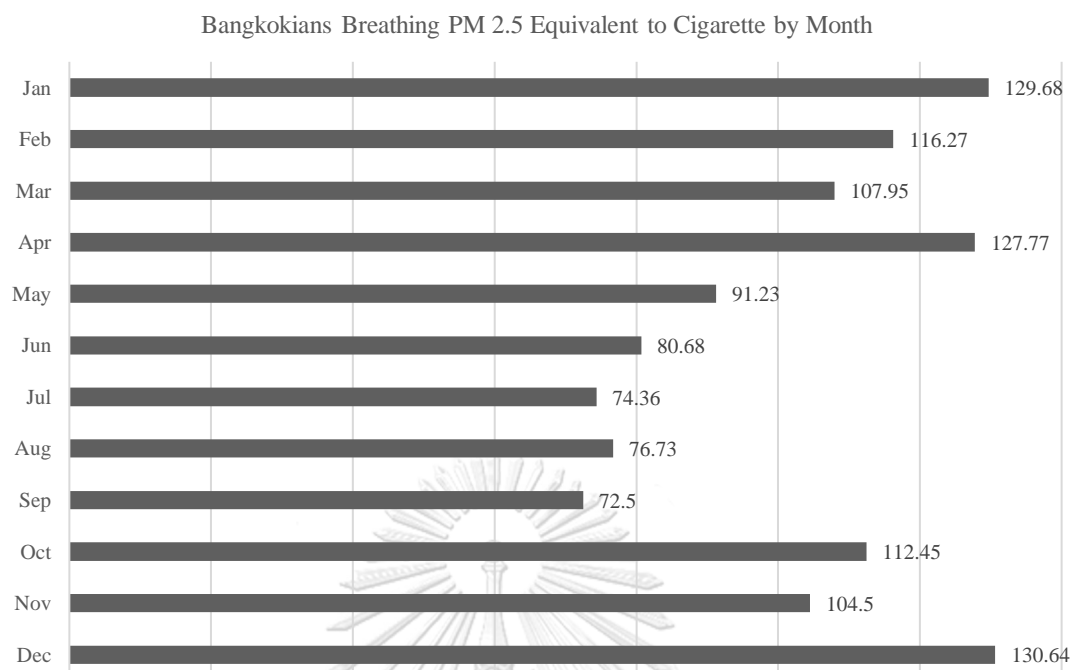
“By leveraging technology and engaging the public, transport issues can be addressed. The collaboration between the public and private sectors are required to unlock the full potential of technology and fosters changes” – Interviewee 15.

4.1.7 Health Concerns

During the interviews, the issue of health concerns related to air pollution, specifically PM 2.5, was highlighted as a significant factor influencing people’s driving choices. The BMR has faced increasing challenges related to PM 2.5 pollution. The problem stems from various sources, including vehicle emissions, industrial activities, agricultural burning, and dust particles from construction sites and roads.

According to the World Health Organization (WHO), the PM 2.5 concentrations in Thailand’s air in 2022 were reported to be four times higher than the annual air quality guideline rate set by the WHO. A report from the Rocket Media Lab further revealed that in 2022, the level of PM 2.5 that Bangkok residents breathe in is equivalent to smoking over 1,200 cigarettes per year. These secondary data support the findings highlight the severity of the air pollution issue and its impact on public health, which influences individuals’ decisions to prioritize private driving as a means to mitigate exposure to polluted air.

Figure 27 Air Pollution and Cigarette Equivalence in Bangkok, modified from Rocket Media Lab (2023).



Based on the interviews, it was observed that the BMR experiences high concentrations of PM 2.5, particularly during the dry season and certain weather conditions, resulting in poor air quality and adverse health effects for the population. To address this issue, the Thai government has implemented various measures. These include improving emissions standards, promoting cleaner fuels, and implementing stricter regulations on industrial and agricultural practices. Public awareness campaigns and efforts to reduce open burning and control dust are also being undertaken.

Participants highlighted that individuals from different income levels have varying abilities to protect themselves from air pollution. Despite the seasonal nature of PM 2.5 pollution in the BMR, many individuals perceive it as a significant health risk, prompting them to prioritize private car usage as a means of transportation. While research conducted in other countries has shown that air pollution can increase awareness of negativity from private car use, individuals in the BMR feel compelled to prioritize self-protection due to limited alternative options available to them.

- Landscape developments pressuring automobility regime -

Even if there are numerous landscape developments that support the automobility, certain landscape dynamics have emerged, putting pressure on the existing regime. The following findings highlight the landscapes that present challenges to the longstanding private-car dominant system and facilitate the windows of opportunity for niche transport options.

4.1.8 Environmental Issues and Commitment to International Goals

During interviews with stakeholders, the topic of environmental sustainability sparked discussions regarding the long-term viability of continuous car production and sales. Participants highlighted the current trend's focus on environmental issues as another challenging landscape for the BMR. They emphasized the need to reduce reliance on private car due to its contribution to CO₂ emissions and depletion of natural resources. The prevailing traffic congestion in the BMR was also highlighted as a significant factor leading to excessive fuel consumption.

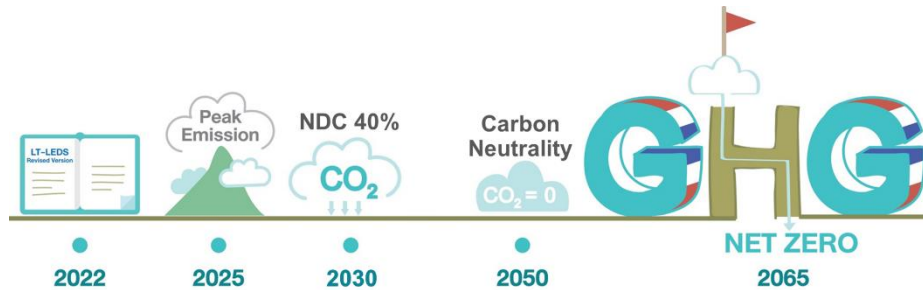
Stakeholders also acknowledged the active involvement of the private sector in developing products that align with environmental trends and goals. They mentioned innovative solutions such as energy-efficient vehicles, electric vehicles, and new mobility services like car sharing, which not only promote sales but also contribute to addressing environmental challenges.

In terms of government action, stakeholders discussed the Thai government's dedication to international goals towards environment and sustainability. They cited the integration of global targets and obligations such as the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) into national plans and policies to ensure successful implementation.

The stakeholders also highlighted Thailand's commitments made at COP 26, including the pledge to achieve carbon neutrality by 2050 and net-zero greenhouse gas (GHG) emissions by 2065. The country further committed to enhancing its Nationally Determined Contributions (NDC) by raising the target for GHG emission reduction to 40% by 2030, surpassing the previous target of 20%. Thailand's dedication to the United Nations Sustainable Development Goals (SDGs) for 2030

was emphasized through the integration of these goals into national policies and development plans.

Figure 28 Thailand's Long-term low greenhouse gas emission development strategies, Office of Natural Resources and Environmental Policy and Planning (2022).



Moreover, stakeholders noted the government's efforts in promoting environmentally friendly policies, citing the electric vehicle promotion policy as an example. This policy aims to meet global standards, cater to market demand for electric vehicles, and address pollution concerns. It strives to reduce the environmental impact caused by transportation and mitigate costs associated with dust pollution, aligning with the country's commitment to the international community. Stakeholders think the fact that Thailand has actively engaged in international commitment regarding environmental issues is challenging the stability of the automobility regime in the BMR.

Stakeholders believed that Thailand's active engagement in international commitments regarding environmental issues presents challenges to the stability of the automobility regime due to the need for significant policy changes, societal attitudes, economic considerations, and stakeholder coordination. The BMR is specifically affected by the national commitment because it is a densely populated urban center, a significant economic hub, relies heavily on car-centric infrastructure, and experiences severe environmental impacts from the automobility regime.

4.1.9 Shift in National Direction Toward Social and Environmental Goals

During the interview process, it was noted that there is a growing emphasis on environmental concerns, particularly since the 12th National Economic and Social Development Plan (2017 – 2021), which includes initiatives related to non-motorized transportation and pollution reduction. The 13th Plan (2023 – 2027) further addresses

these issues with specific strategies such as Smart Cities. Actually, there have been attempts to steer the shift in policy direction toward social and environmental goals, rather than solely focusing on economy. The commitment to international standards serves as an early stimulus for these efforts.

“In fact, our focus on the environment and prioritizing the well-being of people has been in place since the 8th Plan (1997 – 2001). The concept of sufficiency economy plays a significant role in this regard. But our commitment to international standards and agreements has helped raise awareness and drive action” – Interviewee 05.

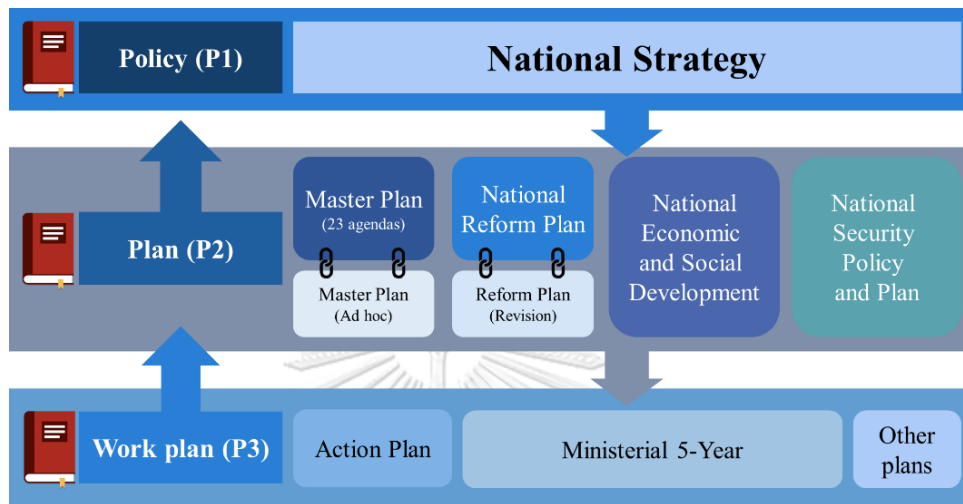
While the allocation of budget and manpower still predominantly prioritize economic growth, stakeholders underlined an increased emphasis on the environmental and social dimensions. The Strategic Environmental Assessment (SEA), for example, has been adopted and now driven by the national planning body. SEA is a systematic process that supports decision-making in the formulation of policies, plans, and programs. It aims to integrate environmental considerations into decision-making processes at an early stage, helping to identify potential environmental impacts and promote sustainable development. It takes into account environmental factors, along with economic, social, and other integrated considerations.

A few interviewees with public policy and planning expertise highlighted the importance of Strategic Environmental Assessment (SEA) as policy development tool that has been recently adopted across policy levels. During the 10th Plan (2007 – 2011), there was a significant drive to incorporate SEA at every stage of policy formulation, planning, and development, specifically focusing on addressing and managing the area’s pollution challenges.

According to the interviewee, SEA has been actively promoted as a prominent tool for presenting alternative options in decision-making processes. The interviewee further explained that SEA is utilized at all levels of policies, including policy (P1), plan (P2), and work plan (P3). Its primary objective is to ensure the implementation of suitable and sustainable development strategies. By incorporating SEA into each stage, policymakers aim to consider environmental impacts and

explore environmentally friendly alternatives, ultimately leading to more effective and sustainable development.

Figure 29 Level of National Plan in Thailand, modified from the Office of National Economic and Social Development Council.



The Office of National Economic and Social Development Council has shown investment promotion policies starting to align with the country's policy direction. Over the past 5-6 years, there has been a noticeable increase in the emphasis on investment promotion aligned with social and environmental agendas. This shift in focus reflects a growing awareness of the need to balance economic growth with social well-being and environmental sustainability. In term of transportation, investments that contribute to public transport infrastructures such as the development of rail systems are also promoted.

Moreover, the shift in consumer preferences and market demands has led to a growing emphasis on environmental considerations. As a result, there is now a need for car manufacturers to comply with regulations. Their mother companies have also made commitments to mitigate global warming, aligning themselves with global trends and markets.

The shift in national direction toward social and environmental goals has the potential to challenge the automobility regime in the BMR. National policies are often initially implemented in capital cities or urban areas due to population densities, economic importance, existing infrastructure and resources. The BMR also have a higher level of visibility and influence compared to other regions. Policies

implemented in these areas can attract greater attention and can serve as demonstration models for the rest of the country. This landscape development, therefore, puts pressure on the automobility regime in the BMR to adapt to and align with the evolving national policies and goals.

The example can be seen in the case of the National Electric Vehicle Policy, where the government's focus has been on transitioning the Thai automotive industry from internal combustion engines (ICEs) to electric vehicles (EVs). The objective is to establish Thailand as a production hub for EVs and position the country as a leading player in the manufacturing and export of electric vehicles. This policy aligns with the global trend towards sustainability.

Although, it is a national policy, the popularization of EVs has been prominently witnessed in the BMR due to factors such as higher purchasing power (as an economic hub) and the readiness of infrastructure, including charging stations. In comparison to other parts of Thailand, the BMR exhibits a more conducive environment for the adoption and growth of EVs. Hence, it is reasonable for participants to highlight the shift in the national direction toward social and environmental goals as a challenging landscape for the automobility regime in the BMR.

4.1.10 Changes in Social Values Among Young Generation

Stakeholders also raised the discussion regarding changes in social values among the younger generation, which could potentially destabilize the automobility regime. People's values and preferences have been gradually changing, and the pace of these changes may have accelerated due to the disruption caused by the Covid-19 pandemic. A participant in private sector shared that in the past, they used to assess business partners' or customers' credibility based on physical assets such as buildings or companies. However, with the increasing amount of online platforms, companies have completely shifted their operations to the digital world. As a result, status and values are no longer solely attached to physical possessions or tangible assets.

Interviews noted the younger generation especially shows a significant decrease in their tendency to buy cars. The possible reason might be because they no longer view car ownership as a status symbol or a measure of their asset value. The

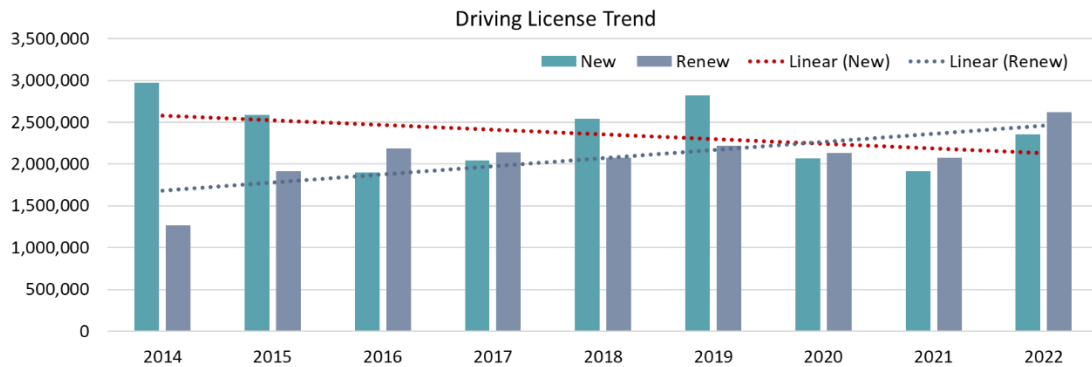
concept of social status could shift towards other indicators, such as popularity on social medias, having numerous followers, or being an online influencer. The evolving values of each generation shape what individuals perceive as valuable and desirable. As a result, the traditional belief of displaying social status through car ownership may vanished as society progresses and adapts to new trends and lifestyles.

Participants further highlighted that young people are increasingly viewing cars as less essential in their daily lives. Instead, they prefer alternatives like ride-hailing services such as Grab, which provide convenient transportation only when needed. This shift in mindset allows them to avoid the burden of car ownership.

These landscape developments can be maximized as a bottom-up approach to driving change. When the younger generation favors public transport over cars, it creates a resonance that can influence the government to adapt its priorities. The shift in preference from cars to public transport becomes a driving force for a greater change. The graph below here also reflects the declining trend of new driving license in Thailand, of which the BMR accounts for about 25%. There is a chance that people no longer view car ownership as a status symbol or a measure of their asset value.



Figure 30 Driving License Trend in Thailand,
data adopted from the Department of Land Transport.



4.1.11 Digital Technology Promotion and Development

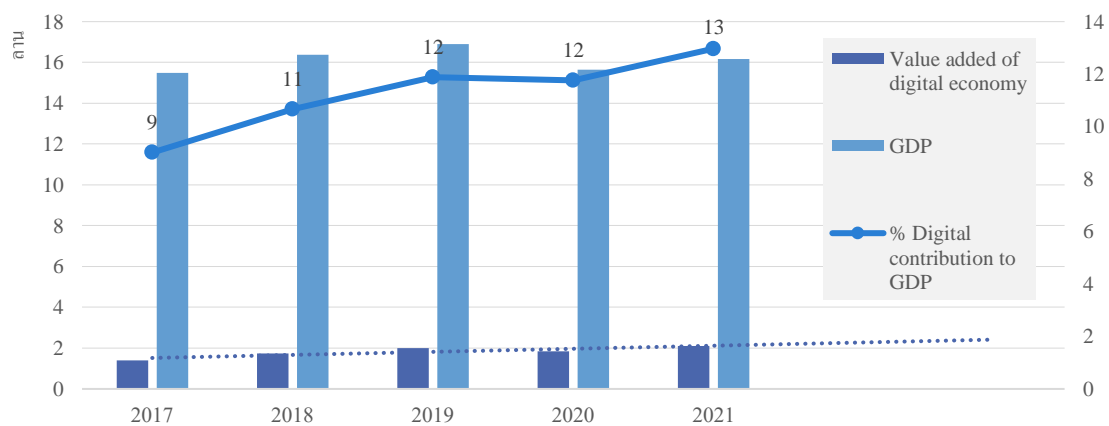
Participants also shared that in recent years, there has been a huge effort to promote digital economy development in Thailand. This national-level endeavor reflects the potential impact on the BMR as the capital city and urban areas, as described earlier in section 4.1.9. The rationale behind this is attributed to several factors, including higher population densities, economic importance, existing infrastructure and resources, visibility and influence, and the potential for these areas to serve as demonstration models for the rest of the country.

During the interviews, a respondent emphasized the growing focus on digital promotion. One noteworthy example is the transformation of the Ministry of Information and Communication Technology (MICT) in 2015 into the Ministry of Digital Economy and Society (MDES). This transformation aimed to promote digitalization for both social and economic development.

The secondary data also supports findings from the interviews. According to the Office of the National Digital Economy and Society Commission (ONDE), the digital economy contributed 11.77% and 12.97% to the GDP in 2020 and 2021 respectively, showcasing a rising trend. Although there was a slight decline in 2019, this indicates the shift of the Thai economy towards the digital era, with a greater focus on digital activities such as ICT and the internet, which are more adaptable compared to traditional economic sectors.

Figure 31 Digital Contribution to GDP in Thailand,

data adopted from the Office of the National Digital Economy and Society Commission.



According to the insights gathered from the interviews, the promotion of smart mobility primarily focuses on enhancing efficiency, safety, and environmental sustainability. These aspects drive the development of new projects aimed at addressing traffic congestion, reducing road accidents, and minimizing the environmental impact. Stakeholders have given priority to efficiency improvement as it is closely tied to economic growth.

In parallel, the promotion of the digital industry is expected to generate a wealth of valuable data that can be harnessed to support the development of innovative mobility services, including car sharing. Data plays a crucial role as a fundamental infrastructure for digital advancement. The automotive industry is also embracing this trend, particularly with the emergence of CASE (Connected, Autonomous, Shared, Electric) vehicles that rely heavily on digital technologies.

To attract investments in these areas, the government has begun implementing policy mechanisms. For instance, incentives for smart city projects offer a range of benefits, such as an eight-year exemption from corporate income tax. Additionally, non-tax incentives, including land ownership rights and five-year work visas for investors, specialists, and scientists, are provided to attract and support the development of digital initiatives in the country.

Another notable initiative discussed through an interview is the Digital Service Account, which serves as a comprehensive listing platform bringing together a wide array of digital service providers. Its primary objective is to ensure that customers have access to high-quality digital products and services at fair prices. The platform acts as a convenient marketplace for individuals and businesses seeking

digital solutions. Moreover, government agencies aim to enhance public services through the adoption of digital technologies. By facilitating connections between service providers and customers, the Digital Service Account promotes accessibility, affordability, and efficiency in the digital marketplace.

These insights from the interviews shed light on the efforts being made to promote smart mobility, drive digital innovation, and implement policy mechanisms to support the growth of the digital industry in Thailand.

4.1.12 Economic Slowdown

The interviewee also discussed the economic challenges faced by both the global and domestic economies even before the COVID-19 pandemic. They pointed out that sluggish growth was already a concern. However, statistics show the problem has been elevated by new threats, such as COVID-19 variants, inflation spikes, increasing debt, and income inequality. This combination of challenges has led to a slowdown in the global economy. Furthermore, disruptions caused by Russia's invasion of Ukraine have added to the headwinds, including elevated inflation, higher interest rates, and reduced investment. The interviewee emphasized that these developments have added to the existing economic challenges, making it a more complex and difficult environment for both global and domestic economies to navigate.

