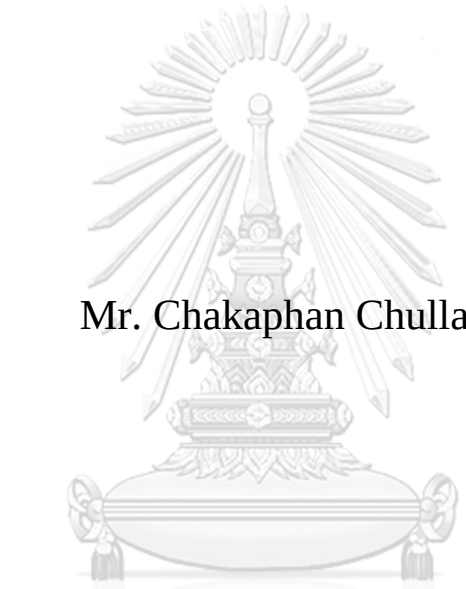
PARKING PROBLEMS AND POLICIES IN BANGKOK: ISSUES, CAUSES, AND IMPLICATIONS

Mr. Chakaphan Chullabodhi



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ปัญหาและนโยบายด้านการจอดรถในกรุงเทพมหานคร: ประเด็นสำคัญ สาเหตุ และนัยเชิงนโยบาย

นายจักรพันธ์ จุลละโพธิ

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรดุษฎีบัณฑิต
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Thesis Title	PARKING PROBLEMS AND POLICIES IN BANGKOK: ISSUES, CAUSES, AND IMPLICATIONS
By	Mr. Chakaphan Chullabodhi
Field of Study	Civil Engineering
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นโยบายที่จอดรถยนต์เป็นกลไกสำคัญของการส่งเสริมให้เกิดการสัญจรอย่างยั่งยืนภายในเมือง รวมถึงช่วยสร้างความน่าอยู่ของเมืองโดยการสนับสนุนให้ผู้คนเดินทางด้วยรูปแบบการเดินทางที่มีความที่ยั่งยืน แต่ทว่ากรุงเทพมหานครในปัจจุบันไม่มีนโยบายที่จอดรถยนต์ที่เป็นรูปธรรม ที่มีอยู่เป็นเพียงกฎระเบียบและข้อกำหนดที่มีวัตถุประสงค์เพียงเพื่อลดความแออัดของการจราจรเท่านั้นแต่กลับขาดวัตถุประสงค์ของนโยบายที่ชัดเจน การศึกษานี้จึงมีวัตถุประสงค์เพื่อศึกษาปัญหาและผลของนโยบายที่จอดรถยนต์บนถนนและในอาคารในปัจจุบัน ศึกษาหาต้นเหตุของปัญหาด้านที่จอดรถยนต์ที่เกิดขึ้น และกำหนดนโยบายที่จอดรถยนต์ที่สนับสนุนการสัญจรอย่างยั่งยืนในเมือง ผู้วิจัยใช้กรอบแนวคิดที่ได้ดัดแปลงจากกรอบการวิเคราะห์ภูเขาน้ำแข็งและการวิเคราะห์เศรษฐศาสตร์การเมืองในการศึกษาเพื่อตอบวัตถุประสงค์ของงานวิจัย โดยข้อมูลที่ใช้ในการวิจัยถูกเก็บรวบรวมโดยใช้เทคนิคที่หลากหลาย ได้แก่ การสำรวจภาคสนาม การสำรวจป้ายทะเบียนรถยนต์ การวิจัยเอกสาร และการสัมภาษณ์เชิงลึกแบบกึ่งโครงสร้าง จากหลักฐานเชิงประจักษ์ในการศึกษานี้พบว่านโยบายที่จอดรถยนต์บนถนนและในอาคารที่มีอยู่ได้สร้างปัญหาในหลากหลายมิติซึ่งส่งผลกระทบในเชิงลบต่อสังคม นอกจากนี้ผลการวิจัยยังพบว่าปัจจัยอันได้แก่ การวางผังเมืองและการขนส่ง กรอบการเมือง-เศรษฐกิจ โครงสร้างองค์กรและสถาบัน ข้อกฎหมาย นโยบายและกลยุทธ์ด้านที่จอดรถยนต์ การบริหารจัดการ และแบบแผนความคิดอ่านของผู้มีส่วนได้ส่วนเสียต่าง ๆ ล้วนมีข้อบกพร่องและเป็นต้นเหตุของปัญหาที่จอดรถที่ค้นพบในงานวิจัยนี้ สุดท้ายนี้จากข้อมูลและผลการวิจัยต่าง ๆ ผู้วิจัยได้กำหนดข้อเสนอแนะเชิงนโยบายจำนวน 6 ข้อเสนอสำหรับผู้กำหนดนโยบายและผู้เชี่ยวชาญด้านการขนส่งเพื่อใช้เป็นข้อมูลและแนวทางในการสนับสนุนให้เกิดการปฏิรูปนโยบายด้านที่จอดรถยนต์ทั้งในกรงเทพฯ และประเทศที่กำลังพัฒนาอื่นต่อไป