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Figure 32 Real GDP Growth (annual percent change),

International Monetary Fund



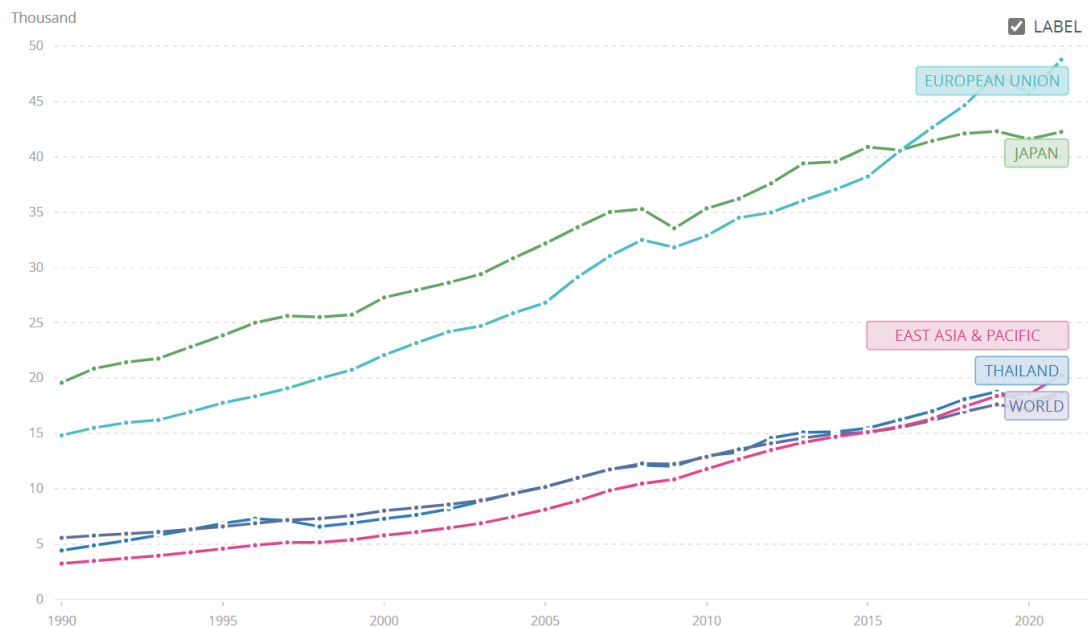
The global economy is on the brink of a recession due to various factors, with one of the most significant being the scarcity of gasoline resulting from the ongoing political crisis. Additionally, the rising prices of fuel and natural gas have increased production expenses, leading to higher manufacturing costs. Given that Thailand heavily relies on global economic growth, with exports and tourism as primary economic drivers, these challenges pose a significant threat to the country's economic stability.

The current economic slowdown is having a significant impact on people's income, leading to a decline in purchasing power. Figure 32 shows purchasing power parities (PPPs) trend, comparing the purchasing power of Thailand with the world and other developed countries. This situation has further widened the gap between the rich and the poor. With those who already have purchasing power owning cars, the automotive market is suffering due to the shrinking consumer demand.

Moreover, during economic downturn, both private and public investments are adversely affected. Private investment, essential for expanding product development and businesses, decreases as companies face financial constraints. Simultaneously, public investment in infrastructure projects also suffers due to limited resources. The BMR, as the economic hub of Thailand, tends to be more affected by economic slowdowns compared to other parts of the country due to its higher concentration of economic activities and higher cost of living.

Figure 33 GDP per capita, PPP (current international \$),

World Bank



Based on the interview data, during an economic downturn, people tend to have less income, which affects their ability to make significant purchases like cars. As the economy weakens, individuals and households may prioritize essential expenses over discretionary purchases, including vehicles. Statistics compiled by the Thai Automotive Industry Association show the decreased consumer demand for cars is a reflection of the overall decline in purchasing power which directly correlate with economic challenges. Figure 33 depicts the stagnant growth of domestic car sales, particularly when compared to the ratio of exports. Also, figure 34 illustrates number of car registration in the BMR alone, reflecting the slowdown in automotive market.

Participants from financial sector and automotive sales highlighted that in the past few years, there has been a significant rise in the proportion of cash transactions for car purchasing. The latest data reveals that cash transactions now make up a higher proportion, ranging from 15% to 20%. Cash transactions previously accounted for only around 10% of the total. The increase in cash transactions highlights the underlying issue of purchasing power disparity. This trend shows the widening gap between the rich and the poor, as cash transactions are often associated with individuals who have high income. Most of their purchases are additional cars or replacements.

Figure 34 Car Domestic Sales and Exports (million unit),
Data obtained from Thai Automotive Industry Association

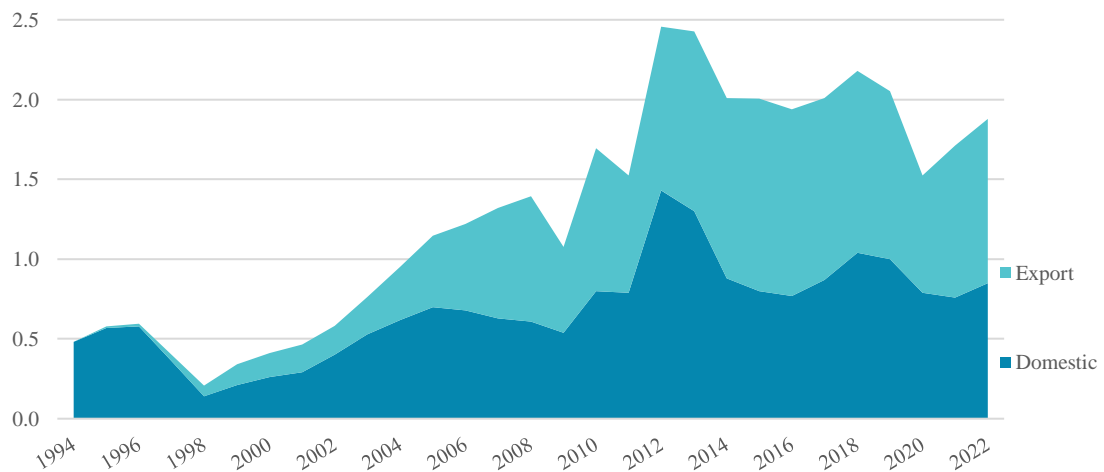
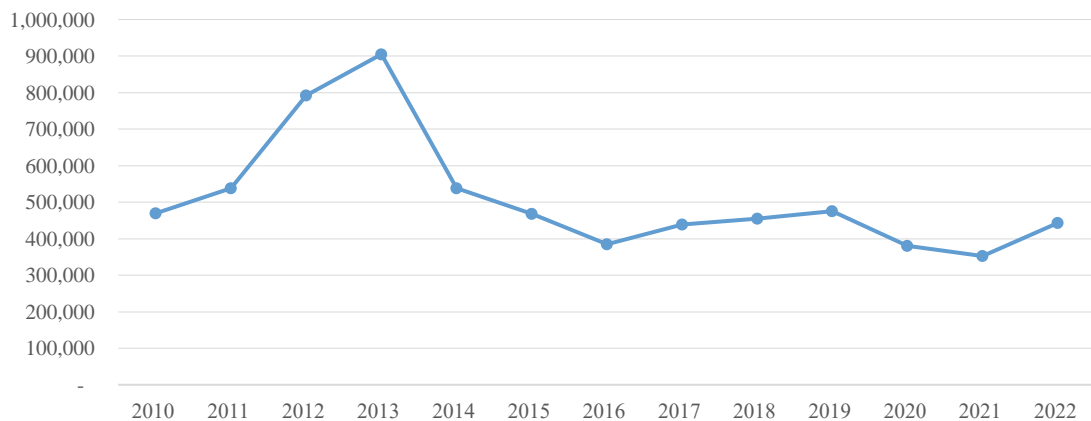


Figure 35 Car Domestic Sales and Exports (million unit),
Data obtained from Thai Automotive Industry Association



Participants also added that this issue is especially worse with the younger generation as they are lacking financial strength. According to the NCB credit bureau, Gen Y (1981 -1985) is responsible for a significant portion of non-performing loan (NPL), as they tend to accumulate high levels of debt. This situation can be attributed to economic factors affecting their financial situation, such as stagnant wage growth and the rising cost of living.

To validate the data derived from the qualitative analysis, an extensive literature review was conducted. Table 8 illustrates that the study confirmed the alignment of all landscape aspects identified in the research with previous literature, with the exception of the degradation of urban space and carbon trading policies and debates. While these two factors are recognized as relevant in the broader context,

they have not been extensively discussed among stakeholders specifically in relation to the automobility in the BMR.

The degradation of urban space refers to the negative impacts on the quality and functionality of urban areas, including the loss of green spaces, increased congestion, and inefficient land use. It is possible that this issue hasn't been as evident in the BMR compared to other countries studied in Western literature due to the city's level of development. However, there is a possibility that it could emerge as another landscape development pressure on the automobility regime in the BMR in the future.

This observation implies that while the BMR may not currently exhibit the same extent of urban space degradation seen in Western countries, rapid urbanization and urban growth in the region could lead to similar challenges in the future. As the city continues to develop and urban areas become more densely populated, issues such as the loss of green spaces and increased congestion may become more prominent, putting pressure on the existing automobility regime. Therefore, it is important to recognize the potential for urban space degradation as a future landscape development pressure in the BMR.

Carbon trading policies and debates revolve around mechanisms aimed at reducing carbon emissions, such as cap-and-trade systems or carbon offsetting. Although carbon trading has gained significant attention, particularly after the commitment to carbon neutrality and net-zero targets, it has not been discussed by any stakeholders during the interviews.

In the context of the automobility system in the BMR, carbon trading policies may not be a prominent topic of discussion among stakeholders due to policy prioritization. The policy emphasis in the region's transportation sector may prioritize other strategies, such as fuel efficiency, vehicle standards, or promoting alternative fuels, as key mechanisms for addressing carbon emissions. These strategies may receive more attention and discussion among stakeholders due to their immediate relevance and tangible impact on the transportation sector.

Figure 36 Comparison of landscape developments affecting the automobility regime of the BMR and literatures.

	Supporting automobility regime	Pressuring automobility regime
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	Supporting automobility regime	Pressuring automobility regime
Literature (Authors)	<ul style="list-style-type: none"> • Economic growth, income growth (Freund and Martin, 2000, Geels, 2012, Hodson et al., 2015, Sperling and Gordon, 2009 as cited in Moradi and Vagnoni, 2018) 	<ul style="list-style-type: none"> • More diffused limits to urban circulation, degradation of urban space (Marletto, 2014) • Carbon trading (Hillman and Sanden, 2008 as cited in Moradi and Vagnoni, 2018)
Interview/Literature (Authors)	<ul style="list-style-type: none"> • Health concern/ Health benefits, low exposure to air pollution (Gascon et al., 2020) • Urban design and planning/ Land use and urban structure (Moradi and Vagnoni, 2018; Pinna et al., 2017; Elzen et al., 2002) • Lack of proper infrastructure for active modes i.e. walking, cycling/ Inadequate pedestrian and cycling infrastructure (Pinhate et al., 2020; Canitez, 2019) • Investment promotion policy/ Economic policies (Canitez, 2019) • Industrial development strategies (Rogge et al., 2015 as cited in Moradi and Vagnoni, 2018) • Poor public transport system i.e. unsafe, doesn't meet users' needs/ Poor quality of public transport services i.e. unsafe, overcrowded, uncomfortable, unreliable, infrequent (Pinhate et al., 2020; Canitez, 2019; Meena et al., 2021) • Limited interconnectivity of PT (Permana and Petchsasithon 2019) 	<ul style="list-style-type: none"> • Environmental issues i.e. pollution, natural resources, sustainability/ Climate change policies (Geels, 2012, Geels et al., 2011, Hillman and Sanden, 2008, Hodson et al., 2015, Pinhate et al., 2020, Marletto, 2014 as cited in Moradi and Vagnoni, 2018; Hoffmann et al., 2017) • Commitment to international goals/ Commitment to international low carbon targets (Foxon et al., 2010) • Shift in national policy direction towards environmental and social focus • Government policies for low carbon mobility (Moradi and Vagnoni, 2018) • Changes in social values among the young generation/ Changes in values and ideologies of younger generations (Moradi and Vagnoni, 2018; Wu et al., 2019) • Digital trend and promotion/ Smart city strategies (Moradi and Vagnoni, 2018) • Technology development/ ICT (Geels, 2012) • Economic slowdown/ Economic crisis (Hodson et al., 2015 as cited in Moradi and Vagnoni, 2018)
Interview	<ul style="list-style-type: none"> • Limited coverage of public transport • Lack of integrated PT systems • High expense of public transport compared to private car use • Global economic order, making Thailand an automobile production base • Concentration of growth and prosperity • Politics i.e. no political will, corruption, conflict of interest, inconsistency, failure to keep up with technology 	

4.2 Mechanisms Behind the Automobility Regime

Findings from the stakeholder interviews reveal that the socio-technical regime of the automobility system has been stabilized by multiple factors and actors over a long period of time. These dynamics allow multiple actors and institutions to actively shape and sustain the current system. The regime operates through coordinated activities among these actors, which helps maintain stability within the system.

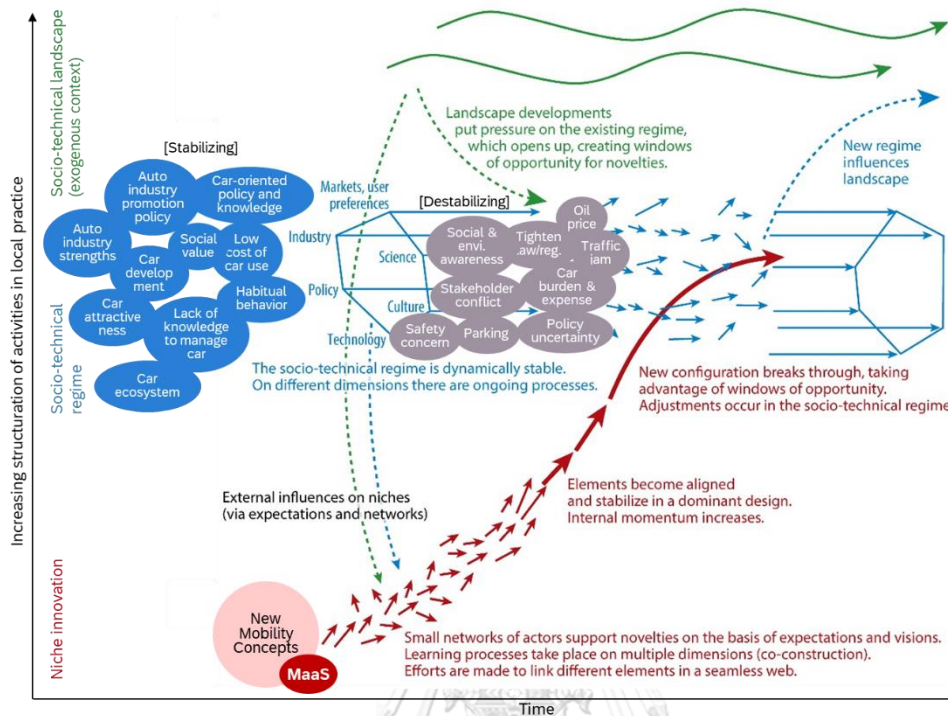
However, there are emerging indications of potential cracks within the regime, particularly regarding issues related to car driving, ownership, and the challenges faced by businesses. These factors present significant challenges that may introduce instability and call for interventions to seize the window of opportunity for niche innovations, including the development of new mobility services.

Table 9 and Figure 37 illustrate the observed dynamics in the socio-technical regime of automobility. The results indicate that there are currently mechanisms that both stabilize and destabilize the existing automobility regime.

Figure 37
Mechanisms behind automobility regime.

Stabilizing automobility regime	Destabilizing automobility regime
<ul style="list-style-type: none"> • Social Values • Provision of car ecosystem and strong actor network • Car-oriented transport policy and knowledge i.e. road, traffic • Automotive promotion policy • Automotive industry strengths • Car attractiveness i.e. privacy, convenience, multi-purpose, personal safety, family trip, freedom, door-to-door, on-demand • Product development of car • Low cost of car use compared to public transport (out-of-pocket expense) • Lack of knowledge (for car use management) • Habitual behavior 	<ul style="list-style-type: none"> • Social and environmental awareness of users • Tighten law and regulation (increasing cost) • Stakeholder conflict of interest i.e. gov't vs private, among private • Oil price • Traffic congestion • Lack of parking space • Burden of ownership • Expense of car ownership • Uncertainty of public policy • Road safety concern

Figure 38
Mechanisms behind automobility regime,
results from interviews, graphic modified from Geels, 2002 and Aruni et al., 2019.



- Mechanisms behind the stability of automobility regime -

Based on the interview data and analysis, the following mechanisms were identified as contributing to the preference for private vehicle use and stabilizing the automobility regime.

4.2.1 Social Values of Car Ownership and Driving

Interviewees highlighted the social value of owning a car as a symbol of status, and how the older generation particularly still holds onto this notion. They perceive cars not only as a means of transportation but also as a social statement. Cars are seen as a reflection of success, character, and dignity, and they contribute to presenting a positive image when visiting workplaces or interacting within society. This has been heavily detailed in previous research regarding ride-hailing applications in the BMR as well. Cultural values that associate car ownership with social status have a significant influence on car purchasing for Bangkok residents (Thaithatkul et al., 2023). Additionally, if you live in a car society, societal trends and the desire to

conform to social norms can further motivate individuals to aspire to own and drive cars.

4.2.2 Provision of Car Ecosystem and Strong Actor Network

During the interviews, stakeholders emphasized the active involvement of the hire-purchase business in facilitating car purchases, noting the strengthening of their network through associations that share information about upcoming changes and prepare to support new trends.

There is a robust network of actors that promote and facilitate the sale and usage of cars. Stakeholder interviews attributed them to actively encouraging car sales, retaining existing customers while seeking new ones, and creating business opportunities related to car usage. This network also organizes activities like road trips and car racing for recreational purposes, promoting a healthy lifestyle for car owners. Moreover, they emphasize comprehensive car maintenance, creating an ecosystem and value chain that focuses on customer comfort. Whether it involves car renewal, installation of accessories, or providing a complete range of car-related services, this network ensures a comprehensive car experience for customers.

The hire-purchase industry is also identified as playing a significant role in boosting car sales, with a growing trend of individuals applying for loans from these companies. These loans typically cover approximately 80% to 85% of the car's purchase, making it more accessible for buyers compared to cash transactions, as indicated by external data.

Additionally, various facilities and infrastructure related to car ownership, such as car dealerships, maintenance shops, and gas stations, have expanded across the country. The life-cycle duties associated with car usage, such as tax renewal, vehicle inspection, and insurance purchasing, have become much more convenient. As an example, a stakeholder mentioned the improvement in the registration renewal process. Previously, individuals had to visit the Department of Land Transport Office in person, but now these processes can be easily completed online. The relevant agencies have made significant developments to provide such conveniences to car owners.

During the interviews, stakeholders from the information and communication technology (ICT) sector highlighted the role of ICT in supporting road transport and private car use, considering the significant reliance on private vehicles. They emphasized the high demand for features such as navigation systems and real-time traffic information to enhance the car driving experience. The technology required to fulfill these needs is readily available. While efforts have also been made to enhance public transport usage through technological advancements, the market demand for such technologies has been relatively limited. As a result, the primary focus has remained on applying technologies that cater to road and private car use.

Furthermore, stakeholders discussed the digital promotion of startups targeting driver pain points associated with finding car parking. These startups aim to address driving-related challenges by developing advanced parking systems that leverage technology. Their goal is to create a comfortable parking experience for drivers by utilizing innovative solutions.

These insights from stakeholders provide valuable information about the utilization of ICT in supporting road transport and private car use, as well as the focus on addressing specific challenges related to parking through digital startups.

4.2.3 Car-oriented Transport Policy and Knowledge

The country's infrastructure primarily revolves around roads, aiming to make them convenient, efficient, and accessible. Transport policies have been focusing on the development of a comprehensive infrastructure system that accommodates the needs of private car users. There are numerous agencies at both local and national levels that are involved in road transportation. This indicates the allocation of government budgets and the attention given to road-related initiatives.

Some government agencies are specifically designated and mandated by law to focus on road construction, expansion, and maintenance. Their main objective is to conduct research and develop strategies for the construction, restoration, and maintenance of roads. Stakeholder interviews for this study revealed these agencies are also given priority over other modes of transportation, such as waterways,

railways, and buses. Their roles are emphasized within the Ministry of Transport, highlighting their significance in the transportation sector.

The construction of well-built roads enables people to conveniently access various locations using cars. As a result, cars have become a primary factor in terms of convenience. The streets in Bangkok are primarily designed to accommodate cars, rather than considering other modes of transportation. In contrast, overseas intersections are often designed with a balance between pedestrians and cars, prioritizing the safety and convenience of pedestrians.

“We prioritize the quantity of roads, with a stronger emphasis on serving private car usage rather than improving public transportation. There are even days when expressways are made free (indicating a focus on enhancing the comfort of car users)” – Interviewee 07.

This prioritization has resulted in a concentration of knowledge and expertise in road construction, creating a “technology trap” where the focus remains predominantly on roads due to their relative ease of construction. Thai contractors have historically been more experienced in building roads compared to other infrastructure projects like railways. Stakeholders stressed that building railways requires specialized technology with a lot more investment on more complicated infrastructure and facility than roads.

Part of the reason for the emphasis on road expansion in Thailand can be attributed to historical decisions made in favor of building expressways instead of investing in a rail system, similar to Japan’s approach. Traffic congestion is a common problem that researchers and policy makers aim to address, but the approaches to solving it may vary. Rather than prioritizing policy interventions aimed at reducing private car usage or improving public transportation accessibility, the primary focus has been road expansion.

Interviewees emphasized the conundrum of a prevalent “predict and provide” paradigm in transport planning, based on the notion that the existing public transportation network is not convenient enough for commuters. Therefore, people still rely on private cars for their transportation needs. In response to this, the government takes on the responsibility of enhancing the convenience of car driving by

implementing measures such as traffic flow management and road expansion. The policy direction has primarily focused on reducing traffic congestion. Even the development of public transportation infrastructure, like the construction of the Skytrain, aims to alleviate traffic congestion rather than primarily increasing public transport travel behavior.

4.2.4 Automotive Industry Promotion Policy

One of the instability factors found during the interview process is government policy nurturing the automotive industry as one of the engines for national export and economic growth. On the other hand, this also makes private cars more affordable, especially with policy that directly promotes the domestic car market such as low excise tax or first-car buyer programs.

Similar to the discussion on landscape developments, national policies typically have a stronger impact on the BMR. Although the automotive industry promotion policy is implemented at the national level, its effects are particularly evident in the BMR's car market. This is due to the region's higher purchasing power, robust infrastructure, and the readiness of the network for car sales and utilization. On average, domestic automobile sales in Thailand amount to approximately 800,000 to 1,000,000 units per year, with around 500,000 cars registered in the BMR alone, accounting for more than 50% of the country's total car registrations.

Thai government policies have been playing a crucial role in shaping the automotive industry growth throughout its history. At first, the government provided incentives for companies establishing assembly plants in Thailand, such as reduced import taxes on automotive parts. The focus was on replacing imported vehicles with domestically produced ones.

As the industry grew, the government implemented measures to increase local content in automotive production. Import bans on automobiles and higher import duties on parts were introduced to protect the Thai automotive assembly. The industry began expanding due to a rising domestic demand. The government recognized the potential for exports and promoted the country as an automobile production hub, serving the relocation from Japan.

The, free trade agreements facilitated regional cooperation and reduced import duties among member countries. This period showed significant growth in automotive sales and the establishment of Thailand as a major production base for one-ton pickup trucks. However, the economic crisis of 1997 had a severe impact on the industry. Parent companies of manufacturers in Thailand focused on export markets to help the sector recover. As globalization and free trade progressed, import tariffs were gradually reduced to align with World Trade Organization requirements.

Recently, the government has recognized the need for the automobile industry to adapt and evolve in response to technological advancements, product standards and quality, to meet consumer safety and environmental concerns. Various tax incentives were introduced to encourage investments in green vehicle development, signaling a transition from being a pickup truck production base to a manufacturing hub for sustainable and eco-friendly vehicles. Figure 39 illustrates the timeline of automotive development in Thailand aligned with the government strategies, demonstrating the significance of supportive policies on the industry's growth.

Likewise, the policy aimed at transitioning Thailand as the world's electric vehicle (EV) production hub, as outlined in the 13th National Economic and Social Development Plan (2023 – 2027), has had a significant impact on the automobile market. The promotion of EVs has also increased public awareness of the cost-effectiveness of electric vehicles. As people become more aware of the lower costs associated with EVs, they tend to switch to electric vehicles and remain driving private cars. Moreover, as the price of EVs decreases due to competitive pressures, especially from Chinese manufacturers, as well as government subsidies, the affordability of this option is heavily promoted.

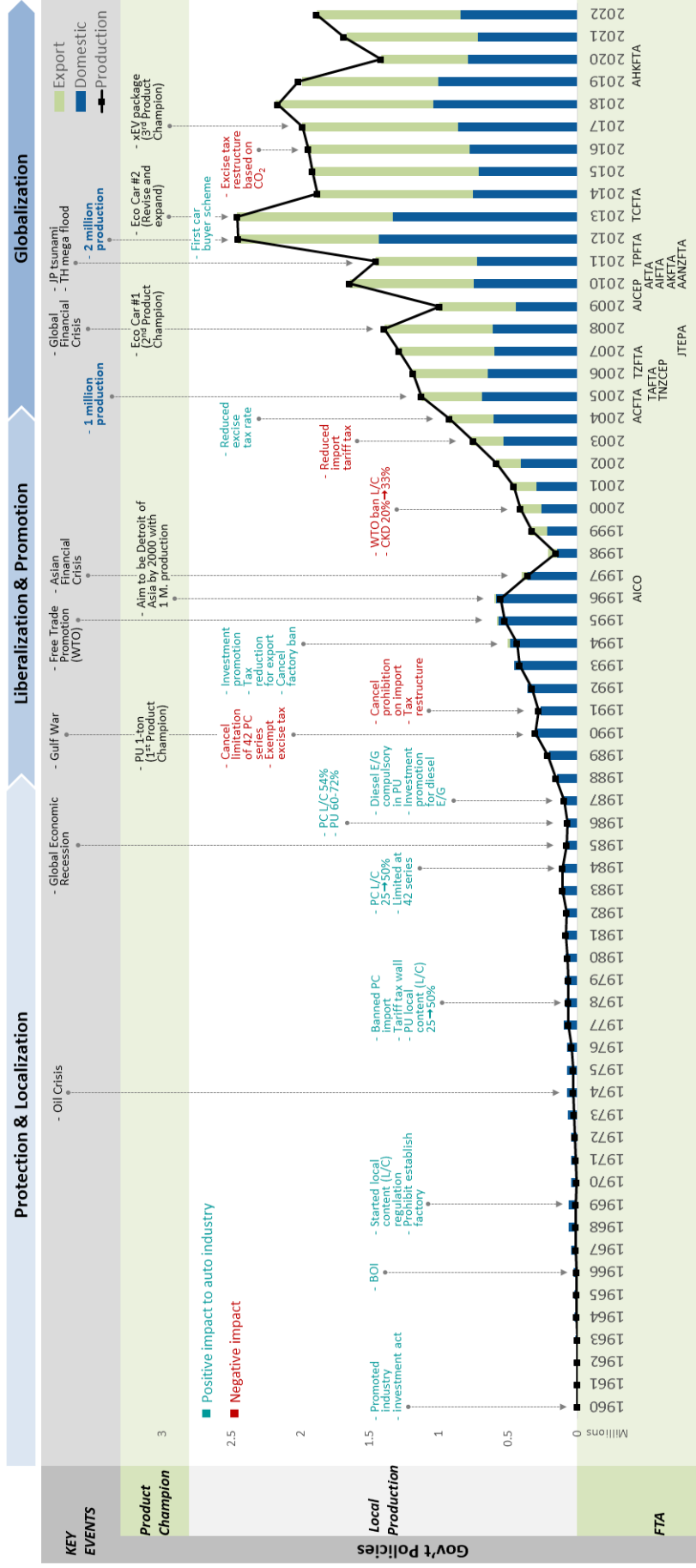
These policies have transformed the industry into a global production and export hub, making it a vital sector for the country's economic growth.

Additionally, the recent regulations imposed by the Office of the Consumer Protection Board (OCPB) regarding the maximum interest rates for auto hire-purchase loans could have an impact on favoring car buyers. The OCPB has introduced new rules that set a relatively low ceiling interest rate for new car loans at 10% per year or an average fixed rate of 5.5% per year. For used car loans, the ceiling is slightly

higher at 15% or 8.5% for the fixed rate. These regulations are aimed at benefiting consumers by providing them with more favorable terms for car hire-purchase agreements.



Figure 39 Thai Automotive Development under Government's Policies, data obtained from Thai Automotive Industry Association and Thailand Automotive Institute



4.2.5 Automotive Industry Strengths

The automotive industry in Thailand holds a strong position and maintains its influence over the government through various associations representing manufacturers, suppliers, and hire-purchase providers. This mechanism is recognized as a stabilizing force for the automobility in the BMR, aligned with the rationale discussed in section 4.2.4.

These associations play a crucial role in supporting industry stakeholders, of which were interviewed for this study, by shaping government policies that align with the interests of their members. Acting as intermediaries between entrepreneurs and the government, these associations gather the needs and concerns of the private sector, advocating for policies concerning production, regulations, vehicle standards, and other related areas.

Efforts are made to strengthen the supply chain and enhance the bargaining power of industry representatives, enabling them to engage in negotiations with the government. The objective is to convince policymakers to implement favorable policies that address the industry's needs and promote its growth and development. By effectively representing the interests of the automotive industry, these associations strive to ensure that the sector receives the necessary support and conducive policies from the government.

Certain stakeholders noted the government also has intermediary organizations that work closely with the automotive industry to promote the competitiveness of the domestic automotive manufacturing sector and support the use of safe and environmentally friendly vehicles. These organizations engage in activities such as consultation, training, testing, and product certification, all in accordance with state regulations. Through these close collaborations, mutual trust and linkages are established between policy makers and the industry, facilitating negotiations and effective communication.

Another strength of the automotive industry which was highlighted is its ability to adapt to trends and changes. Currently, there is a shift towards transforming from being solely a car manufacturer to becoming a mobility service provider. The vision is broader, requiring adaptation towards a business model that focuses on usership, or subscription, rather than ownership. Customers are no longer just buyers;

they are users or subscribers. This shift highlights the need to explore other types of businesses within the industry, such as car sharing, medical transport, or logistics.

Furthermore, the industry has applied various platforms to enhance customer service. Nowadays, online applications have streamlined the process. Customers can use dedicated applications to select their desired services and customize their experience according to their preferences.

4.2.6 Car Attractiveness and Product Development

Cars, themselves as products, possess a range of appealing qualities, such as offering privacy, space (especially when traveling with a group or family), convenience, and the ability to carry belongings. They serve multiple purposes and are not solely meant for transportation, especially in Thailand, where one-ton pickup trucks have gained significant market share. Notably, cars were said to also give the interviewees freedom, independence, and the advantage of door-to-door or on-demand accessibility, making them an ideal choice for both personal and business use.

“When you travel with your family, using a car makes things easier. Public transport is great for individual trips. Using a car for just one person may not be the most cost-effective choice but when you travel together, it makes sense. Everyone can share the expenses” – Interviewee 15.

The automobile technology is also continuously evolving to meet the changing demands of customers. The focus is on developing more fuel-efficient electric vehicles (EVs) and incorporating advanced technologies to enhance the driving experience. The introduction of autonomous features has made driving easier, with the ability to effortlessly reverse and park by simply pressing a button. Moreover, modern cars are equipped with various technologies aimed at providing a comfortable and convenient ride for passengers.

4.2.7 Low Cost of Private Car Use

In the BMR, using a private car is a cost-effective option for transportation. Many feel the expenses associated with using a private car, such as fuel costs, express way, and parking fees, are relatively low compared to other modes of transportation. Additionally, the availability of parking spaces in the city is convenient, making it

easier for car owners to find affordable parking options. Malls are a popular destination and designed to accommodate people with cars. The parking fees are not expensive when compared to other countries. In places like Japan, it can be difficult to find parking, and rather expensive.

The affordability of private car use was further highlighted with the mention of reasonable car taxes. With affordable car taxes, cheap parking fees, and inexpensive – and sometimes free – expressway tolls, car ownership becomes enticing. Traveling cost by car in the BMR has also been noted in other research as only 13% higher than traveling by rail transit, with a significantly higher level of convenience (Thaithatkul et al., 2023).

The cost for car users is also low when compared to those of foreign countries around the globe. In economics, this is referred to as externality cost, which represents the value associated with causing air pollution and impacting public health. Currently in the BMR, it remains low or none.

Although there has been an attempt to apply price mechanism to increase the cost of car use, stakeholders mentioned that the lack of data and knowledge presents a significant challenge in formulating the policy. The primary objective of these policies is to influence individual behavior by making car use more expensive and encouraging a shift towards more sustainable and efficient transportation options, such as public transportation, cycling, or walking. However, research on these policies remains insufficient. Many proposed concepts require data and investigation, like implementing city taxes, congestion charges, or zone pricings.

Based on the analysis of the interviews, it was found that the availability of data poses a significant limitation in addressing car use management. There is a lack of systematic collection and sharing of necessary data, which hampers the ability to conduct credible research and support progressive policies. This limitation makes it challenging to identify problems and develop effective solutions.

For instance, when addressing parking issues in the BMR, it is crucial to formulate policies based on accurate information. However, essential data such as the number of street parking spaces, available parking spots, maximum car capacity, and average hourly costs for private parking are non-existent. The absence of

comprehensive research or surveys that provide meaningful data analysis further hinders the establishment of effective parking policies.

The limited availability of data is a key barrier that needs to be addressed to enhance the understanding of car use management and inform evidence-based policy-making in this regard.

4.2.8 Habitual Behavior of Car Driver

Results from the interviews indicate that the habitual behavior of private car drivers are attributed to factors such as convenience, comfort, familiarity, perceived time savings and cost-effectiveness. Individuals tend to stick to their established habits and may choose to use their private cars even when alternative transportation options are available. Breaking these habits and promoting alternative modes of transportation requires efforts to change people's attitudes, provide accessible and reliable alternatives, and create a shift in awareness towards sustainable transportation choices.

Habitual behavior plays a significant role in influencing private car use. People often develop routines and patterns of behavior that involve relying on their cars for transportation. The habit of relying on cars limits the inclination to seek or even try alternative transportation options.

In addition, interviewees often admitted to the habit of not liking to plan ahead of time, which also influences the preference for private car use in commuting. When individuals do not plan their trip in advance, private cars can provide them with convenience and flexibility. Owning a car allows them to have more control over their travel schedule and route choices, as they can make spontaneous decisions and adapt to any changes or delays that may occur during their trip. Driving a car means having immediate access to transportation without the need to wait for public transit, or coordinate with others.

- Mechanisms behind the instability of automobility regime –

Though numerous mechanisms that stabilize automobility have been identified, there are also certain mechanisms that have been highlighted as having the

potential to disrupt it. The following mechanisms contribute to destabilizing the automobility regime.

4.2.9 Social and Environmental Awareness

During the interviews, participants highlighted several mechanisms that contribute to destabilizing the automobility regime. While stakeholders acknowledged that private cars are convenient and their promotion can be beneficial for businesses and economic growth, they also recognize the associated externality costs, such as CO₂ emissions, air pollution, urban degradation, and long-term societal impacts.

Relying on private cars was also recognized as often limiting opportunities for social interactions compared to more communal modes of transportation. The use of private cars also discourages active transportation modes such as walking and cycling, resulting in sedentary lifestyles and associated health issues. On the other hand, active transportation promotes spontaneous interactions with neighbors, local businesses, and other pedestrians or cyclists, fostering a sense of connection and well-being. Japan was once again cited as an example during the interview, where public transportation frequently involves walking and provides opportunities to support local businesses along the way, thereby contributing to the local economy.

From an economic standpoint, the reliance on private cars occupies significant space, particularly in the context of traffic congestion. This results in excessive energy and space consumption that could otherwise be utilized by alternative modes of transportation.

Furthermore, as awareness of urban challenges grows, more discussions on urban development are taking place. Concerns related to sustainability, livability, transportation, and social equity have sparked conversations and prompted calls for innovative solutions to create better cities for future generations. Urban transportation has become a focal point of ongoing discussions.

4.2.10 Tighten Law and Regulation

A consistent theme among interviewees was the growing concern over air pollution and its impact on public health. This very pertinent issue has prompted the government to consider stricter enforcement of Euro emission standards in Thailand

(Euro 5 and Euro 6). The Euro 1 emission standard was implemented in Europe in 1992, which Thailand adopted in 1998. Over the years, Thailand has gradually raised its emission standards, with Euro 4 being in effect since 2012. The introduction of Euro 5 and 6 standards would further reduce nitrogen oxide and hydrocarbon emissions, and establish a particulate number standard.

Figure 40 Timeframe for Euro Emission Standard in Thailand, Department of Land Transport, graphic by the Bangkok Post.

ADOPTION TIMEFRAME FOR EURO EMISSION STANDARDS (EURO) IN THAILAND						
	Euro1	Euro2	Euro3	Euro4	Euro5	Euro6
EU countries	1992	1996	2000	2005	2009	2014
Planned in Thailand	1996	1999	2002	2007	2011	2016
Adopted in Thailand	1996	1999	2005	2012	2024	2025-28

Under the Euro 6 standard, newly manufactured cars are required to maintain an average CO₂ emission level below 98 grams per kilometer. Initially, the Thai government planned to enforce Euro 5 and 6 standards in 2021 and 2022, respectively. However, due to the economic impact of the Covid-19 pandemic, the implementation of Euro 5 was postponed to January 1, 2024.

Despite industry requests to further delay the implementation of Euro 5 and 6 standards for cars until 2025 and 2028, respectively, the government maintains its stance to enforce Euro 5 by January 1, 2024. There are concerns regarding the additional costs for car manufacturers and the challenges they may face in meeting the new standards. However, delaying the emission standards would only worsen the PM_{2.5} air pollution issue in Thailand.

Stricter emission standards pose greater challenges to the BMR compared to other parts of Thailand as it has a higher population density and is a major economic hub, leading to a larger concentration of vehicles in the city. With more vehicles on the road, there is a greater need to address air pollution and reduce harmful emissions. Especially, the BMR grapples with the need to reduce pollution levels and improve air quality, drawing more attention and possibility for stricter law enforcement.

Another area facing tightened regulations is the financial domain of the automotive market. The Bank of Thailand (BOT) has decided to oversee non-bank institutions due to the concerns regarding bad debt in the automotive loans sector. While non-bank institutions may not be subjected to the same level of authority as the commercial bank, they are now obligated to comply with BOT's requirements. This regulatory oversight aims to monitor lending practices, ensuring that non-bank institutions do not engage in excessively aggressive lending, or lend to customers with high credit risks. Through these measures, BOT seeks to maintain a favorable household debt profile, while reducing the risk of accumulating bad debt within the country.

Stricter Euro standards will make car manufacturers to invest in technologies for lower emissions, potentially affecting vehicle prices. Likewise, with stricter regulations in place, non-bank institutions may face additional compliance costs, which could be passed on to consumers. It may also impact car financing options, potentially influencing the accessibility and affordability of car purchases. These regulations can indirectly affect car buying decision in the near future.

4.2.11 Stakeholder Conflict of Interest

The automotive industry and car market in Thailand face a significant challenge due to disagreements both within the industry and with the government's direction. While the government aims to promote advanced technologies like electric vehicles (EVs) to align with global trends and markets, some Thai manufacturers are not yet prepared, leading them to seek ways to delay the transition.

Interviewees mentioned many Thai entrepreneurs, especially suppliers, currently lack the core technologies for EVs. Transitioning to new technologies is not a simple task for the industry, and it highlights the need for more discussions among stakeholders and government parties.

While developed nations have shifted away from internal combustion engine (ICE) vehicles, there is still a market for exporting ICE vehicles to countries where high-technology cars are unaffordable or their infrastructure is not yet ready, such as Africa. Some stakeholders advocate for the government to continue promoting the current technologies for export to these countries. However, the government is

concerned that Thailand may miss out on the transfer of new technology from parent companies, especially if they choose other countries as production bases for electric vehicles (EVs).

While entrepreneurs in Thailand seek to continue producing vehicles for export, the government's support focuses on promoting alternative technologies. Stakeholders noted this divergence of opinions within the industry further complicates matters. Some entrepreneurs are affected by the government's preferred direction, while others who remain unaffected and are ready and willing to support the government's policies. Finding a middle ground within the industry, and engaging in discussions with the government, becomes very challenging to address this issue of industry and market direction.

The misalignment between the needs of the government and the industry, and within the industry itself, become apparent when considering the enforcement of the Euro 5 and Euro 6 standards mentioned earlier. For instance, European brands, whose cars already meet these standards, are against postponing the enforcement. They see the delay as a disadvantage since they have already invested in Euro 6 products, while other manufacturers still invest in cheaper Euro 5 products.

During negotiations and the formulation of these policies, uncertainties and unclear directions can potentially harm businesses and investments. The automotive industry, which is currently undergoing a transition driven by environmental pressures, faces challenges due to government policy uncertainties. These conflicting interests, and the unpredictability they bring, have the potential to disrupt the stability of the industry in the long run.

4.2.12 Traffic Congestion and Lack of Parking Space

There are two problems associated with car usage in the BMR that were frequently mentioned by stakeholders during interviews which have the potential to destabilize the car-dominant system: traffic congestion and lack of parking space. A car-dominated system tends to result in more traffic congestion, longer commute durations, and increased stress levels among individuals. Spending excessive time in traffic jams and coping with the frustrations of congestion can have detrimental effects on overall well-being, contributing to social frustration and impatience.

Figure 41 Average Speed in Bangkok,
Traffic and Transportation Department, Bangkok Metropolitan Administration.



In the BMR, a densely populated city, severe parking issues can arise due to limited space and high demand. The escalating number of vehicles presents challenges in providing adequate street parking, leading to problems such as congestion, illegal parking, and a scarcity of available parking spaces. Interviewees agree these factors often worsen the driving experiences in the city.

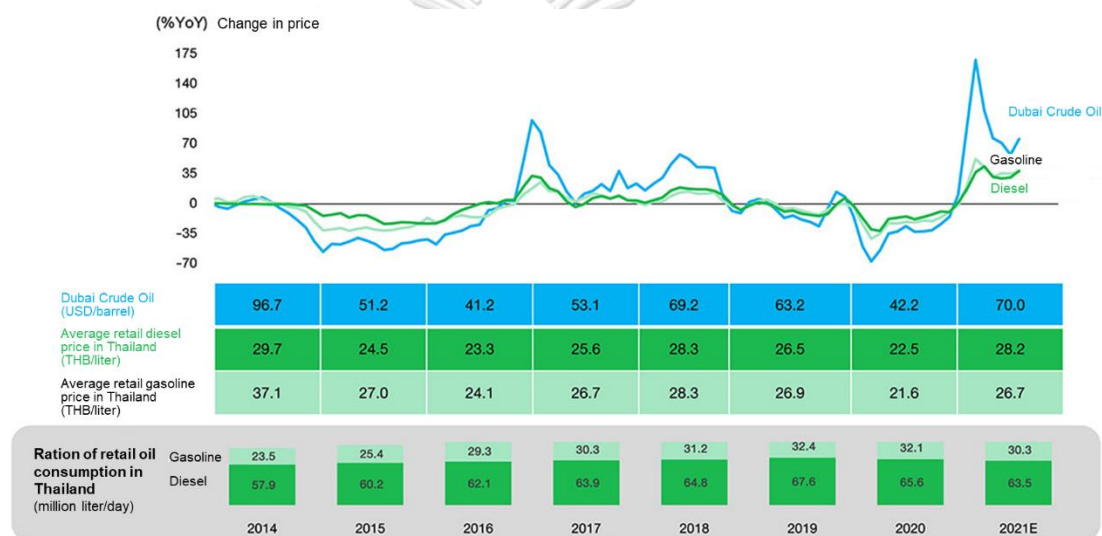
4.2.13 Burden of Ownership

The burden of owning a car can be classified into two types: financial and non-financial. The financial burden includes the cost of the car itself, taxes, registration, insurance, and maintenance. While the out-of-pocket expenses may be competitive with public transport, many of the interviewed are concerned about the recurring costs they have to pay, which can become burdensome for them.

Many feel the price of cars also acts as a barrier. Limited purchasing power and inadequate earnings make it difficult for people to afford buying a car. The drop in purchasing power can be seen from the hire-purchasing sector. Efforts have been made to provide financing options that assist people in purchasing cars. In the past, a down payment of 20-25% was common, but now most people make down payments of 0-5%, indicating they have very little money to invest in a car. The rising cost of living has compelled some individuals to prioritize affordability and focus only on other essential expenses.