สาขาวิชา วิศวกรรมโยธา ลายมือชื่อนิสิต

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ปีการศึกษา 2564 ลายมือชื่อ อ.ที่ปรึกษาหลัก

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5971403121 : MAJOR CIVIL ENGINEERING
KEYWORD: parking policy, Minimum parking requirements, on-street parking, illegal parking, sustainable mobility, developing country

Chakaphan Chullabodhi : PARKING PROBLEMS AND POLICIES IN BANGKOK: ISSUES, CAUSES, AND IMPLICATIONS. Advisor: Assoc. Prof. SAKSITH CHALERMPONG, Ph.D.

Parking policies are integral to promoting sustainable urban mobility and enhancing a city's livability as they can shift people's movement toward more sustainable modes. However, Bangkok still lacks a concrete parking policy. The existing one consists primarily of regulations and standards that help reduce traffic congestion, albeit without well-defined policy objectives. This study examines the current problems of on-street and off-street parking policies, investigates the root causes of parking issues, and establishes a parking policy that supports the city's development of sustainable mobility. We used a modified conceptual framework comprising the Iceberg Model of analysis and the Political Economics Analysis framework. The data were collected through various techniques, including a field survey, a license plate survey, documentary research, and semi-structured in-depth interviews. The finding of this study demonstrates, through empirical evidence, that the existing on-street and off-street parking policy has created a number of challenges that have a negative impact on society. The results also reveal that several factors, including urban and transportation planning, political-economic, institutional, and legal frameworks, policy strategy and planning, operational management, and the mental model of stakeholders, are the root causes of these parking problems. This study proposes parking policy recommendations and implications for policymakers and transport planners to support parking reform in Bangkok and other developing countries.

Field of Study:	Civil Engineering	Student's Signature .....
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Chakaphan Chullabodhi

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CHAPTER 1

INTRODUCTION

1.1 Background and Problem Statement

Sustainable development has become a worldwide issue since 2015 when 193 member states of the United Nations agreed on the Sustainable Development Goals (SDGs) to establish a sustainable future for the world across three dimensions – economic, social, and (Major et al., 2018) environmental. Transportation and mobility are among the most major economic, social, and environmental challenges we are facing today (Council of the European Union, 2006). In 2020, the global transportation and mobility industry emitted over 7.3 billion metric tons of carbon dioxide (CO_2) (Tiseo, 2021). Simultaneously, urban passenger and freight movements have negative effects by contributing to congestion, pollution, and traffic safety problems (United Nations, 2015).

Traditional transport planning has focused on providing space for the emergence of automobiles. To create sustainable mobility, however, transport planning must support public transportation, walking, cycling, electric vehicles, car sharing, and rail transport while restricting car use (WWF, 2021). Over the past decade, the rapid growth in automobile use has made parking an essential component of modern urban planning as the primary element of the travel demand management approach to reduce demand for cars in urban areas. Nevertheless, according to CIVITAS (2022), the parking policy remains one of the least-developed policies relating to the promotion of sustainable urban mobility in cities.

The parking research spearheaded by Shoup (2006) advocated parking policy reforms, such as pricing limited parking spaces and elimination of minimum parking requirements. In recent years, a growing number of cities have either completely eliminated or lowered parking requirements in at least one area of the city (Strong Towns, 2022). The calls for those parking reforms are based on empirical evidence, mostly from cities in developed countries. Although empirical studies in developing countries are minimal (Barter, 2011; Rye, 2010; Thanh, 2017), those conducted in Thailand are also included (Augnistasat, 2021; Chalermpong & Ratanawaraha, 2019).

Bangkok lacks a concrete parking policy. The existing one consists primarily of parking regulations and standards that aim to reduce traffic congestion. Nevertheless, it has no well-defined and definitive policy goals. The parking policies in Thailand were first introduced when the government issued the ministerial order No.7 B.E.2517 (1974) under the Building Construction Control Act, B.E. 2479 (1936), which specified a set of minimum parking requirements for several types of buildings. This legislation was the result of the increasing number of cars on roads and the problem of roads being used as car parks, not least in Bangkok. Consequently, parking regulations were revised. The BMA, for instance, passed the Ordinance on Building Control B.E. 2544 (2001) in 2001, including a section on minimum parking standards for 18 types of buildings. However, these parking policies and

regulations are at odds with the government's current plan to encourage the development of mass rail transit systems and transit-oriented development (TOD), since the minimum parking requirements may influence developers' decision to include a large number of parking spaces at buildings that surround mass transit stations (Cervero et al., 2010). This can discourage individuals from switching to public transit as parking spaces at every building make it easier for them to find a parking spot. As a consequence, it inevitably leads to traffic congestion and urban air pollution (Manville & Pinski, 2021).