Oil prices are another significant factor mentioned by numerous stakeholders. The pandemic caused a decline in energy prices in 2020, with the U.S. benchmark oil price even dropping below zero for the first time in history. However, prices have rebounded more quickly than anticipated, largely due to supply not keeping up with demand. Geopolitical conflicts further aggravate the situation. Nevertheless, with the government promoting electric vehicles (EVs), an increase in oil prices may incentivize people to abandon their cars in favor of EVs rather than relying on public transportation.

Figure 42 Retail Oil Price Records in Thailand, data modified from Energy Policy and Planning Office and TTB Analysis,



The non-financial burdens associated with car ownership, which were less frequently touched upon, include daily maintenance tasks such as washing and ensuring security, as well as the time and energy spent on managing expenses. In response, people are increasingly exploring worry-free alternatives like long-term car renting, which signals a positive shift towards behavior change and the adoption of sharing habits in the future.

4.2.14 Road Safety Concerns

During the interviews, stakeholders highlighted the significant risk of accidents when driving in BMR, primarily due to the undisciplined behavior of

drivers. Emotions, impatience, carelessness, and mistakes often lead to drivers violating traffic laws and displaying a lack of road discipline. A research in the BMR supports this issue that these behaviors stems from a perception that traffic laws are lenient and penalties imposed by traffic police are mild (Bhu-Anantanondh et al., 2021) or negotiable. Consequently, drivers frequently violate traffic laws and exhibit a lack of road discipline.

However, stakeholders expressed their belief that autonomous driving technology presents an opportunity for enhanced safety, assuming no system errors occur. Autonomous vehicles are programmed to prioritize safety by maintaining proper distance, adhering to speed limits, and calculating the safest routes. Advanced features like pre-crash detection contribute to accident prevention, even in situations where drivers may be fatigued or visibility is impaired, such as encountering heavy rainfall, smog, or other obstacles.

In challenging scenarios where anticipating the actions of other vehicles or having clear visibility becomes difficult, autonomous systems can effectively detect signals and apply brakes accordingly. Overall, autonomous driving is seen as a safer alternative to human-operated vehicles, offering the potential to reduce the risk of accidents on the roads of the BMR.

Overall, some mechanisms resemble those identified in different contexts from the literature review, while others are specifically observed within the context of the BMR. Table 10 confirms that most of the mechanisms identified in the research align with previous literature, with a few exceptions.

The results of this study are consistent with previous research, except for the finding that increasing demand for mobility, which has been identified as a stabilizing mechanism in other contexts, was not observed. Instead, this study identified several unique destabilizing mechanisms within the context of the BMR. These include a lack of parking space, the burden of car ownership, the expenses associated with car ownership, uncertainty surrounding public policy, and concerns about road safety.

Figure 43 Mechanisms behind automobility regime.

	Stability	Instability
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Literature (Authors)	<ul style="list-style-type: none"> • Increasing demand for mobility (Florice et al., 2009, Castells, 2011, Castells, 2010, Geels, 2012, Florice et al., 2009 as cited in Moradi and Vagnoni, 2018) 	<ul style="list-style-type: none"> • High competition in the industry and innovation (Moradi and Vagnoni, 2018)
Interview/ Literature (Authors)	<ul style="list-style-type: none"> • Social Values/ Cultural values i.e. ownership, progress, wealth, prosperity, status (Geels, 2012; Geels et al., 2011; Pinhate et al., 2020; Canitez, 2019; Urry, 2004; Supaveera, 2022; Charoentakulpeeti et al., 2006; Thaithatkul et al., 2023) • Provision of car ecosystem and strong actor network/ Historical legacies that prioritised automobiles ecosystem (Pinhate et al., 2020), powerful interlinkages with other industries (Urry, 2004; Canitez, 2019) • Car-oriented transport policy and knowledge i.e. road, traffic/ Routines for tools and methods, embedded road-based transport policy and knowledge (Canitez, 2019), predict and provide (Dudley and Chatterjee, 2012) • Automotive promotion policy/ Gov't support to industry, gov't taxes incomes (Ngar-yin Mah et al., 2012; Van der Eerden, 2013 as cited in Moradi and Vagnoni, 2018), Gov't financial support to auto manufacturers/owners (Pinhate et al., 2020) • Automotive industry strengths/ Strong actor network (Hoffmann et al., 2017), gov't-industry relation (Geels et al., 2011), ability to influence the policy arena (Marletto, 2014) • Car attractiveness i.e. privacy, convenience, multi-purpose, personal safety, family trip, freedom, door-to-door, on-demand/ Freedom and flexibility (Urry, 2004; Gascon et al., 2020) • Product development of car/ Technological strengths (Moradi and Vagnoni, 2018) 	<ul style="list-style-type: none"> • Social and environmental awareness of users/ Public demand for change, for sustainable mobility (Dudley and Chatterjee, 2012; Hoffmann et al., 2017; Moradi and Vagnoni, 2018), Citizen awareness of pollution threats (Hodson et al., 2015; Moradi and Vagnoni, 2018; Pinhate et al., 2020) • Tighten law and regulation (increasing cost)/ Tighter emission standards on vehicles, tighter regulation (Hoffmann et al., 2017) • Stakeholder conflict of interest i.e. gov't vs private, among private/ Conflicting interests among regime actor network, within the group of industrial actors or between different governments i.e. disagreement among European automotive companies which weakened the negotiation power of industrial actors (Hoffmann et al., 2017) • Oil price/ Energy and fuel prices and market change (Gerardo Marletto, 2014; Moradi and Vagnoni, 2018) • Traffic congestion/ Chronic traffic congestion (Pinhate et al., 2020; Dudley and Chatterjee, 2012)
Interview	<ul style="list-style-type: none"> • Low cost of car use compared to public transport (out-of-pocket expense) • Lack of Knowledge (for car use management) • Habitual behavior 	<ul style="list-style-type: none"> • Lack of parking space • Burden of ownership • Expense of car ownership • Uncertainty of public policy • Road safety concern

CHAPTER V BELIEFS ON MAAS ADOPTION

This part of the study underlies the importance of comprehending the factors that make MaaS appealing to users and enable its momentum. In addition to examining individuals' attitudes and preferences regarding MaaS, it is essential to understand the underlying reasons behind the formation of these attitudes and preferences. Extensive psychological research has consistently demonstrated that people's attitudes toward an object or a behavior are significantly influenced by their explicit beliefs concerning the object or behavior. User beliefs are crucial in shaping the acceptance and adoption of technologies, but there is a research gap in understanding user beliefs on MaaS.

To address this gap, the study conducted semi-structured interviews with commuters to explore their perspectives and insights on adopting MaaS. The TPB was used only as a guideline for interview design and processes. The aim was to investigate the key beliefs that influence commuters' inclination to adopt MaaS. The results from both parts of the study can demonstrate how MaaS can disrupt the existing automotive system and promote the transition towards sustainable mobility.

Since MaaS is context-dependent and its implementation varies across different areas, it is crucial to define the nature of MaaS being examined. Broadly, MaaS can be categorized as either car-centric or public transportation-centric. Given the objective of this research, which aims to drive a transition from the current automobile-dominated system towards a more sustainable transport system in the BMR, all respondents were aware that the focus was on public transportation-based MaaS. This approach intends to encourage the use of public transportation as a sustainable and efficient mode of travel, with a particular emphasis on minimizing environmental impacts and promoting a shift away from private car usage.

5.1. Participant Characteristics

The inclusion criteria resulted in 35 interviews with heterogeneity among the sample regarding gender, age, socioeconomic status, and main transport mode, as shown in Table 11. In addition to reaching data saturation, the number of participants also complied with the rule of thumb that the study should include a sample of 25 to

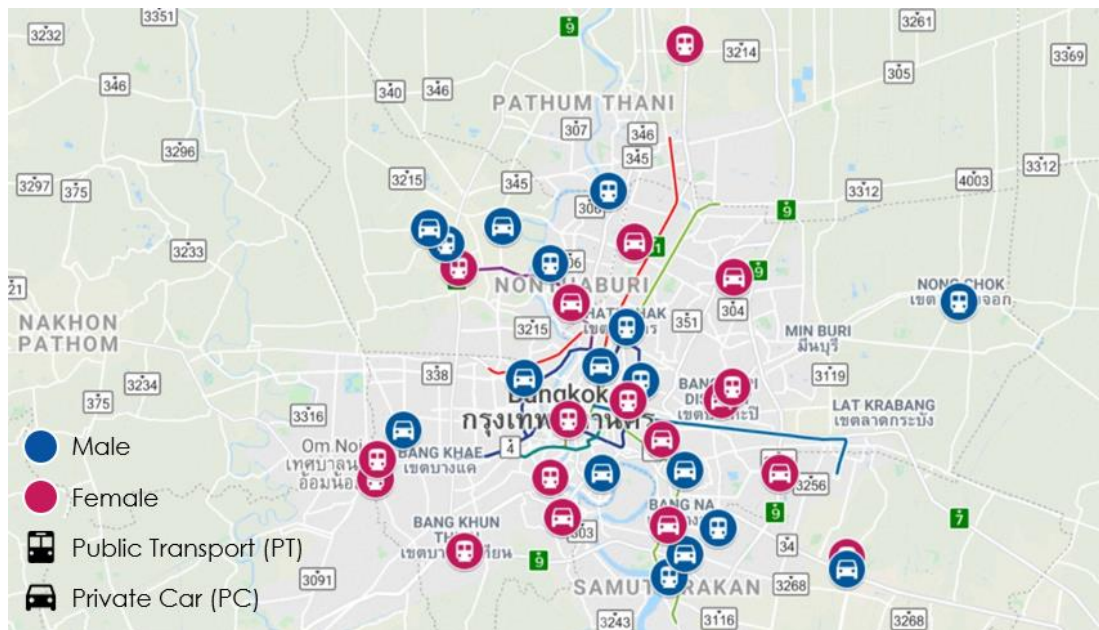
30 participants representing the general research population. The distribution of participants by age and gender accurately reflects the composition of the targeted population, based on statistic data from the National Statistical Office of Thailand (NSO) in 2021. Due to limited data available for other criteria, the study aimed to achieve a balanced representation of all relevant characteristics.

Out of the 35 participants, 24 individuals (69%)—including both private vehicle and public transport users – reported using digital platforms such as Google, Grab, ViaBus, and Longdo for their daily trips. Considering that MaaS is likely to be more relevant in urban areas at its early stage, this study focused on recruiting residents living in the city center. However, to ensure a comprehensive understanding of the target population, efforts were also made to include participants from across the entire BMR, allowing for a broader perspective. Figure 44 illustrates the heterogeneity among the sample with respect to participants' residence locations.

Figure 44 Demographic information of participants (N = 35).

Total: N = 35		BMR (%)	Sample (%)	Frequency (N)
Gender	Female	51	51	18
	Male	49	49	17
Age	18-25	15	17	6
	26-35	21	23	8
	36-45	23	23	8
	46-55	22	20	7
	56-65	19	17	6
Education	High School or lower		12	4
	Bachelor Degree		54	19
	Master Degree or higher		34	12
Employment	Student		6	2
	Employed		60	21
	Self-employed		29	10
	Retired		6	2
Main Transport Mode	Motorcycle		6	2
	Public Transport		43	15
	Private Car		51	18

Figure 45 Residence location of participants classified in gender and main transport mode.



5.2 Beliefs Associated Using Maas

Thematic analysis of the interview data revealed key beliefs that formed the basis of participants' attitudes towards using MaaS. Table 12 presents all beliefs identified during the interviews with frequency and examples. The aim of this study was to identify the beliefs underpinning commuters' attitude associated with intention to use MaaS. Gaining an understanding of the relevant beliefs about using MaaS provides transport planners, policy makers, and MaaS developers a foundation for addressing users' concerns related to this relatively new solution. Additionally, it facilitates the promotion of the favorable aspects of MaaS.

Moreover, qualitative research on beliefs plays a valuable role in informing the conceptualization and operationalization of psychological constructs, thereby enhancing the validity, transparency, and replicability of future quantitative research endeavors. These salient beliefs can also primarily be considered in hypothesizing and generalizing with a quantitative research in the future.

Figure 46 Beliefs identified during the belief study.

(1) Behavioral Belief

<i>Belief</i>	<i>F</i>	<i>P</i>	<i>Keyword</i>	<i>Example</i>
Travel planning	22	11.70		<ul style="list-style-type: none"> • It's good to know the fare or schedule and I don't have to figure things out all by myself. • It would be great if MaaS provided me with all available choices and even compared them for me.
System reliability	19	10.11	data privacy, security, stability, refund	<ul style="list-style-type: none"> • I would want to use MaaS if it functions smoothly and get me to my destination as planned. • I'm worried about both cyber-attacks and fraud.
Convenience	18	9.57	convenience	<ul style="list-style-type: none"> • I hope this service will be available soon. It seems very convenient.
Data accuracy	18	9.57	time, location	<ul style="list-style-type: none"> • I am afraid that MaaS's plan for my trip is unpunctual or the locating system isn't precise.
More and various choices	15	7.98	more choices all modes, private services, new mobility (EV, AV), micro mobility	<ul style="list-style-type: none"> • I would love to know more options to commute so I can choose what's best for me. • It better includes all available modes, especially local ones, which are hard to find during peak hour. • I like that I can chose car sharing because I am familiar with the comfort from private car.
One stop service	14	7.45	all-in-one, common ticketing	<ul style="list-style-type: none"> • I like the fact that I can do everything about my trip in just one application.
Travel information	14	7.45	Info, data	<ul style="list-style-type: none"> • It's good to know the fare or schedule. • I could take the BTS if I knew I would have to wait pretty long for the bus.
Time efficiency	13	6.91	time control/ efficiency	<ul style="list-style-type: none"> • I prefer to efficiently manage my time and schedule.
Customized	11	5.85	meet different travel needs	<ul style="list-style-type: none"> • I can choose travel modes based on different conditions such as raining, being in a hurry, or lazy to walk.
Safety	10	5.32	personal safety	<ul style="list-style-type: none"> • I would feel more safe if I could see the profile of a taxi or motorcycle driver through MaaS platform.
Online payment	9	4.79	cashless, digital payment	<ul style="list-style-type: none"> • I can pay with my credit cards, without using cash, I like online payment.
Car pain points solving	8	4.26	parking, ownership, driving	<ul style="list-style-type: none"> • It is very difficult to find parking lots in Bangkok and it is also expensive. It's good if I don't have to drive.
Seamless trip	6	3.19	smooth multimodal	<ul style="list-style-type: none"> • MaaS could make my multimodal trip easier and more smooth.
Accessibility	4	2.13	service coverage	<ul style="list-style-type: none"> • Will the pick-up and drop-off points be easily accessible?

<i>Belief</i>	<i>F</i>	<i>P</i>	<i>Keyword</i>	<i>Example</i>
Service quality	4	2.13	public transport quality	<ul style="list-style-type: none"> • Bus services in Bangkok have never been improved. They are so old and dirty.
Door-to-door service	3	1.60	not too far walk, door-to-door	<ul style="list-style-type: none"> • It would be good to have someone pick you up and drop you off right in front of your doorstep.
<u>Total</u>	<u>188</u>	<u>100</u>		

(2) Normative Belief

<i>Belief</i>	<i>F</i>	<i>P</i>	<i>Keyword</i>	<i>Example</i>
None	17	39.53	n.a.	<ul style="list-style-type: none"> • I am responsible for my own life and my own choices.
Family	15	34.88	parents, wife, siblings, children	<ul style="list-style-type: none"> • My dad would support me to use if it could save me money but he would also be worried about my safety. • My wife would be an early adopter and even encourage me to use it. • My daughter would want me to use it because it helps me plan and travel.
Friend	8	18.60	colleague	<ul style="list-style-type: none"> • I would want to use it if my friends use it and we can share locations or meet along the way.
Influencer	2	4.65	reliable source	<ul style="list-style-type: none"> • I would give it a try if a reliable source (i.e. famous Facebook page) recommends it.
General public	1	2.33	more people are using	<ul style="list-style-type: none"> • I would want to use it if a lot of people used it.
<u>Total</u>	<u>43</u>	<u>100</u>		

(3) Control Belief

<i>Belief</i>	<i>F</i>	<i>P</i>	<i>Keyword</i>	<i>Example</i>
Usability	20	45.45	require few information, comprehension	<ul style="list-style-type: none"> • I think I can use it if I understand all the procedure and functions. • I would want to use MaaS if it's easy to use. • I don't like filling out a lot. I just want to know how I can get from A to B.
Compatibility	12	27.27	mobile phone, public transport, online payment	<ul style="list-style-type: none"> • I am already familiar with using public transport so MaaS would make it easier. • I don't think I would have any difficulty using MaaS because it includes the services I have used before like online payment or application.
Facility	9	20.45	mobile phone, internet	<ul style="list-style-type: none"> • It would be nice if MaaS includes mobile phone charging service in case anything happens during my trip. • The internet must be fast or at least stable enough.
Emergency assistance	2	4.55	call center	<ul style="list-style-type: none"> • Whom do I contact when there is any problem during my trip? Will they respond immediately? Call centers in Thailand is

<i>Belief</i>	<i>F</i>	<i>P</i>	<i>Keyword</i>	<i>Example</i>
Complicated city plan	1	2.27	too many local roads	hopeless. • It is not easy to follow the navigation in Bangkok because there are so many small roads and complications.
<u>Total</u>	<u>44</u>	<u>100</u>		

(4) Other Beliefs

<i>Belief</i>	<i>F</i>	<i>P</i>	<i>Keyword</i>	<i>Example</i>
Financial incentive	20	48.78	price, promotion, money saving, loyalty program, government support, package	<ul style="list-style-type: none"> • I am willing to pay if it is reasonable. • I would like to use MaaS if it offers good promotions or reward points. • MaaS could save me money if I get to travel conveniently through public transport instead of taxi. • I would really like to try the package option, assuming it's cheaper.
Comfort zone	10	24.39	familiarity, trial period, car-related, forced	<ul style="list-style-type: none"> • I am already familiar with something else (driving, google map, routine trip). • I wouldn't want to change unless I was forced to.
Better society	5	12.20	environment, stress reduction, traffic congestion, air pollution, better life quality	<ul style="list-style-type: none"> • I would love it if I can track my carbon footprint. • MaaS could allow people to drive less, which could lead to less traffic, less pollution and stress. • If MaaS can reduce private cars and traffic, it is better for health. • I am willing to pay more if MaaS can improve my life quality.
Personal image	4	9.76	trendy, cool, young	• I would like to look trendy and have a cool lifestyle.
Smart functions	2	4.88	location sharing, alert	• I would like to be able to share my location during my trip with someone I trust for my safety.
<u>Total</u>	<u>41</u>	<u>100</u>		

5.2.1 Behavioral Beliefs

Overall, commuters mentioned several positive and negative behavioral beliefs regarding their willingness to use MaaS. While some of these beliefs, such as system reliability, convenience, and data accuracy, have been previously established in the literature, this study revealed several new attitudes that impact their intention to use MaaS. The findings demonstrated that a majority of participants believed that utilizing MaaS would enhance their trip planning, particularly for unfamiliar

destinations. They expressed a strong desire for MaaS to offer comprehensive availability of all transportation options, along with the ability to compare and receive suggestions for the best choices.

“It would be great if MaaS provided me with all available choices and even compared them for me” – Commuter 31.

“MaaS could help me be less worried about getting lost or if a taxi driver is cheating when I travel to somewhere new” – Commuter 6.

This finding is consistent with research on private car driving, where some individuals prefer driving due to the freedom and flexibility it offers, eliminating the need for extensive planning. Consequently, planning a trip can become a hassle for them, and they have high expectations that MaaS can address this issue.

Other beliefs that influence users' intention to use MaaS are regarding data accuracy, the availability of more choices, and customization. These factors can shape users' intention to use MaaS. By effectively addressing these aspects, MaaS providers can attract and retain users, fostering the adoption and success of the service.

Reliable and accurate data is also cited as crucial for decision making of using MaaS platforms. Few users mentioned that they need to trust that the information provided, such as real-time transit updates or availability of shared mobility options, is accurate and up to date. If users perceive the data to be inaccurate or unreliable, it can undermine their confidence in using MaaS. They believe that high data accuracy is important and can enhance user trust and increase their intention to use MaaS.

“Will the transport modes I choose arrive as scheduled? How can buses ensure timely arrivals?” – Commuter 5.

Offering a wide range of transportation options within the MaaS ecosystem can also positively influence user intention. They mentioned that if they have access to diverse choices, such as public transportation, ride-hailing services, bike-sharing, and car-sharing, they can select the mode that best suits their needs. The availability of more choices increases the perceived value and convenience of MaaS, attracting more users and driving their intention to use the platform.

“I would use it if it includes new technology cars like EV or AV so I get to try them before buying” – Commuter 8.

Many also mentioned about ability to personalize their MaaS features and experience. Customization – such as preferred modes of transportation, route preferences, or tailored recommendations based on user preferences and behavior, can make MaaS more appealing. When users feel that the service is tailored to their individual needs and preferences, they are more likely to perceive it as a viable alternative to private vehicles.

Other interesting beliefs that may be unique in the context of Thailand include one-stop service, travel information, safety, and online payment. These beliefs highlight the current pain points experienced by commuters in the BMR, where there is a lack of integration like common ticketing system and limited availability of travel information, such as bus stop locations and train schedules. Safety in public spaces and concerns regarding online payment are still subjects of debate and uncertainty.

Users believe that the ability to access and manage multiple transportation options seamlessly through a single window is important. By eliminating the need for multiple platforms or even ticket, they can save time and effort in their journeys. The ease and efficiency of accessing different modes of transportation through a unified interface can enhance user satisfaction and increase their intention to use MaaS.

“I would use MaaS if I could pay and ride every service with only one application despite service charge” – Commuter 3.

These pain points differ from those in Europe or Japan, where common ticketing systems and readily accessible information are already in place. Therefore, implementing MaaS in Thailand could begin with simpler solutions aimed at addressing the specific pain points of local commuters, rather than adopting the entire concept of new mobility solutions, which may require more time to implement.

5.2.2 Normative Beliefs

Although most participants believed that they have full authority in normative decisions, it was reported that families and friends are more likely to

support or approve of using MaaS. This suggests that the opinions of their close circle of people still hold importance to them when making decisions.

Normative beliefs serve as a bridge connecting social contexts and individual behavior. Previous studies have also demonstrated the importance of normative beliefs across several empirical contexts including travel mode choice, public transit use (see Donald et al. (2014), private car use (Bamberg & Schmidt, 2003), electric vehicle adoption (Singh et al., 2020), and car sharing adoption (Zhang & Li, 2020). Interestingly, this study found that some people also believed that it is important to them if internet influencers or tech experts think they should use MaaS. This suggests a shift in the social context, where influence is not limited to real-life circles but extends to virtual communities and online societies.

“I would give MaaS a try if a reliable source (like famous Facebook page) recommends it” – Commuter 19.

This finding is in line with the growing body of research that highlights the persuasive power of social media influencers as influential figures in online environments (Hudders et al., 2021; Vrontis et al., 2021). Studies have identified their impact on attitudes and behaviors across various domains, including intellectual, social, ethical, health-related, and political contexts (Vrontis et al., 2021), with particular emphasis on the younger population. These changes reflect a shift in values and beliefs across generations.

5.2.3 Control Beliefs

Usability, characterized by its easiness and user-friendliness, along with compatibility with other behaviors such as online payment and mobile phone usage, contributed to an increased sense of control among participants in using MaaS. This aligns with findings from previous studies, indicating that commuters consider a lack of understanding of the services as a significant barrier to adopting shared and demand-driven mobility services (Casadó et al., 2020; Sochor et al., 2016).

On the contrary, internet connection, for example, reduced the amount of control perceived by the participants. They expressed numerous concerns regarding the lack of or poor internet connection and issues related to mobile phones. Consistent with existing literature, this study reinforces the established understanding that

uninterrupted internet access is crucial for real-time data exchange, service coordination, and seamless user experience within MaaS systems.

“Our communication network has not yet achieved full coverage. In certain areas, there is still a lack of internet access. To effectively operate all these services, a fast and reliable internet connection is essential” – Commuter 8.

Additionally, research by Tussyadiah, Zach, and Wang (2020) investigated the influence of internet connectivity on user experiences and adoption of MaaS. They found that poor or unreliable internet connections can significantly hinder user satisfaction, trust, and willingness to adopt MaaS services. The study emphasized the importance of robust connectivity infrastructure to ensure the seamless functioning and acceptance of MaaS.

5.2.4 Other Beliefs

Almost half of the mentioned beliefs from the TPB model are related to financial considerations, such as price, discounts, saving money, and appealing price packages. These financial beliefs are in line with previous studies that have highlighted the price sensitivity of users (Alonso-González et al., 2020; Durand et al., 2018; Ho et al., 2020; Ratilainen, 2017).

However, in this study, commuters also expressed specific expectations regarding financial issues, such as promotions, loyalty programs for future benefits, and government support, such as subsidies or tax refunds. This indicates that while price sensitivity plays a role, commuters are open to using MaaS if they receive special support or benefits.

“The government should offer some incentives for people who use MaaS instead of private cars” – Commuter 15.

“There should be reward points or loyalty program from using it so that I can exercise the points for discount or other benefits” – Commuter 6.

The second most frequently mentioned beliefs relate to the user’s comfort zone, including familiarity, trial periods, and car-related factors. This finding aligns with previous studies that have identified the influence of user experience, such as

membership, car sharing, and public transport usage, on the intention to use MaaS (Alonso-González et al., 2020; Fioreze et al., 2019).

“I am already familiar with something else (driving, google map, routine trip), I wouldn't want to change” – Commuter 14.

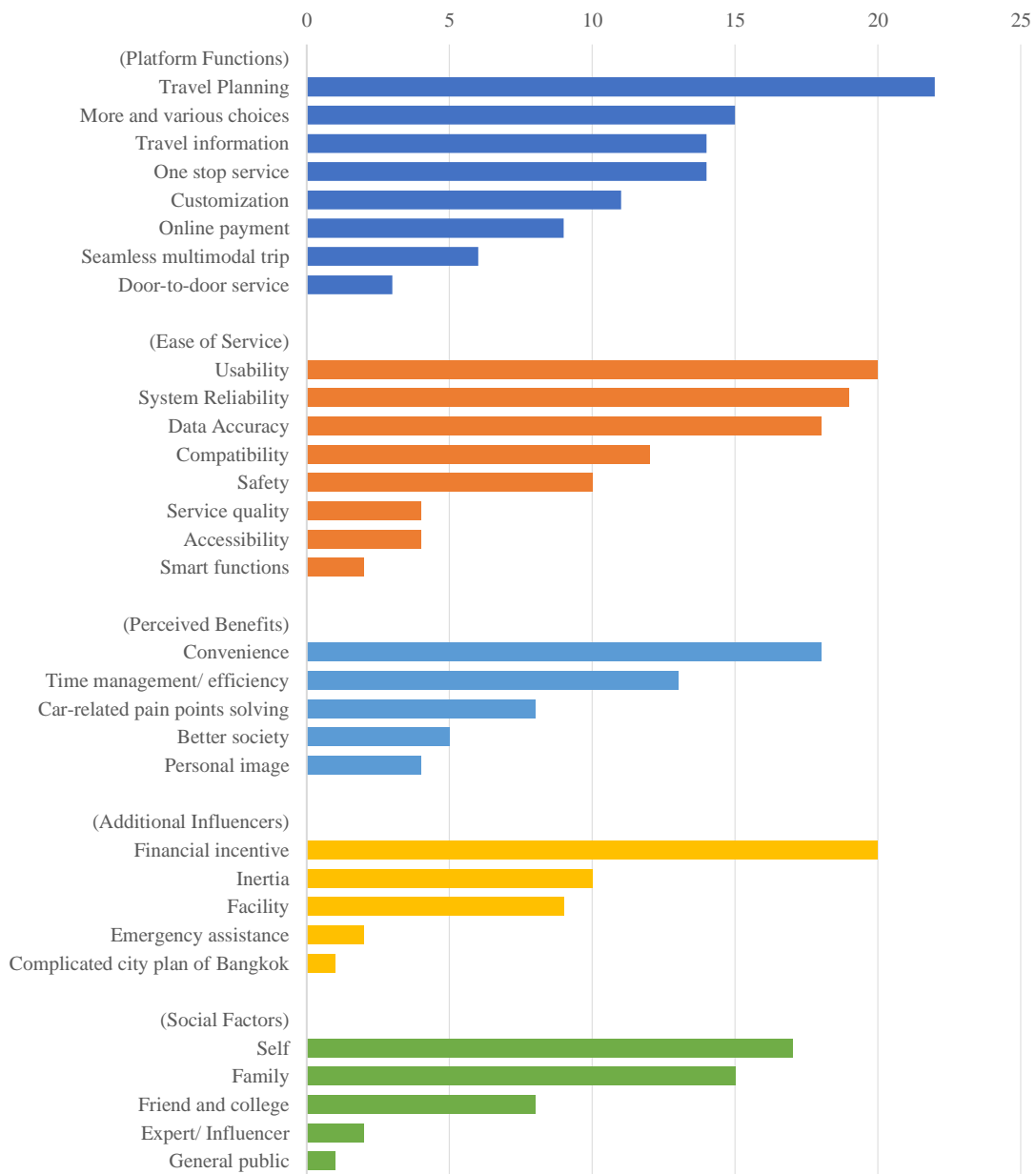
“I prefer not to change if the alternative mobility option is not significantly better than my current one. I don't like change” – Commuter 34.

This resistance to change or the familiarity with existing behavior relates to inertia in the context of human behavior. Inertia often stems from a natural resistance to change. It describes the tendency for individuals to maintain their current habits, routines, or beliefs instead of adopting new ones, even when presented with alternative options that may be beneficial. Users may be accustomed to their current transportation habits and find it difficult to break away from their established routines. They may be reluctant to explore and adopt a new system like MaaS, even if it offers potential benefits. Inertia can manifest in various aspects of life, including personal habits, decision-making, organizational behavior, and technology adoption.

5.3 Beliefs Classification for Service Design and Promotion

While the previous section outlined the beliefs based on the TPB framework, this section explored the specific results obtained from interviews, focusing on the classification of these beliefs towards MaaS design. This part is crucial for MaaS development as it establishes a direct link between user beliefs and the design and development of MaaS. The beliefs mentioned earlier were categorized into platform functions, ease of service, perceived benefits, additional factors, and social factors (for public communication). Figure 47 presents the categorized beliefs identified during the interviews, along with their frequencies.

Figure 47 Beliefs identified during the belief study by category.



Understanding user expectations and preferences in these areas allows the creation of a user-centric MaaS platform that meets their needs effectively. It informs design decisions, service offerings, and marketing strategies, ultimately ensuring that the platform is appealing, convenient, and aligned with user expectations, thus driving user acceptance and adoption of MaaS services.

5.3.1 Important Platform Functions

The interview results highlighted key beliefs regarding the important platform functions of MaaS, with travel planning being the central focus. Participants noted the importance of having manageable and plannable trips, as well as the budgets associated with such use. They prefer the feeling of being confident about their destinations in advance, mainly the desire for a journey without surprises. This, along with the need for assistance when navigating unfamiliar locations, were often remarked upon.

Commuters also appreciated the ability of MaaS to provide a smooth experience if it allowed them to compare options, avoid scams, and receive guidance. They expressed the desire for a comprehensive and user-friendly platform that offers various choices for their travel needs. This includes access to detailed travel information such as routes, schedules, and availability of different modes of transportation.

Participants also emphasized the importance of a one-stop service that integrates different transportation options into a seamless experience. They sought a platform that provides convenience and eliminates the need to switch between multiple apps or services to plan and book their trips. Customization was another significant function mentioned, as participants wanted flexibility to personalize their travel preferences, such as selecting specific modes of transportation or setting preferences for travel time or cost.

The ability to make online payments was seen as a crucial factor for a smooth and hassle-free experience. Participants desired a secure and efficient payment system that would eliminate the need for cash transactions and provide real-time payment confirmation. This feature would add convenience and simplify the process of using different transportation services if the route required it.

Seamless multimodal trips were also seen as an important function of MaaS. Participants expressed the desire for a system that integrates different modes of transportation, allowing them to transition between buses, trains, taxis, or other options without any disruptions or complications. They envisioned a seamless journey with smooth transfers and optimized travel routes.

Lastly, door-to-door service was considered an essential function of MaaS. Participants expressed the desire for a service that offers a complete end-to-end experience, starting from their doorstep to the final destination. This would ensure a stress-free travel experience, eliminating the hassle of users needing to piece together multiple connections of their trip.

Overall, the interview results demonstrate the expectations and desires of individuals for an effective and user-friendly platform regarding the capabilities of MaaS. These key functions reflect the aspirations of users to have a comprehensive and integrated mobility solution that simplifies their travels and enhances their overall experience.

5.3.2 Ease of Service

The interview results also revealed several beliefs regarding the ease of using MaaS. Participants emphasized the importance of usability, indicating that MaaS should require minimal information, knowledge and comprehension of its users. System reliability was also mentioned, with participants expressing the need for data privacy and security, secure payment processes, app stability, and the availability of compensation or refunds in the case that any issue were to arise.

Data accuracy was also considered crucial, particularly in terms of providing accurate information about time, punctuality, location, and other relevant details. Compatibility with other products or services, such as mobile phone usage, public transport integration, and online payment systems, were identified as important aspects of a seamless user experience.

Safety was a significant concern. Commuters highlighted their personal safety during the trips. They thought the assurance of driver or shared passenger information when booking ride-sharing or ride-hailing modes would be helpful. They also emphasized the importance of service quality, including clean and well-maintained vehicles or facilities. Accessibility, in terms of coverage and availability of MaaS services in different areas across the board, was seen as a key factor for its ease of use as well.

Lastly, participants expressed an interest in smart functions that would enhance the user experience, such as location sharing with friends and AI-powered

calculations for optimal routes or travel suggestions. These beliefs reflect the expectations of participants regarding the ease of service when using MaaS, which are highly important for the service design and promotional strategies.

5.3.3 Expected Benefits from Using MaaS

The interview results revealed several beliefs regarding the expected benefits of using MaaS. Participants emphasized the convenience of MaaS, highlighting its expected ability to provide a hassle-free and efficient travel experience. They felt that MaaS would allow for better time management, improving the overall efficiency of their daily commutes.

Participants also identified several car-related pain points that MaaS could help to solve. They believe that using MaaS would eliminate the need to find parking spaces, remove the burden of car ownership, and ultimately eliminate the need to drive, all of which can be stressful and time-consuming for the driver.

Another important belief mentioned by participants is the perception that MaaS contributes to a better society. They viewed MaaS as a promotional toll for the environment, as it helps reduce traffic congestion and air pollution. By reducing the reliance on private cars, MaaS is seen as a way to promote a more sustainable and eco-friendly transportation system. Participants also believe that MaaS contributes to a better quality of life by reducing stress from driving and planning public transport trips, as well as improving overall well-being for those shifting from private car use.

Additionally, participants mentioned the personal image associated with using MaaS. They viewed it as a trendy and cool lifestyle choice, particularly among the younger generation. Using MaaS is seen as a way to align with modern trends and portray a positive public image.

5.3.4 Additional Influencers

Another aspect of beliefs about using MaaS are concerning additional influencers. The interview analysis revealed several beliefs that can significantly affect commuters' decision-making regarding the adoption of MaaS. The most important one is related to the presence of financial incentives. Participants expressed that reasonable and affordable prices, promotions, royalty programs, and government

subsidies can positively influence their decision to use MaaS. They perceive MaaS as a money-saving option, especially when offered in cost-effective packages.

Inertia, or a reluctance to change, was another belief mentioned by participants. Some commuters are hesitant to switch from their current transportation habits and prefer to stick with what they are already using. They mentioned the need for a free trial or feeling compelled to switch to MaaS before considering its adoption.

The availability of suitable facilities and reliable technology was also identified as an important factor. Participants highlighted that poor internet connections or problems with their mobile phones, especially battery depletion, could hinder their use of MaaS. They emphasized the need for a reliable and stable internet connection to effectively access and utilize MaaS services.

Emergency assistance was identified as a significant belief among participants. They emphasized the importance of having responsive customer service or support to provide assistance during travel emergencies. Having reliable and prompt assistance was seen as crucial for addressing any issues or problems that may arise during their journeys.

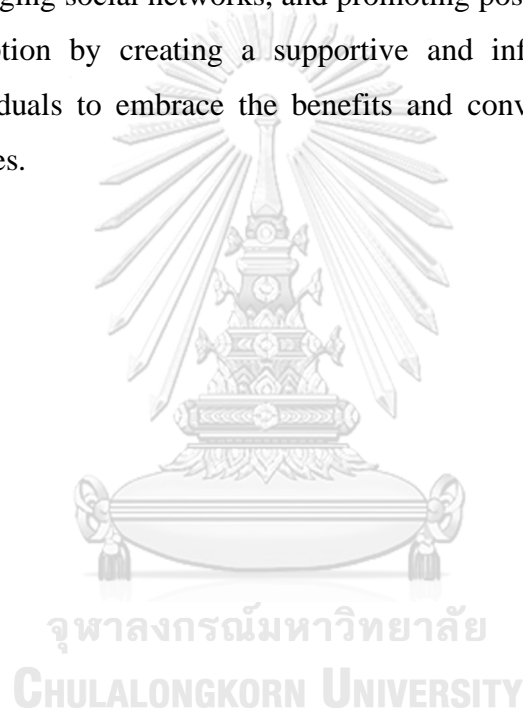
The complicated city plan of Bangkok was another belief mentioned by a participant. Navigating the complex road network and city layout of the BMR can be challenging, and the participant expressed concerns about locating specific places that may not be readily available in the MaaS system or map. They highlighted the importance of MaaS effectively addressing these complexities and providing accurate navigation guidance.

5.3.5 Social Factors

To develop effective marketing channels and public communication strategies MaaS, it is crucial to identify the beliefs surrounding social factors and understand influencers that shape commuters' decisions. While many participants expressed a sense of individual responsibility in their decision-making process, it is undeniable that social factors can play a significant role. The influence of family members, friends, and colleagues can sway perceptions and choices, as individuals often seek advice and recommendations from their trusted social networks.

Additionally, the opinions and expertise of influencers and experts in the field can hold considerable weight, impacting commuters' perceptions and attitudes towards MaaS. The power of the general public's perception should not be underestimated either, as societal norms and trends can influence individuals' decisions and willingness to embrace new mobility solutions.

By gaining insights into these social factors and their underlying beliefs, MaaS providers can develop targeted marketing campaigns and communication strategies that effectively engage with these influential networks. Engaging with key influencers, leveraging social networks, and promoting positive social norms can help drive MaaS adoption by creating a supportive and influential environment that encourages individuals to embrace the benefits and convenience of MaaS in their daily travel routines.



CHAPTER VI DISCUSSION

6.1 The Dynamics of the Automobility Regime

This study shows that the system of automobility in the BMR, Thailand has established a robust network of actors and elements that have sustained it for many years. Breaking this long-standing system is not a simple task. It has become deeply embedded in our societies, to the extent that it dominates over all dimensions of the socio-technical system, including industry, regulations and policies, markets and user practices, distribution networks and maintenance, infrastructure, scientific knowledge, and cultural meaning.

The findings reveal numerous landscape developments that support and reinforce the existing automobility system, contributing to its continued existence and strengthening. These landscape developments reflect deep-rooted structures, values, and institutions shaping the transport system in the BMR as predominantly car-oriented. These landscapes are concerning challenges in public transport (limited coverage, interconnectivity, integration, expensive fares, lack of infrastructure for active modes, urban design and planning), economic development goals (investment promotion policy, global economic order, concentration of prosperity), social factors (health concerns), and politics (corruption, inconsistency, conflict of interest, failure to keep up with technology, lack of political will).

Over time, with the driving forces from these landscapes, the BMR's automobility regime has been developed and stabilized through a combination of various mechanisms that have reinforced and perpetuated the dominance of car-centered transportation. The study found that these mechanisms revolve around the provision of a car ecosystem (strong actor network, car-oriented transport policy and knowledge, low cost of private car use, lack of knowledge for car use management), automotive industry promotion (investment policy, industry strengths and network, car development), and cultural values (social values, habitual behavior, car attractiveness). These mechanisms have worked together to support and sustain the existing transportation system, making private car usage the dominant mode of transportation in many societies. Table 13 summarized the dynamics of the automobility regime.

Figure 48 Summary of the Automobility Regime Dynamics

	Supporting and stabilizing	Pressuring and destabilizing
Landscape	<ul style="list-style-type: none"> • Urban design and planning • Poor public transport system • Limited coverage of public transport • Limited interconnectivity • Lack of integrated public transport systems • High expense of public transport compared to private car use • Lack of proper infrastructure for active modes • Investment promotion policy • Health concerns • Global economic order • Concentration of economic growth and prosperity • Politics (corruption, inconsistency, conflict of interest, failure to keep up with technology, lack of political will) 	<ul style="list-style-type: none"> • Environmental issues (pollution, natural resources depletion, sustainability) • Commitment to international goals • Shift in national policy direction towards environmental and social focus • Changes in social values among the young generation • Digital trend and promotion • technology development • Economic slowdown (affecting purchasing power)
Regime	<ul style="list-style-type: none"> • Social values • Provision of car ecosystem and strong actor network • Car-oriented transport policy and knowledge • Auto industry promotion policy • Auto industry strengths and adaptation • Car attractiveness • Car development • Low cost of private car use (out-of-pocket expense) • Lack of knowledge for car use management • Habitual behavior 	<ul style="list-style-type: none"> • Social and environmental awareness • Tighten law and regulation • Stakeholder conflict of interest • Uncertainty of public policy • Oil price • Traffic congestion • Lack of parking space • Burden of ownership • Expense of car ownership • Safety concern

However, changes in the landscape are also observed and have the potential to create pressures on regimes, potentially leading to transitions. These landscapes are centered around three main agendas: Environmental (pollution, natural resources depletion, sustainability, commitment to international goals, shift in national policy), Social and Cultural (changes in social values among the young generation), Technology and Innovation (digital promotion and development), and Economic (economic slowdown).

The automobility regime itself, while providing convenience and mobility for people, also poses challenges that gradually undermine its solidity. The study found several mechanisms that destabilize the regime. It contributes to environmental issues such as air pollution, greenhouse gas emissions, and resource depletion, which increases social and environmental awareness among users against it. The automotive

industry is also facing challenges that weaken their collaboration and relationship with the government, such as tightening regulations, conflicts of interest among stakeholders or uncertainty in public policy. Owning and using a car can also be burdensome, both financially and non-financially. Traffic congestion, a lack of parking space, and safety concerns due to a high rate of road accidents also pose difficulties in using cars.

Figure 49 illustrates the dynamics of the BMR's automobility regime identified in the study, highlighting the relationship and interactions between the macro and meso levels. Over time, the automobility regime in the BMR has been developed and stabilized through a combination of mechanisms that reinforce and sustain the dominance of the car-centered system.