Therefore, governments and key agencies require empirical evidence outlining the reality, the problem, and the criteria for implementing parking policies that satisfy demand of people and all parties in society equitably in order to reform the parking policies and resolve other related issues in Bangkok. Consequently, based on the problem statement, this study is a response to supporting parking reform by analyzing the Bangkok parking situation. The following are three primary research questions: 1) What is the current parking situation? Where, when, and what are parking issues? 2) Why do parking issues arise and persist? and 3) How should parking policies be established in Bangkok to support sustainable mobility? In addition, we investigate the structures and mental models of stakeholders by analyzing how their institutional structures and mental models contribute to these challenges.

1.2 Research Objectives

To answer the research questions, this research aims to achieve the following three primary and two sub-objectives:

1) To examine the problems of current on-street and off-street parking policies and regulations. *(Chapter 4 and 5)*
    a) To examine the characteristics and efficiency of on-street parking facilities *(Chapter 4)*
    b) To examine the effect of minimum parking requirements on parking provision in the development of large buildings *(Chapter 5)*
2) To examine the contexts, underlying structures, and mental models that may cause parking problems. *(Chapter 4 and 5)*
3) To establish a parking policy that supports the city's development of sustainable mobility *(Chapter 6)*

1.3 Scope and Limitations

This study's scope for on-street parking is limited to the city center of Bangkok, focusing on the streets where the BMA Ordinance designates on-street parking as a paid parking zone. Motorcycle usage that may park in on-street parking areas is excluded from this study.

The study focuses on off-street parking in large building developments, including condominiums, hotels, offices, and mixed-use buildings. The supply and demand of park-and-ride facilities are not examined in this study.

1.4 Outline of Dissertation

This dissertation consists of the following seven chapters and appendices:

Chapter 1 Introduction: as described in this chapter.

Chapter 2 Literature review: This chapter gives theories, research, and case studies relevant to on-street and off-street parking policies in developed and developing countries. The relationship between parking policy and sustainable mobility is presented. In addition, the background and research on parking in Bangkok and the research gap are summarized.

Chapter 3 Research Methodology: This chapter describes the conceptual framework and research methods used to answer the research questions and achieve the research objectives.

Chapter 4 On-Street Parking Situation in Bangkok: This chapter discusses the findings of on-street parking issues and their underlying causes.

Chapter 5 Off-Street Parking Situation in Bangkok: This chapter discusses the findings of off-street parking issues and their underlying causes.

Chapter 6 Parking Policies for sustainable mobility in Developing Cities: Case Study of Bangkok: This chapter outlines the recommended parking policies and actions to address Bangkok's parking issues and promote sustainable mobility.

Chapter 7 Conclusions and Recommendations: This chapter summarizes the findings, significant contributions, and limitations of this research. The recommendations for future research are also provided.

1.5 Glossary

Term	Definition
Sustainable Mobility (SM)	Sustainable mobility refers to the provision of infrastructures, services, technologies, and information to enable access to goods and services, as well as participation in activities in a manner that, like all other forms of "sustainability," allows for the continuation of such access and participation across future generations (Budnitz, 2019). The sustainable mobility approach requires actions to reduce the need to travel, to encourage modal shift, to reduce trip lengths, and to encourage greater efficiency in the transport system (Banister, 2008).

Term	Definition
Minimum parking requirements (MPRs)	The laws that require new buildings to include a specific number of off-street parking spaces.
Actual parking spaces	The actual number of parking spaces provided in a building.
Required parking spaces	The number of parking spaces required by the city's ordinance.
Excess parking spaces	The number of parking spaces in excess of the required number.
Excess parking ratio	The number of excess parking spaces divided by the required parking spaces.
Central Business District (CBD)	The city's central, most populated, and most expensive district. It is the area of the city where most people work and shop, indicating that it is the city's financial center.
Parking warden	A parking fee collector hired by the Department of Finance, Bangkok Metropolitan Authority.
Paid on-street parking	Parking on the street authorized by the BMA Ordinance on Parking Management B.E. 2564, for which drivers must pay a parking fee.
Unauthorized parking reservation	Obstacles such as chairs, tires, wooden barricades, or traffic cones placed in on-street parking spaces, including vendor stalls, utility carts, and broken cars.
Double parking	Vehicles parked on the road parallel to legal curbside parking.
Illegal parking	On-street parking in no-parking zones or with no-parking signs, or parking at the time when it is prohibited.