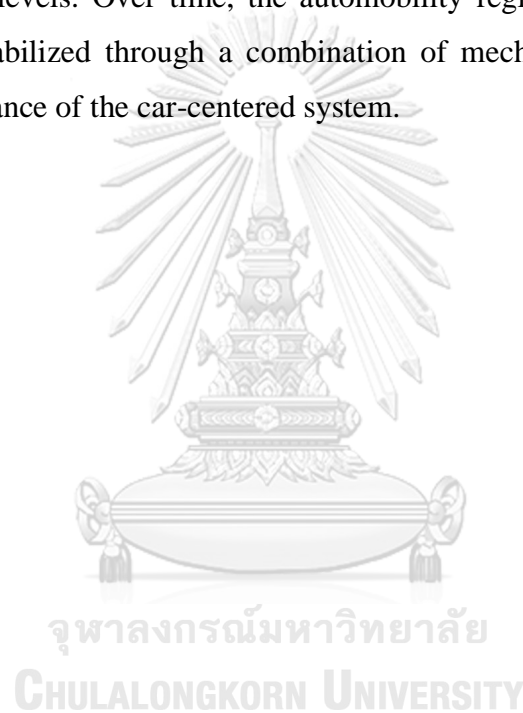
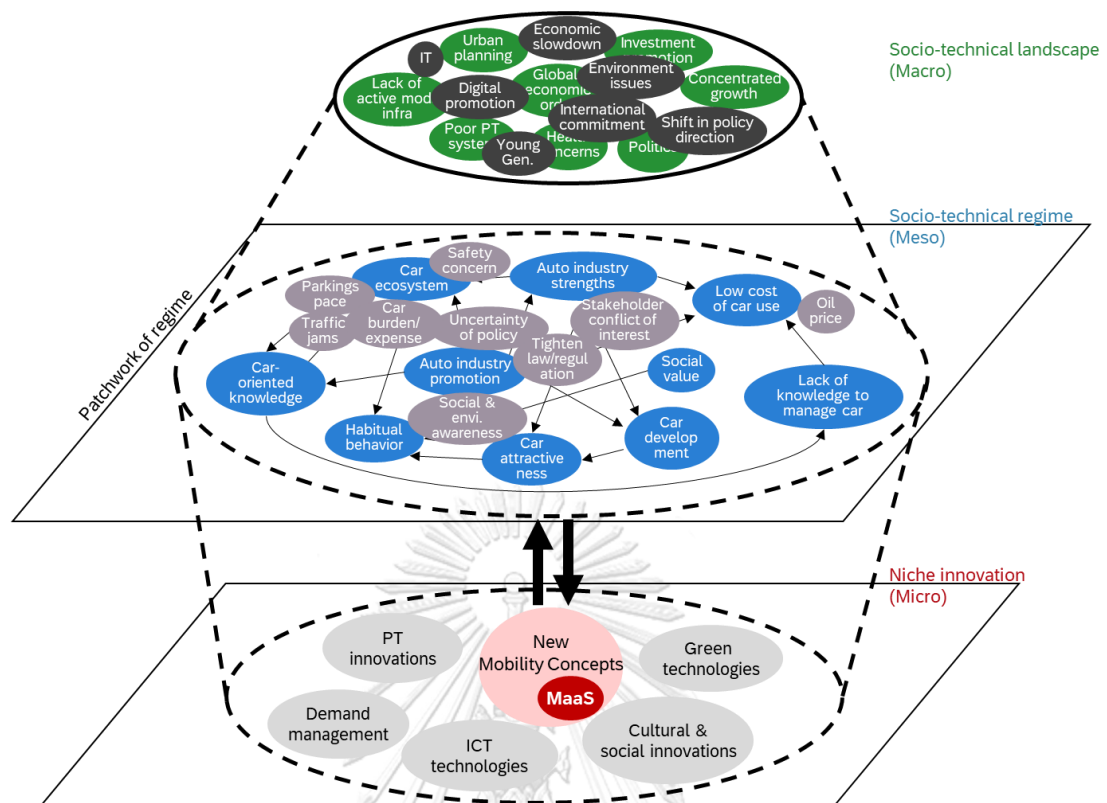


Figure 49 The Dynamics of Automobility Regime in the BMR, Thailand. results from interviews, graphic modified from Geels, 2002



Overall, the automobility regime in the BMR is characterized by the alignment of various components, including infrastructure (such as roads and supporting ecosystem), the automotive industry, transport and industrial policies, knowledge, and the social values and habitual behavior of users. These mechanisms work together to support and maintain the automobility system, making it challenging for alternatives to emerge.

The study also identifies changes in the landscape that have the potential to create pressures on the existing regime. These landscapes revolve around environmental concerns, social and cultural shifts, digital advancements and technology, and economic slowdown. While the stabilizing mechanisms and supporting landscapes contribute to the resilience of the automobility regime, the regime itself poses challenges that can gradually create cracks within its structure. These cracks represent tensions and weak points in the existing system, which can potentially open the way for promising niche innovations to emerge.

The study further reveals several mechanisms that destabilize the regime, providing opportunities for niche innovations like new mobility concepts to gain

traction and challenge the dominance of the existing regime. These tensions present a window of opportunity for transformative changes in the automobility landscape.

6.2 Future of the Automobility Regime

Results from stakeholder interviews and analysis indicate that the automobility regime in the BMR, Thailand is supported by various landscape developments and stabilizing force within the regime. However, the automobility regime also faces numerous pressures and challenges from both the landscape and regime levels.

At the landscape level, the dynamics identified in this study, including environmental issues, commitment to international goals, shifts in policy direction, digital trends and promotion, technology development, changes in values among the younger generation, and economic slowdown, exert pressure on the automobility regime. These challenges highlight the necessity for adjustments and improvements within the regime to ensure its sustainability and adaptability to changing circumstances.

The future of the automobility regime depends on how these pressures and challenges are addressed by the actors involved and how they impact the stability or instability of the regime. The analysis of the current automobility regime indicates that the transition to new mobility concepts will most likely occur along a transformation path.

There is landscape pressure at a moment when niche-innovation like MaaS has not yet been sufficiently developed. In response, regime actors will modify the direction of development paths and innovation activities. The results of this study show that the regime is experiencing significant transformations in response to landscape pressures and niche innovations. This involves the integration of new technologies, such as electrified vehicles and shared mobility services, resulting in a more diverse and integrated transportation system.

Evidence was presented throughout the analysis of the interviews. The automobility regime is supported by intensive stabilizing mechanisms within the regime, which revolve around a robust car ecosystem, promotion policy, strong network of actors, and cultural values. These factors provide the automobility regime

with abundant resources to make adjustments. Furthermore, the regime's success in navigating various challenges and changes throughout history demonstrates its resilience and adaptability. Furthermore, the significant investments made in infrastructure development will continue to support the continuity of the automobility regime.

Since the regime actors continuously respond to the challenges and pressures, the automobility regime will maintain its dominant position in the transportation landscape. The trend of automobility is expected to adjust and grow due to its prominent stability, which is encompassed by the interactions of many mechanisms. These factors indicate a sustained trajectory of growth in the automotive industry.

6.3 Initiating Cracks in the Automobility Regime

According to an insightful analysis, key factors that can contribute to the "cracks" in the BMR's automobility regime include intensive intervention to leverage regime mechanisms, strong promotion of MaaS to develop and gain momentum, and the interplay of push (people away from driving) and pull (people towards using MaaS) strategies. These factors can create windows of opportunity for transitions within the regime.

Intensive intervention involves targeted efforts to disrupt and challenge the stability of the automobility regime. By leveraging destabilizing mechanisms, such as social and environmental awareness, the burden and expense of car ownership, inconveniences and concerns related to car use (such as parking space availability, traffic congestion, and safety issues), along with landscape developments that pressurize the system, cracks can be initiated.

The study provides compelling evidence indicating that interventions, such as promotional policies, have played a crucial role in strengthening the automobility regime over its course of development. As these interventions have been successful in fostering the regime, it stands to reason that they possess the potential to be equally effective in destabilizing it, as well as promoting alternatives in niche level such as MaaS. Therefore, implementing targeted interventions aimed at disrupting and challenging the existing mechanisms of the automobility regime could prove

instrumental in initiating its destabilization and paving the way for alternative solutions.

Parallely, the strong promotion of MaaS plays a crucial role in creating a potential shift in the transportation landscape. As landscape developments create pressure on the regime, along with its internal issues, it creates opportunities for niche-innovations like MaaS to gain traction. If MaaS and other niche-innovations are fully developed, they can take advantage of these windows of opportunity and offer alternative transportation options that challenge the dominance of traditional car ownership.

Hence, it becomes imperative to simultaneously destabilize the current regime while also supporting and strengthening niche innovations. This combined approach aims to create the necessary cracks within the regime, which can serve as opportunities for transformative change. By actively destabilizing the existing system and fostering the growth of alternative solutions, we can cultivate favorable conditions for transitioning towards a new and improved paradigm.

Overall, a combination of intensive intervention, strong promotion of niche-innovations like MaaS, and the interplay of push and pull factors can contribute to the emergence of cracks in the BMR's automobility regime. These factors create opportunities for transitions towards more sustainable and integrated transportation systems.

6.4 Impacts of Landscape Developments and Regime Mechanisms on MaaS

Understanding the impact of landscape developments and regime mechanisms is crucial for assessing the opportunity for MaaS in the BMR, Thailand. By analyzing these dynamics, policymakers and stakeholders can identify the potential barriers and enablers for the successful introduction and integration of MaaS. This knowledge can inform decision-making and support the development of strategies that promote the adoption of MaaS as a viable alternative within the existing automobility regime.

The results from the interview analysis provide insights into the potential impact of landscape developments and regime mechanisms on the introduction and opportunities of MaaS within the stabilized automobility regime. Figure 50

demonstrates the impact analysis of landscape developments and regime mechanisms on the automobility regime and the potential for MaaS. The study aims to examine the dynamics of landscapes and the regime to understand their influence on the window of opportunity for a shift towards new mobility concepts.

Starting with landscape developments that have a positive impact on the automobility regime but display negative signs for MaaS. This includes investment promotion policies and politics, which tend to continue favoring heavy industry for economic growth. While these factors support the existing regime, they pose challenges for the emergence of new mobility concepts.

Health concerns, on the other hand, have a positive impact on the automobility regime as they highlight the importance of private car for personal healthiness. However, these concerns can pose challenges for MaaS, which aims to promote alternative modes of transportation, especially multimodal trips based on public transport. One potential challenge is that using public transport may expose individuals to higher levels of air pollution compared to private cars.

Figure 50 Impact Analysis of Landscape Developments and Regime Mechanism.

	Automobility	MaaS	Opportunity
Landscape Developments			
Investment promotion policy, Politics	○	×	
Health concerns	○	×	
Urban design and planning and Public transport system	○	△	MaaS for feeders
Infrastructure for active modes	○	△	MaaS for feeders, sharing personal mobility
Environmental issues, Commitment to international goals	×	○	MaaS for feeder, EVs sharing
Shift in policy direction, Digital trend & promotion, Technology	×	○	Digital ecosystem
Changes in values among young generation	×	○	Digital literacy
Concentration of economic growth and prosperity	○	—	
Economic slowdown	×	×	
Regime Mechanisms			
Social Values, Habitual behavior	○	×	
Low cost of private car use	○	×	
Lack of knowledge for car management	○	×	
Provision of car ecosystem and strong actor network	○	○	MaaS for feeder using EVs, potential players
Automotive industry promotion policy	○	○	MaaS for feeder using EVs
Automotive industry strengths	○	○	Potential players
Car attractiveness, Product development of car	○	○	MaaS for feeder using EVs
Social and environmental awareness	×	○	MaaS for feeder using EVs
Oil price, Parking space, Burden of ownership	×	○	MaaS for feeders
Traffic congestion	×	○	MaaS for feeders, sharing personal mobility
Car-oriented transport policy and knowledge	○	—	
Tighten law and regulation	×	—	
Stakeholder conflict of interest	×	—	
Uncertainty of policy	×	—	
Safety concern	×	×	

The issues with urban planning, public transport, and active modes of transportation can either present threats or opportunities for MaaS depending on the situation. MaaS can be utilized as feeders or for sharing personal mobility, providing first and last mile services to connect with the public transportation. Environmental issues and commitments to international goals, while harmful to the automobility regime, present opportunities for MaaS, particularly in terms of feeder services using electric vehicle sharing to facilitate public transport use.

Shifts in policy direction, digital trends, technology development, and changes in values have a positive impact by promoting the digital ecosystem and increasing digital literacy. These factors create an enabling environment for the emergence and adoption of MaaS. The concentration of economic growth does not show any direct influence on MaaS.

Economic slowdown poses challenges for both the automobility regime and new mobility concepts, unless the government decides to subsidize alternatives to reduce car usage. Overall, the impact analysis reveals the complex interplay between landscape developments, existing automobility regime, and the potential for MaaS. It highlights both the challenges and opportunities for a transition towards innovative and sustainable mobility solutions.

When examining the opportunity for new mobility concepts, it is important to understand the prevailing dominance of the existing automobility system. Regime mechanisms play a significant role in shaping people's preferences and behaviors towards car dependence. Some mechanisms within the regime can pose a threat to MaaS. These mechanisms include social values, habitual behavior, the low cost of private car use, and a lack of knowledge about car management. These elements create a support system for individuals who prefer using private cars, making it challenging for new mobility concepts to gain traction.

On the other hand, there are regime mechanisms that are related to the strengths of automobiles, which can offer opportunities for MaaS that based on cars. These mechanisms include the provision of a car ecosystem, the strength of automotive industry, the attractiveness of cars as a mode of transportation, and ongoing product development.

Car-based MaaS, such as car sharing and ride-hailing services, benefit from these dynamics. To encourage public transport-based MaaS, these mechanisms should be leveraged to create MaaS for feeder services that use EVs to connect with public transport. This way, the car's strength can be leveraged to promote the use of public transport. At the same time, these car-centric mechanisms also create possibilities for new market entrants to join and support the growth of these services.

Additionally, certain destabilizing mechanisms within the automobility regime can actually create opportunities for MaaS. Mechanisms such as social and environmental awareness, fluctuations in oil prices, limited parking space, the burden of car ownership, and traffic congestion can all contribute to a growing interest in alternative transportation options. These elements highlight the drawbacks and challenges associated with traditional car usage, which in turn can make people more open to exploring and adopting new mobility concepts.

It is important to note that some mechanisms within the regime may not have a direct influence on either the threat or opportunity for MaaS. These mechanisms include car-oriented transport policy and knowledge, tighten law and regulation, stakeholder conflict of interest, uncertainty of policy. Safety concern poses challenges to both automobility system and the opportunity for MaaS.

6.5 Key Success Factors from Countries Using MaaS

The success factors for implementing MaaS demonstrated in other countries can be grouped into several key areas that are crucial for its effectiveness. First and foremost, collaboration and cooperation emerge as critical factors, emphasizing the need for close collaboration between public and private actors. This collaboration should be based on trust and shared visions among stakeholders, ensuring that differing perspectives are considered and integrated into the MaaS framework. Engaging a broad set of strategic and operational key stakeholders is also imperative, as their involvement enables a more comprehensive approach to MaaS implementation.

Data availability and standardization form another crucial factor in the success of MaaS. Establishing robust digital infrastructure and data exchange centers becomes essential to facilitate seamless data sharing among stakeholders. This

enables the integration of diverse data sources and the creation of comprehensive, real-time information for MaaS users. Standardized data formats and interfaces further enhance interoperability and compatibility, allowing for efficient data exchange and integration across multiple systems.

Financial support plays a significant role in sustaining MaaS initiatives. Strong and continuous financial backing from both the public and private sectors is necessary to overcome financial barriers, stimulate innovation, and ensure the long-term availability of MaaS services. This support can manifest in the form of grants, subsidies, investments, or other financial mechanisms that incentivize MaaS development and operations.

Infrastructure and regulation are key considerations in implementing successful MaaS systems. Provision of appropriate physical infrastructure, such as designated MaaS hubs, seamless intermodal connections, and supportive transport networks, is crucial for enabling efficient and convenient multimodal travel experiences. Suitable regulation, including data security and privacy regulations, plays a vital role in establishing trust among users and service providers, ensuring that data is handled securely and in compliance with relevant laws and regulations.

Technological advancements and innovation are instrumental in driving the success of MaaS. Availability of enabling technologies, such as mobile applications, smart ticketing systems, and real-time data platforms, facilitate seamless access to MaaS services and enhance the overall user experience. Experimentation with new institutional arrangements, business models, and service delivery mechanisms encourages innovation and fosters a dynamic MaaS ecosystem.

Creating awareness and outreach efforts are critical in promoting the adoption of MaaS among the target audience. Effective marketing strategies, high-quality services, and strong customer support play pivotal roles in attracting users to MaaS platforms and encouraging them to embrace new mobility concepts. Comprehensive community outreach programs, coupled with clear communication of the benefits and value proposition of MaaS, help build awareness, understanding, and acceptance among the public.

Lastly, the ability to learn and adapt is paramount for sustained success. Adopting an interactive and co-creative approach, engaging in field trials and pilot

projects, and actively seeking feedback from users and stakeholders contribute to ongoing improvements and refinement of the MaaS system. The ability to revise and adapt the MaaS vision based on learnings and changing needs ensures its continued relevance and effectiveness in addressing evolving mobility challenges.

By considering these diverse factors across collaboration, data, finance, infrastructure, regulation, technology, awareness, and adaptability, countries can lay a strong foundation for successful MaaS implementation, creating a transformative and integrated mobility solution that meets the needs and aspirations of their communities.

6.6 Leveraging the Window of Opportunity for New Mobility Concepts

When examining the opportunity for new mobility concepts, it is important to understand the prevailing dominance of the existing automobility system. Discussions regarding the future of these concepts as a pathway to a more sustainable transportation system naturally take place in the context of car dominance. These concepts are meant to reduce dependency on private cars by complementing the public transport system. Therefore, analyzing the automobility regime becomes an essential perspective. The legacy of the automobility system implies that transitioning to new mobility concepts requires a comprehensive assessment of the entire system, rather than solely focusing on individual elements. The better understanding of mechanisms behind automobility regime found in this study provides valuable insight into the opportunity for new mobility concepts.

This study has successfully identified various landscape developments that pressurize the BMR's automobility regime and the mechanisms that contribute to its destabilization. While these factors have negative impacts on the automobility regime, they also present different impacts and opportunities for mobility services in the BMR.

At the landscape level, environmental concerns drive the need for sustainable transportation alternatives, with a focus on reducing reliance on private cars and promoting energy-efficient and electric vehicles, as well as car-sharing services. Additionally, a shift in national policy direction towards social and environmental goals, along with Thailand's commitment to international standards, further promotes action towards environmental sustainability.

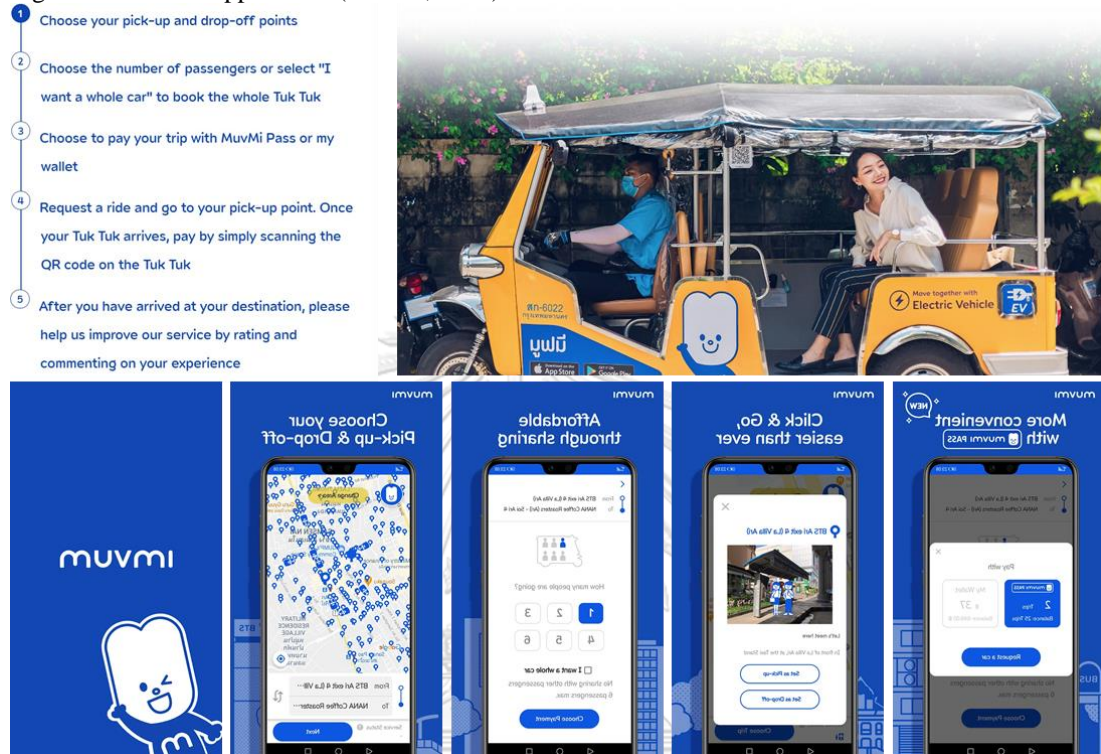
Within the regime, certain mechanisms also revolve around the eco-friendly trend. Social and environmental awareness regarding externalities associated with private car usage, including CO₂ emissions, air pollution, and urban degradation, prompt a need for change. The dominance of private cars restricts social interactions and active transportation modes, leading to inactive lifestyles and health issues. Moreover, traffic congestion caused by private cars results in excessive energy consumption and space utilization. Discussions on urban development highlight the necessity for innovative solutions to create sustainable and livable cities.

Consequently, tightening laws and regulations, such as the enforcement of stricter emission standards, were implemented. The financial domain of the automotive market also faces tighter regulations to monitor lending practices, impacting vehicle prices and financing options, ultimately influencing consumer car-buying decisions. These factors, challenge the stability of the automobility regime in the BMR and create a conducive environment for the adoption and growth of alternative solutions.

These mechanisms related to environmental issues can present opportunities for an environmentally friendly mobility service in the BMR, particularly in addressing first and last mile transportation needs. Muvmi is a mobile application-based ride-hailing service operating in specific areas. The service aims to provide high-quality electric tuk-tuks that are safe and environmentally friendly. It also addresses the challenges of unconnected and uncovered public transportation, offering cheaper, safer, and easier travel solutions. Muvmi marks an initial level for MaaS implementation in the BMR and has already been used for over 1,000,000 trips since its launch in 2019.

Muvmi benefits from the focus on addressing environmental concerns and reducing reliance on private cars. Its alignment with international goals enhances its reputation, while a shift in national policy direction supports its operations. Increasing social and environmental awareness drives demand for sustainable transportation options like Muvmi, and stricter laws and regulations related to emissions and transportation create a supportive environment for its services. Together, these mechanisms contribute to Muvmi's success in providing eco-friendly and convenient ride-sharing options in line with sustainable mobility goals.

Figure 51 Muvmi Application (Muvmi, 2023)



Likewise, the landscape developments driven by new trends, such as changes in social values among the younger generation, the rise of digital trends and promotion, and advancements in technology, pose challenges to the traditional automobility regime. However, they also present an opportunity for application-based mobility services that cater to the evolving lifestyles and preferences of the young generation.

The younger generation's changing social values, including a decrease in car ownership as a status symbol, present opportunities for MaaS. Their value and activities have shifted to the digital world, instead of physical assets like cars. They prefer alternatives such as ride-hailing services, which provide convenient transportation without the burden of car driving and ownership. This shift in mindset can drive change from the bottom-up, influencing government priorities and promoting public transport over cars.

Digital technology promotion and development, as reflected in the growth of the digital economy, supports the development of innovative mobility services and the utilization of data for efficiency, safety, and environmental sustainability. The government offers incentives and initiatives to attract investments in smart city projects and digital initiatives, aiming to enhance public services and facilitate connections between service providers and customers, thus promoting the digital ecosystem.

Advancements in technology have also caused a change in the social values and lifestyles of the younger generation. Their high digital literacy makes them digital natives which doesn't just aid new mobility concepts because they are adept in technology use, but the extra time that new mobility provides them can also allow them to be efficient during travel periods. With smartphones at everyone's fingertips, work is available 24/7 for those who know how to utilize their time. The freedom that public transport brings, can be beneficial to a working man's lifestyle.

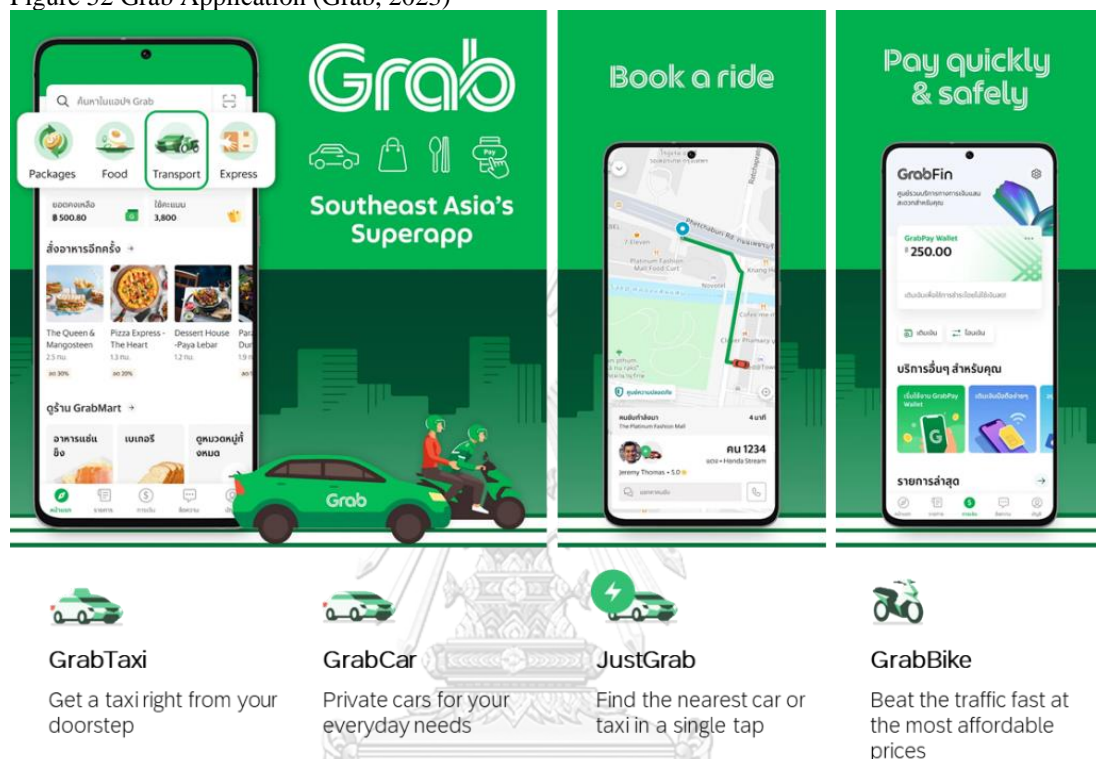
These mechanisms support the implementation of MaaS. The services align with the changing perceptions of time efficiency and the increased importance of online activities in today's digital age. The younger generation, with their lesser focus on the social value of cars and higher digital literacy and preference for applications and digital gadgets, find value in mobility services that don't require them to drive.

Ride-hailing service like Grab has rapidly gained popularity in the BMR. Accordingly, regulations to govern the ride-hailing service industry has finally been introduced. The Ministry of Transport issued the Ministerial Regulation on Ride-Hailing Vehicles Via Electronic System in 2021. The regulations impact drivers and electronic system operators in four main areas: drivers must register their cars, electronic system operators need approval and verification, cars must meet specified criteria, and ride-hailing service fees are regulated.

According to Measurable AI, the recent e-receipts data indicates that Grab continues to dominate the ride-hailing market in Thailand, holding approximately 70% of the market share in the first quarter of 2022 in terms of order volume. However, it is crucial to promote services like Grab as feeder services that connect to public transportation, rather than as door-to-door solutions. By emphasizing this

complementary role, Grab can provide seamless and efficient transportation options that integrate with public transport networks and optimize overall mobility.

Figure 52 Grab Application (Grab, 2023)



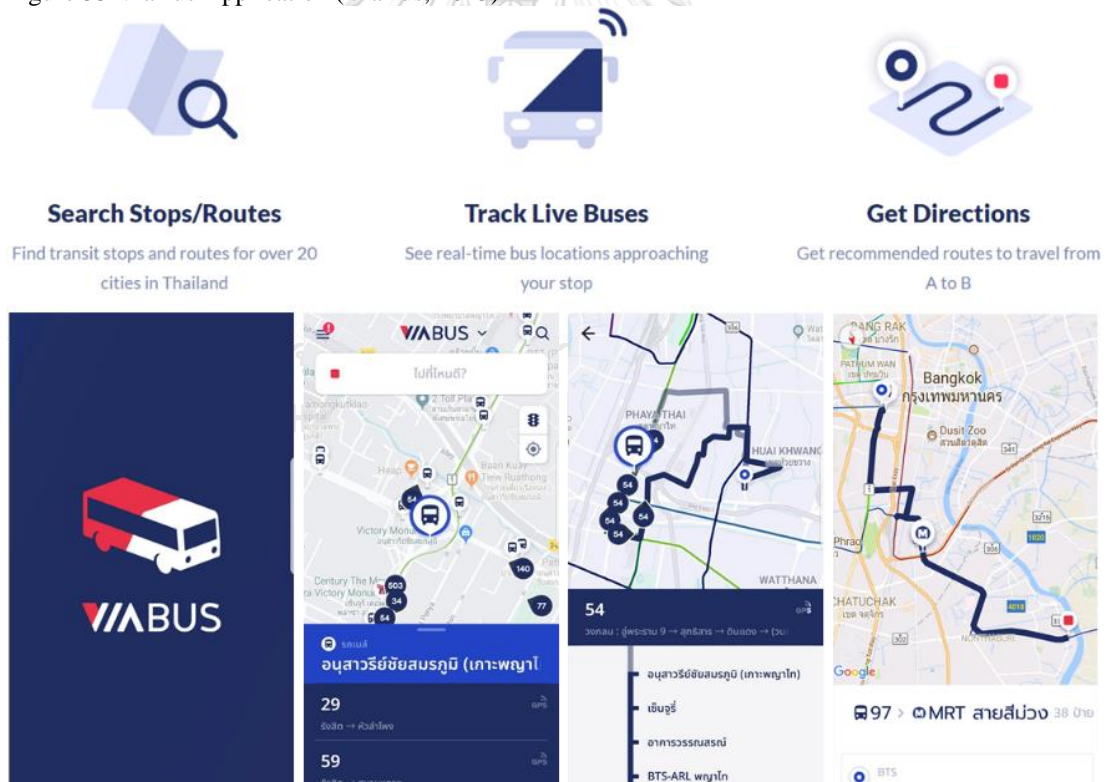
Similarly, other destabilizing mechanisms within the BMR's automobility regime, such as the difficulties associated with private car use, can greatly influence the adoption of MaaS. Factors like increasing traffic congestion, limited availability of parking spaces, the burdens associated with car ownership, expenses related to vehicle maintenance, fluctuating oil prices, and economic slowdowns all contribute to the decreased convenience of using private cars, thereby creating an opportunity for alternative options to address these pain points.

MaaS offers alternative transportation solutions that can alleviate congestion, reduce the need for parking spaces, lessen the burden of car ownership, mitigate maintenance expenses, provide flexibility during fluctuating oil prices, and offer cost-effective mobility options during economic downturns. Muvmi, as mentioned earlier, provides affordable ride-sharing services starting at 10 baht per ride, making it a viable option compared to private car usage. It is also safer that

typical feeders like motorcycle taxis. Initiatives like ViaBus, at an initial level of MaaS in the BMR, facilitate the use of public transportation by making it more convenient for riders. By addressing the challenges associated with private car use, ViaBus contributes to the attractiveness of public transportation in the region.

The popular public transportation service in the BMR is buses, but one major issue is the uncertainty of their arrival, causing wasted time and confusion for users. To address this problem, the ViaBus application was developed, initially as a small system but expanded to assist both locals and foreign tourists who are unfamiliar with the routes. While the study's findings suggest that the automobility regime in the BMR remains dominant and influential in transportation, the development of the ViaBus application offers promising evidence of MaaS's potential to significantly enhance users' experiences when utilizing public transport services.

Figure 53 ViaBus Application (ViaBus, 2023)



The application tracks the current location of buses, providing users with real-time information, trip planning, as well as reliable arrival time. ViaBus has made public transportation in the BMR more convenient and efficient. ViaBus is in the

initial stage of MaaS, classified as Level 1 according to the classification mentioned in section 2.1.3, focusing on information integration. ViaBus integrates route and station information for various modes of transportation, including buses, rail, boats, and Songthaews. Additionally, it offers navigation services for public transport journeys.

The landscapes and mechanisms identified in this study play a significant role in destabilizing the current regime of the BMR. To address research question 1.3 on leveraging mechanisms to discourage private vehicle ownership and enable a transition towards new mobility concepts, the regime mechanisms were categorized as shown in Figure 54. Additionally, potential soft landing interventions to discourage private vehicle ownership and create conditions for embracing new mobility concepts are discussed in alignment with the categorization.

Figure 54 Mechanisms with Potential for Leverage.

Mechanisms behind automobility regime		Possible Intervention
[Stabilizing]	[Destabilizing]	
<ul style="list-style-type: none"> • Lack of knowledge for car use management • Low cost of private car use compared to public transport (out-of-pocket expense) 	<ul style="list-style-type: none"> • Burden of ownership • Lack of parking space • Traffic congestion 	Increasing the difficulty of private cars
<ul style="list-style-type: none"> • Habitual behavior • Social values 	<ul style="list-style-type: none"> • Social and environmental awareness • Oil price • Expense of car ownership (total cost of ownership) • Safety concern (due to car accidents) 	Influencer partnerships
<ul style="list-style-type: none"> • Automotive industry promotion policy • Automotive industry strengths and adaptation 		Shifting industry promotion policy
<ul style="list-style-type: none"> • Provision of car ecosystem and strong actor network • Car-oriented transport policy and knowledge • Car attractiveness • Car development 		Prioritizing Public Transport Attractiveness

6.6.1 Increasing the Difficulty of Private Cars

It is crucial to enhance the difficulties associated with using private cars. Both the financial and non-financial burden should be leveraged and magnified to make public transportation a more competitive alternative. When addressing the

reduction of private car usage, there has been a predominant emphasis on supply-side measures, with the belief that it is crucial to offer sufficient alternatives before implementing demand-side control policies. This approach is often driven by factors such as insufficient data, limited knowledge, or a lack of research to justify the policies. However, it is essential to recognize that demand-side measures are equally significant and should be implemented in conjunction with supply-side efforts, akin to a “carrot and stick” strategy.

One approach to demand-side measures is to impose a heavier financial burden on individuals who rely on cars. The economic mechanisms should be applied to reflect the actual cost associated with owning and using a private car, considering negative external impacts such as parking usage in public areas, air pollution, traffic congestion, and the increased likelihood of accidents.

These financial measures can manifest in various forms, such as high rates of city parking fees, car entry fees, or road usage fees, that require individuals using the roads to pay additional taxes. Moreover, there may be additional costs like high annual taxes on emission cars and high fuel taxes. In urban areas where public transportation options already exist, if some individuals still prefer driving, congestion pricing should be introduced. This means that drivers would be required to pay a fee for entering the city center.

Similarly, non-financial measures aimed at reducing car usage can also be effective. Examples of these measures include regulations requiring individuals to have a personal parking space when purchasing a car, implementing access control measures for cars entering the city, imposing restrictions on parking availability, and designating certain areas as “no parking” zones.

In the BMR, where these interventions have not been previously implemented, an alternative approach to reduce public resistance is through an indirect method. Rather than directly imposing high parking fees, the local government can consider implementing charges or incentives for buildings along the public transport network based on the parking spaces they provide.

Overall, the results from the discussions with stakeholders indicate that leveraging the challenges associated with private car usage through comprehensive financial measures is crucial in promoting behavioral change. The revenue generated

from these measures can be utilized to fund improvements in alternative modes of transport or provide subsidies.

However, since the effectiveness of the travel demand-side measures varies across geographical areas of the BMR, the interventions should be tailored according to the needs and characteristics of communities in each residential area (Thaithatkul et al., 2023b). In order to determine the appropriate measures for specific areas and address the concerns about social acceptance and the need for sufficient data to justify interventions, implementing a sandbox approach in a selected area with public transport options can serve as a pilot project for trial and data collection. This phased approach allows for gradual implementation and informed decision-making.

6.6.2 Influencer Partnerships

Influencer partnerships can play a crucial role in reshaping public awareness and promoting behavior change, particularly in reducing private car use and increasing public transport ridership. Based on interview results, it is evident that the habitual behavior of private car drivers is driven by convenience, comfort, familiarity, and perceived time savings. By collaborating with employers and institutions, as well as leveraging influencers' reach, awareness campaigns and educational initiatives can emphasize the availability of those benefits within public transport, along with its social and environmental advantages.

Engaging influencers can amplify the message and encourage a shift towards new mobility concepts, especially among younger generations who prioritize digital assets and are receptive to social value changes. Younger generations tend to value different things compared to previous generations, especially when it comes to physical assets due to digitalization trends.

Collaborating with social media influencers who align with the desired messaging and target audience can amplify the reach and impact of awareness campaigns. Influencers can use their platforms to share educational content, personal experiences, and endorsements that help reshape mindsets and promote positive behaviors. We have witnessed the young generation's influence on public awareness in politics recently. Now is a convenient time to stimulate this new social value among the younger generation and expand it to the others.

In addition to weakening the mechanisms that stabilize private car use, it is also essential to apply influencer partnerships to maximize public awareness regarding social and environmental issues, the overall expense or total cost of car ownership (TCO) including rising oil price, and safety concerns arising from high rates of road accidents. This approach may help destabilize the dominance of car usage and promote alternative mobility options.

The results from stakeholder interviews indicated an increase in environmental issues within landscape developments, leading to the growth of social and environmental awareness among individuals as travelers in the system. These dynamics present an opportunity to leverage and shape people's perception regarding the use of private cars.

Incorporating total cost of ownership information into labeling systems and utilizing media or social channels can be effective strategies to disseminate awareness and influence public perceptions. By leveraging influencer partnerships, public awareness can be leveraged to reshape behavior and pave the way for alternative mobility solutions and concepts.

Providing total cost of ownership information has been found to significantly influence decision-making when purchasing an electric vehicle, especially among young consumers. This influence might be observed in transportation modes, especially during economic downturns, as individuals meticulously consider how they allocate their limited purchasing power.

To ensure widespread dissemination of information, governments can play a proactive role by mandating the inclusion of total cost of ownership information for private cars within labeling systems. For instance, the introduction of an ECO Sticker that prominently displays this information can be an effective tool. Simultaneously, government entities can actively promote the realization of this initiative through various media and social channels. By leveraging influencer partnerships and effectively raising public awareness, we can reshape behaviors, pave the way for alternative mobility solutions, and embrace new concepts that are more sustainable and environmentally friendly.

6.6.3 Shifting Industry Promotion Policy

The results of this study have emphasized the significant role of automotive promotion policies in driving the growth of the automotive industry and maintaining the stability of a car-dependent regime. However, a shift in national policy direction towards environmental, social, and digital focus was observed in the landscape dynamics throughout the stakeholder interviews. Thai government has acknowledged the downward trend in heavy industries like automobiles, electronics, and petrochemicals. The challenge lies in facilitating a smooth transition without causing significant harm to many stakeholders.

Since promotion policies have proven effective in promoting the growth of the automotive industry, shifting towards digitalization in investment promotion can further stimulate the digital ecosystem and create favorable conditions for the emergence of new mobility concepts.

To promote investment in digital industry – including new mobility concepts like car sharing or MaaS, several strategies can be employed. This includes offering incentives to startups, investing in supportive infrastructure, ensuring favorable regulatory frameworks, fostering collaborations among stakeholders, and facilitating pilot projects and demonstrations. These promotion policies can encourage investment in digital ecosystem, support the development of integrated mobility solutions, and create an environment for the advancement of MaaS initiatives.

The government has implemented measures such as tax incentives, investment promotion privileges, and streamlined regulations to attract digital investments. They also provide a range of incentives for digital-related projects, including software development, e-commerce, data centers, and digital services. These incentives include tax holidays, exemptions on import duties, and permission for foreign ownership.

However, it is important to note that while the government has taken steps to promote the digital industry, focusing solely on the supply-side may not be sufficient to encourage digital technology investment. Digital technology heavily relies on technology adoption. Policies should also aim to facilitate the demand-side and attract investment accordingly. Demand-side promotion strategies are such as digital literacy

improvement, pricing incentives, or incentivizing through workplaces and educational institutions.

Furthermore, the government should consider promotion policies that enhance data availability and accessibility to support the growth of the digital industry. Ensuring integration with the public transport network is also crucial. By implementing these strategies, policymakers can drive the shift away from private car use towards new mobility services.

6.6.4 Prioritizing Public Transport Attractiveness

The results of this study have identified that mechanisms related to the attractiveness of private car have a strong influence on the stability of the automobility regime in the BMR. These mechanisms include the provision of a car ecosystem through a strong actor network, car-oriented transport policies and knowledge, and car attractiveness and development. Alongside the challenges faced by public transport in landscape development, breaking the car-oriented system becomes a difficult task.

Obviously, the ultimate intervention is to prioritize the public transport ecosystem over private cars. This study identifies the need to address the issues of a poor public transport system, limited coverage, limited interconnectivity, lack of integration, high expenses, and inadequate infrastructure for active modes. This will help create a more efficient, accessible, and sustainable public transport system that can compete with private car use and set the preconditions for new mobility concepts. However, new mobility services can complement and address some of the challenges faced by public transport as well. The relationship between them is reciprocal, with each influencing and benefiting from the other.

6.7 Empowering MaaS for the Momentum

The first part of this study has provided a better understanding of the elements within the current landscape and regimes, as well as their interactions that reinforce the preference for private vehicle use and ownership among travelers. Possible intervention measures and necessary policies have also been discussed. However, to achieve the aim of identifying how to maximize the window of

opportunity for a shift towards new mobility concepts, this section focuses on discussing the beliefs that influence end-users' decision-making to adopt new mobility solutions.

Among the sampled commuters in the BMR, key salient beliefs regarding commuters' willingness to use MaaS were identified. These beliefs collectively offer valuable insights into the factors that influence commuters' attitudes and their decision-making relating MaaS. These insights will be useful in developing and promoting the adoption of MaaS, as well as for the future study towards new mobility service adoption.

The most significant beliefs identified in this study encompass various aspects. The first set of beliefs revolves around travel planning and system reliability, which fall under the category of behavioral beliefs. Participants expressed the importance of efficient trip planning and dependable MaaS systems in shaping their intention to use the service. During the interviews, several noteworthy beliefs were also expressed that hold particular relevance within the context of Thailand. These beliefs encompass the significance of one-stop service (common ticketing), the need for accessible travel information, concerns regarding safety, and the importance of reliable online payment methods.

The second set of beliefs pertains to the influence of family and friends, representing normative beliefs. The opinions and support of their close social circle play a crucial role in shaping participants' attitudes towards MaaS adoption. Notably, this study revealed an interesting finding that some participants attach importance to the opinions of internet influencers or tech experts regarding the adoption of MaaS. These participants believe that the endorsement or recommendation from influential figures in the online sphere holds significance in shaping their perception and decision-making process when it comes to using MaaS.

The third set of beliefs focuses on usability and compatibility, representing control beliefs. Participants emphasized the importance of user-friendly interfaces and compatibility with existing behaviors, such as online payment and mobile phone usage, in influencing their perceived control over using MaaS. In contrast, the participants felt less in control due to internet connection issues. They had many concerns about unreliable internet and problems with mobile phones.

Furthermore, the study uncovered two additional beliefs that go beyond the traditional TPB model. These include financial considerations and comfort-zone preferences. Participants expressed concerns related to the financial aspects of using MaaS, such as pricing, discounts, and government subsidy. They also highlighted the importance of maintaining their comfort zone, which encompasses familiarity, trial periods, and factors related to personal transportation preferences. Overall, these beliefs contribute to a comprehensive understanding of the factors influencing individuals' intentions and behaviors regarding MaaS usage.

6.8 Suggested Roadmap for MaaS Development in the BMR

The development of MaaS has the potential to enhance the way people access transportation services and move in the BMR, Thailand. To ensure the successful and sustainable implementation of MaaS in the region, it is imperative to formulate a comprehensive roadmap for MaaS development.

To achieve a successful and sustainable implementation of MaaS, it is essential to integrate the findings of this study with the key success factors identified in Section 6.5 to propose a clear path to sustainable mobility in the BMR. This roadmap is constructed upon the interplay of push and pull strategies, aiming to change the current transportation system and bring about transformation to support it. By pinpointing areas in need of amendments, we can lay the foundation for a transformative shift towards sustainable transportation through the effective development of MaaS. Figure 55 summarizes the key content of the roadmap for the BMR.

6.8.1 Short-term Plan

In the short-term plan for MaaS development, several strategies can be implemented to push people away from the automobility regime and towards MaaS, and public transportation in general. First, initiatives like pedestrianizing city centers and implementing car-free streets for special events and tourist activities can create a more pedestrian-friendly environment, and encourage people to reduce their reliance on private cars. Occasionally opening up certain roadways to pedestrians and local vendors can support local businesses while simultaneously pushing people toward

public transit. Additionally, regulations can be introduced to reduce and regulate parking requirements for buildings located near mass-transit corridors, encouraging people to opt for public transportation instead.

To pull people towards MaaS and public transportation, incentives for early adopters can be offered, such as discounts, subsidies, or special incentives to encourage users to try MaaS services. Promoting seamless and secure digital payment options for MaaS transactions, such as mobile wallets or electronic payment cards, can also enhance the user experience and convenience given that many users may already be technologically inclined. Improving the quality of public transportation services, including active modes, buses, rails, vans, and boats, by supplying amenities like free Wi-Fi, charging facilities, and intermodal facilities, can make public transportation more appealing and user-friendly as well. Participants have reported the comfort factor these amenities would provide and their influence on decision-making on MaaS adoption. Furthermore, regulating and improving informal mobility services can ensure their safety, reliability, and integration into the overall transportation system.

Figure 55 Roadmap for MaaS Development in the BMR.

		Short-term (2023-2030)	Midterm (2031-2040)	Long-term (2041-2050)
Rail Mass Transit		M-MAP: 14 lines, 553 KM)	M-MAP2: 18 lines, 648 KM (tentative)	
Pressuring Landscape		Economic slowdown, Digital promotion and technology advancements, Environmental issue, Shift in policy direction, Young generations		International commitment (Carbon Neutrality 2050 & Net Zero 2065)
Strategic Goal		Preparation	Implementation	Popularization
Policy toolbox	Push (people away from automobility regime)	<ul style="list-style-type: none"> • Tourist and special event (pedestrianize city center, walking streets – pilot car free zone) • Reduce and regulate parking requirements for buildings near mass-transit corridors 	<ul style="list-style-type: none"> • Parking restrictions, car-free areas (strict enforcement) • Reduce access of shopping/business areas to certain types of vehicles (EVs) • Eliminating fuel subsidies → Sustainable Mobility Fund 	<ul style="list-style-type: none"> • Create car free days/weekends/week • Restriction measures on private car use: road pricing, parking pricing, pay-as-you-drive pricing → Sustainable Mobility Fund
	Pull (people towards MaaS and Public Transport)	<ul style="list-style-type: none"> • Incentives for early adopters: discounts, subsidies, or special incentives to encourage users to try MaaS services • Promote seamless and secure digital payment for MaaS transactions (mobile wallets, electronic payment cards) • PT quality improvement (active modes, bus, rail, van, boat service) – free Wi-Fi, charging facility, intermodal facility • Regulate and improve informal mobility services 	<ul style="list-style-type: none"> • Tax incentives or rebates for users who shift from private car ownership to using MaaS services • Fare integration and common ticketing, ensuring seamless and cost-effective travel for users. • PT coverage expansion and missing link • Integrate mobility services into MaaS ecosystem. 	<ul style="list-style-type: none"> • Strong and continuous financial support to users using Sustainable Mobility Fund • Extensive marketing campaigns to raise awareness about the benefits of MaaS • Road space reallocation based on a sustainable transport hierarchy (sidewalks, bike and bus lanes) • Integrate MaaS with public transport
	Supply	<ul style="list-style-type: none"> • Partnerships (stakeholder engagement – public and private; national and local government) • Funding sources for MaaS platforms that integrate various modes of transport, providing real-time information, ticketing, and payment options. • Encourage transport operators to share their data with MaaS platforms to enable comprehensive information on routes, schedules, and availability. 	<ul style="list-style-type: none"> • Encourage ongoing engagement and cooperation to address challenges, share resources • Tax incentive for investment on Mobility services • Data exchange center or data standard to facilitate data sharing 	<ul style="list-style-type: none"> • Building a "product champion" to advance MaaS and integrate to public transport • Revenue sharing among various stakeholders, including transport operators, MaaS platform providers, and public authorities • Data integration for scalability and interoperability across the regions
	Demand	Pilot project, Sandbox (Test the effectiveness, assess user feedback, and identify areas for improvement)	Designated area, Smart city area (Soft launch in specific areas, testing in a real-world environment)	General public

On the supply side, fostering partnerships between public and private stakeholders, including national and local governments, is crucial. These partnerships can facilitate collaboration, knowledge sharing, and coordinated efforts in developing and operating MaaS platforms. Identifying funding sources for MaaS platforms to integrate various modes of transport and provide real-time information, ticketing, and payment options is essential to ensure their financial viability and sustainability. Encouraging transport operators to share their data with MaaS platforms is also important, as it enables the provision of comprehensive information on routes, schedules, and availability, enhancing the overall user experience.

To stimulate demand and assess the effectiveness of MaaS services, pilot projects and sandbox initiatives can be implemented. These allow for testing in a controlled environment, gathering user feedback, and identifying areas for

improvement before scaling up to the real-world environment. Under pilot projects, some regulations and legislative difficulties can also be exempted. This approach helps refine and tailor MaaS services to meet the specific needs and user preferences, increasing acceptance and adoption.

By implementing these strategies as part of the short-term plan, the goal is to create a supportive environment for MaaS development, promoting its adoption among early and targeted users, enhancing the quality of public transportation services, and establishing the necessary partnerships and sources of funding for a successful and sustainable MaaS ecosystem.

6.8.2 Midterm Plan

For the midterm plan, similar strategies can be escalated and leveled up to a soft launch for MaaS in designated areas, or under smart city projects, to stimulate demand and test the effectiveness of MaaS in a real-world environment.

To further push people away from the automobility regime, strong enforcement of parking restrictions and the establishment of permanent car-free areas can be implemented. Smaller streets in direct vicinity of BTS and MRT lines, or direct access to informal transportation, can be prioritized in the early stages. Furthermore, limiting access to only certain types of vehicles, such as electric vehicles, to shopping and business areas can reduce conventional private car use as well. Additionally, eliminating fuel subsidies and reallocating fuel tax to the establishment of a Sustainable Mobility Fund could become an essential tool to promote MaaS adoption.

To pull people towards MaaS and public transportation, tax incentives or rebates can be offered to individuals who transition from private car ownership to using MaaS services. Fare integration and common ticketing systems can ensure seamless and cost-effective travel for users, while expanding the coverage of public transportation networks and addressing missing links. Incorporating various mobility services into the MaaS ecosystem will also further enhance its appeal.

In terms of supply, ongoing engagement and cooperation among stakeholders should be encouraged to address challenges and the sharing of resources. Tax incentives can also promote investment in mobility services, nurturing their development and integration into the MaaS framework. Additionally, the

establishment of a data exchange center, or at least the adherence to data standards, can facilitate data sharing and integration among different stakeholders.

By implementing escalated strategies, MaaS development can begin to make significant progress in shifting transportation behaviors towards more sustainable and efficient mobility solutions.

6.8.3 Long-term Plan

For a long-term plan, the strategic goal should be about the popularization of MaaS. More aggressive measures will be important and society will be better prepared by the short-term and midterm preparations. Besides, the landscape developments that have been pressuring the automobility regime would be strongly grounded.

The introduction of car-free days, weekends, or weeks can be implemented to promote alternative modes of transportation and reduce reliance on private cars. Bangkok has previously asked residents to work from home during the international conventions to alleviate traffic volume. The idea can become a reality if the short-term and mid-term plans regarding private car volume management show success. Restriction measures on private car use such as road pricing, parking pricing, and pay-as-you-drive pricing can now be enforced, with the generated revenue directed towards the aforementioned Sustainable Mobility Fund, further discouraging private car use. By that time the BMR's rail mass transit network will become more extensive, giving commuters choices in their travels.

To pull people towards MaaS and public transportation, strong and continuous financial support, through discounts and special offers, can be provided to users through the Sustainable Mobility Fund, incentivizing them to utilize MaaS services. Extensive marketing campaigns can be conducted to raise awareness about the benefits of MaaS and further encourage its adoption among the general public. Road space reallocation based on a sustainable transport hierarchy can prioritize the allocation of space for sidewalks, bike lanes, and bus lanes, promoting active and public transport modes. Lastly, integrating MaaS with all public transport systems can enhance the connectivity and convenience of multimodal travel.

As far as supply, building a "product champion" who advocates for MaaS, and facilitates its integration with public transport, can drive its advancement and widespread adoption. Revenue sharing mechanisms among various stakeholders, including transport operators, MaaS platform providers, and public authorities, can ensure a fair distribution of resources and facilitate collaboration. Data integration efforts can be explored to enable interconnectivity of MaaS services across different regions.

To stimulate demand among the general public, comprehensive awareness campaigns can be launched to showcase the benefits of MaaS, emphasizing its convenience, cost-effectiveness, and positive impacts on congestion reduction. By fully implementing strategies as such, the popularization of MaaS as a sustainable transportation solution can become a reality.

6.9 Implications for Future Study on MaaS Adoption

The salient beliefs identified in this study serve as valuable insights for the development of indicators for future quantitative studies on MaaS adoption. These beliefs provide a foundation for constructing indicators to measure three latent variables – behavioral, normative, and control beliefs, of the TBP model. They can also be applied in forming other measurable variables that capture the key factors influencing individuals' attitudes, intentions, and behaviors towards MaaS.

Given the empirical evidence from the study, it seems rational to consider more constructs of MaaS adoption into an extended TPB model to investigate the behavioral intention of commuters. The first potential additional construct is financial incentive since most participants viewed it as important to their decision making process. Financial incentive has also been proven by several studies to significantly exert a positive effect on technology adoption such as renewable energy technology, block chain technology, electric vehicles, and most importantly, commuters' mode choice i.e. driving, carpooling, public transport, and active modes (walking, biking).

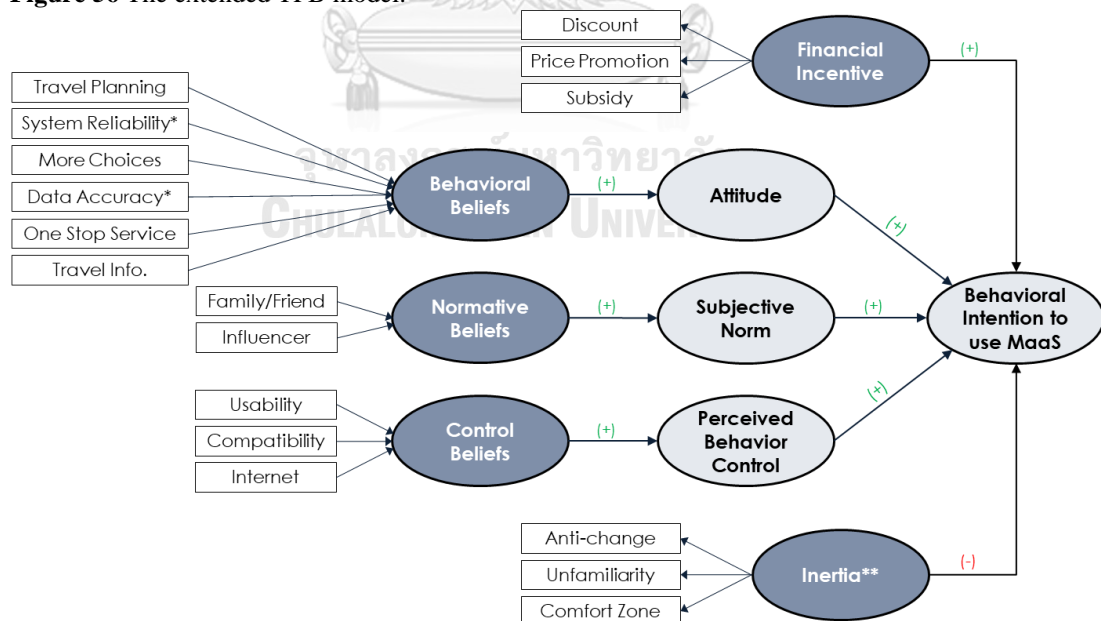
Another possible additional construct is inertia – an individual's attachment to one's current situation. Inertia is a psychological factor, which is defined as the tendency to maintain the status-quo (or default option) unless compelled by a psychological motive (Gal, 2006). Despite a lot of perceived benefits from using

MaaS, most participants feel that they still wouldn't use it just because they wouldn't want to change the way they live their lives, unless they were forced to. This complies with the empirical evidence from the COVID-19 pandemic where people have been forcefully digitalized due to situational restrictions, becoming more familiar with online technologies in the process – shopping, meeting, working, etc.

The recommended extended TPB modeling framework for future studies is visualized in Figure 56, which includes the subsequent hypothesized associations between the constructs. Additionally, the possible indicators derived from the findings of this study are presented. While the other constructs are measured using reflective indicators, the belief constructs could be measured using formative indicators to examine causal relationships and determine the relative importance of each belief.

By incorporating these salient beliefs into quantitative research designs, researchers can gain a deeper understanding of the factors that drive or hinder MaaS adoption and assess their impact more systematically. This can contribute to the development of robust measurement tools and the formulation of effective strategies to promote MaaS adoption in the future.

Figure 56 The extended TPB model.



6.10 Implications for Early Service Design

Based on the current study, the Bangkok Metropolitan Region (BMR) is still in the early stages of developing new mobility services, especially in reducing private car dependency for sustainability reasons. However, there are opportunities for early service design in two key aspects.

Firstly, there is an opportunity to develop a mobility service platform that serves as a centralized platform for accessing all available transportation information. Currently, there is a lack of integration in real-time traffic and travel information. Providing real-time data to assist riders will enhance the convenience of public transport and enable the collection of user behavior data. This initiative will also contribute to increasing digital literacy among users. Therefore, implementing new mobility service in the BMR could begin with simpler solutions aimed at addressing the specific pain points of local commuters, rather than adopting the entire concept of new mobility solutions, which may require more time and efforts to implement.

Secondly, new mobility concepts have the potential to serve as feeders for public transport. They can expand the reach of public transportation by providing connectivity to destinations that may not be easily accessible by mass transit. Users can utilize these new mobility services to bridge the gap and efficiently reach their desired destinations. This can significantly improve overall accessibility and convenience of transportation options, particularly in areas with limited or insufficient public transportation infrastructure.

Additionally, these new mobility concepts can also serve as last and first-mile solutions for daily commuting. By seamlessly integrating with mass transit networks, they create a comprehensive and integrated mobility system. This helps address the current challenges faced by public transport and enhances the overall commuting experience.

However, to establish MaaS as a feeder of public transport, several strategies need to be adopted. There is a need for a strong collaboration and partnership between public transport authorities, private transportation providers, and technology companies to develop the necessary infrastructure and digital platforms. This can help ensure smooth integration and interoperability between different modes of transportation, which has been one of the pain points of current system.

Nevertheless, given the current high cost of public transport, the early stage of feeder services should be free of charge and implemented in a sandbox area through a public-private partnership. This arrangement allows for mutual collaboration and exchange in a pilot study. The government, with its authority, can help address regulatory and legal challenges, while the private sector can provide financial and technological support. Both parties can gather valuable data and results to further develop public policies and business models, respectively.

Overall, developing and promoting new mobility concepts as a feeder of public transport involves creating a seamless and user-centric experience, fostering collaboration among stakeholders, and providing incentives to encourage its adoption. By integrating MaaS with public transport systems, commuters can enjoy the convenience of door-to-door journeys while contributing to reduced congestion and environmental benefits.

By focusing on these areas of opportunity, the development of new mobility services can contribute to reducing private car dependence, improving the efficiency of public transport, and promoting sustainable transportation options in the BMR.

CHAPTER VII CONCLUSION

7.1 Conclusion

Mobility as a Service (MaaS) represents a promising solution for transforming transportation and achieving sustainable mobility. However, there are still several unanswered questions about its potential to replace private cars and overcome the challenges posed by existing car-dependent socio-technical regimes. This study aimed to bridge the knowledge gap by examining the current automobility regime in the Bangkok Metropolitan Region (BMR), Thailand, which provides a unique and valuable context for understanding the dynamics of a well-established car-dominated transportation system. By focusing on public transportation-centric MaaS, the study aimed to promote sustainable mobility and facilitate a shift away from private car usage in the region.

The research objectives were two-fold: to analyze the current automobility regime's impacts on the potential for MaaS adoption and to understand the factors influencing commuters' decisions about using MaaS, particularly the salient beliefs guiding their intentions. By employing in-depth interviews and thematic analysis with stakeholders and commuters, respectively, the study revealed the landscape developments and mechanisms influencing the BMR's automobility regime. Moreover, it identified factors that impact commuters' decision about using MaaS, showing the salient beliefs that determine the intention to use MaaS.

This study highlights the establishment of automobility system, which is deeply embedded in society and dominates all aspects of the socio-technical system. The study identifies landscape developments that reinforce the existing car-oriented transport system, including challenges in public transport, economic factors, social concerns, and political issues. The automobility regime is sustained through various mechanisms, such as a car ecosystem, automotive industry promotion, and cultural values. These mechanisms perpetuate the dominance of private car usage. Breaking this system requires addressing the landscapes and mechanisms that support it.

However, changes in the landscape, driven by environmental, social, cultural, technological, and economic slowdown, have the potential to put pressure on

the existing automobility regime. By leveraging the changing landscapes and destabilizing mechanisms of the existing system, MaaS can gain traction and contribute to the shift towards a more sustainable and efficient transportation future in the BMR.

Therefore, the study also further analyzed the dynamics and mechanisms that can be leveraged to discourage private vehicle use and pave the way for the adoption of new mobility concepts. Possible interventions and strategies to facilitate this shift are also discussed in detail.

To ensure its successful implementation, a comprehensive roadmap for MaaS development is recommended. This roadmap, based on the interplay of push and pull strategies. In the short-term plan, initiatives such as pedestrianizing city centers and incentivizing early adopters will push people away from the automobility regime, while partnerships and data sharing on the supply side will support MaaS development. The midterm plan escalates these strategies and introduces a soft launch of MaaS in designated areas, while the long-term plan focuses on popularizing MaaS through car-free initiatives and extensive marketing campaigns. By addressing challenges and seizing opportunities, this roadmap paves the way for a transformative shift towards sustainable transportation in the BMR, benefiting both residents and visitors.

Additionally, this study explored the main factors underlying intentions to adopt a new mobility concept. Key beliefs underlying commuters' willingness to use Mobility as a Service (MaaS) were identified, including travel planning and system reliability (behavioral belief), influence from family and friends (normative belief), and usability and compatibility (control belief). Furthermore, two additional beliefs emerged, pertaining to financial considerations and comfort-zone preferences, which extend beyond the Theory of Planned Behavior (TPB) model.

In conclusion, there is an opportunity to drive a shift towards new mobility concepts and steer the current automobility regime in the Bangkok Metropolitan Region (BMR) towards a more sustainable transportation system. However, achieving this transition will be challenging and require significant policy interventions. Early implementation of new mobility concepts should focus on simple functions or be

tested in a controlled environment (sandbox area) to achieve quick wins and promote long-term adoption.

7.2 Research Contributions

This study is the first to apply the Multi-Level Perspective (MLP) framework in analyzing the car-dependent system and investigating the potential of new mobility concepts in Thailand. It is also one of the few studies that utilize the Theory of Planned Behavior (TPB) to understand user perspectives on Mobility as a Service (MaaS). The research highlights the mechanisms that stabilize or destabilize the current automobility regime and identifies the factors influencing the adoption of new mobility concepts as a niche innovation within this transition. These factors play a crucial role in shaping the dynamics of the transition and determining the success of new mobility concepts like MaaS in the future.

Furthermore, the study fills a knowledge gap by examining the current automobility regime and the emergence of MaaS, providing insights into strategies for successful implementation. It contributes to both transport research and socio-technical transition studies, offering a holistic understanding of automobility and its interaction with new mobility concepts for sustainable mobility. The findings have implications beyond Western countries, providing valuable insights for Southeast Asia, where knowledge on opportunity for a shift toward new mobility concepts is limited. Additionally, the study explores user beliefs and motivational factors influencing their intention to adopt MaaS, enhancing our understanding of user behavior and informing efforts to promote sustainable mobility.

This study also makes several significant theoretical contributions. Firstly, it enriches the MLP framework by providing a deeper understanding of regime dynamics and landscape developments in the specific socio-technical context of the BMR. This expansion of the MLP's application to a developing and Southeast Asian setting offers valuable insights into the challenges and opportunities for sustainable mobility transitions in this region, bridging the gap between the MLP framework and contexts of developing countries.

Secondly, regarding the TPB, the study plays a crucial role in identifying specific beliefs that strongly influence individuals' intentions toward adopting MaaS in the BMR. The research refines the belief-based components of the TPB model for

MaaS adoption, and these insights can be extended to other cities with similar characteristics. Additionally, the findings open up new avenues by uncovering supplementary factors beyond the core TPB constructs that significantly impact individuals' intentions to engage in MaaS adoption.

The integration of the MLP and the TPB frameworks offers a comprehensive understanding of the complex interplay between the structural regime and individual behaviors. This sheds light on the potential for transformative changes in transportation systems, particularly in promoting MaaS adoption. The theoretical contributions of this study can guide policymakers in implementing effective interventions to drive the shift toward sustainable mobility solutions.

In conclusion, by comprehensively analyzing the current automobility regime and identifying opportunities for MaaS adoption, this study contributes valuable insights that can be applied not only to other Southeast Asian cities facing similar challenges but also to the broader global context. By strategically positioning MaaS and leveraging the changing transportation landscape, the BMR and other regions can pave the way for a more sustainable era of mobility, benefiting both residents and visitors alike. As MaaS continues to evolve, exploring user beliefs and attitudes becomes crucial for creating an effective and diverse approach to tackle transportation challenges on a global scale.

7.3 Limitations and Future Study

The current study has certain limitations. Firstly, it primarily focused on analyzing the dominant automobility regime in the transport system to identify its (in)stability and opportunity for new mobility concepts. However, for a comprehensive understanding of the transition, future studies should encompass all transportation systems, not just the stakeholders and elements related to automobility, in order to capture the dynamics of the entire transport system.

Another limitation of the study is the small sampling size used for the adoption study, which may raise concerns about the representativeness of the findings. However, it should be noted that theoretical saturation was reached during the interviews, indicating that no new beliefs were mentioned by participants. Additionally, the data collection procedure involved a sample from the target population by comparing

socio-demographic profiles. To further investigate the generalizability of these results, future studies can apply the formative beliefs identified in this study in a quantitative research design.



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