CHAPTER 2

LITERATURE REVIEW

This chapter focuses on laying the foundations by covering theories, research, and case studies relevant to parking policy in both on-street and off-street contexts in developed and developing countries. Thereafter, the background of on-street and off-street parking in Bangkok and Thailand, as well as the research conducted in Thailand, are provided. Finally, the gaps in the existing literature are addressed.

2.1 Parking Policy and Sustainable Mobility

A *parking policy* refers to parking programs that involve activities and management of existing resources to achieve specific urban objectives, such as reduction of congestion, maximization of utilization, and revenue generation (McShane & Meyer, 1982). Several studies confirm that parking policies influence travel behaviors and trip-making decisions (Biswas et al., 2017; Manville & Pinski, 2021; Pitsiava-Latinopoulou et al., 2012; Shoup, 2021). This can promote sustainable urban mobility and improve the city's livability by changing people's mobility towards a more sustainable one (Arnott & Rowse, 2013; Gallo & Marinelli, 2020; Gragera & Albalate, 2016; Lower & Szumilas, 2021). Moreover, parking policies are among the most politically acceptable and effective policy instruments for achieving various transport management and urban development goals (Eva Ayaragarnchanakul & Felix Creutzig, 2022; Jakob & Menendez, 2021; Kodransky & Hermann, 2011).

Parking policies apply to both off-street and on-street parking. On-street parking space is one of the most often observed types of parking, including both paid and unpaid parking along the roadside. Off-street parking is defined as a parking area, which is not on a public street, and is related to a building or land use (Rye, 2010; Weinberger et al., 2010). A traditional approach to parking policies is to view parking as a form of infrastructure that ensures enough parking for every car. Free curbside parking and the MPRs are instrumental in this effort (Barter, 2010). A paradigm shift in parking policies is happening in many cities across the world to promote sustainability (Litman, 2021; Rye, 2010). However, planners and city leaders have increasingly recognized that free parking and the MPRs harm the urban quality of life and housing affordability (Rye, 2010; Shoup, 2018). For example, unpaid or underpriced curbside parking encourages cruising for parking by drivers, unnecessarily contributing to local congestion, car emissions, air pollution, and climate change (Alemi et al., 2018; Shoup, 2006). Shoup (2021) argued that underpriced curbside parking leads to off-street parking demand, which urges the city to build more parking spaces. As a result, demand for private vehicle use has become common.

Recent parking policies aim to effectively manage parking demand through several types of interventions, such as control on the number of parking spaces, parking costs, and parking time limitations (Lower & Szumilas, 2021; Pitsiava-Latinopoulou et al., 2012; Shoup,

2006). For instance, in recent years, a growing number of cities have completely eliminated such requirements in at least one area of the city, while others have lowered or removed minimum parking requirements for certain uses (Strong Towns, 2022). To decrease double parking and cruising for parking, San Francisco has implemented a large-scale managed a parking charge initiative to maintain 60% to 80% of parking meter occupancy (Millard-Ball et al., 2014). In Copenhagen, there has been an implementation of flexible on-street parking whereby parking spaces are allocated for bicycles during specific periods of time in order to maximize the use of parking spaces and support sustainable mobility options (Mingardo et al., 2015). Furthermore, parking pricing strategies are considered a viable Travel Demand Management tool that can encourage modal shift and reduce urban congestion (Litman, 2021; Mingardo et al., 2015), arguing that parking pricing is a more technically feasible and politically palatable alternative to congestion pricing (E. Ayaragarnchanakul & F. Creutzig, 2022; Gragera & Albalate, 2016; Jakob & Menendez, 2021).

In the following section, since several cities have adopted parking policies to support sustainable mobility, we discuss how these policies help improve the city and what developed cities and developing cities have experienced in implementing parking policies.

2.1.1 On-street parking policy and management

Well-managed curbside parking can improve the efficiency of using limited urban spaces, increase pedestrians' safety by lowering vehicle speed, support local businesses, and reduce driving (Marshall, 2014). In contrast, poor on-street parking management may encourage illegal street parking, which impedes traffic. Illegal parking in areas designated for other uses can also cause traffic congestion and accidents (Cullinane & Polak, 1992). Unauthorized parking attendants are most prevalent in areas with poor on-street parking management, leading to criminal activities (Barter, 2011; Hoye, 2015). In locations with poor parking management, parking-related conflicts occasionally escalate into physical violence (Bajçinovci & Bajçinovci, 2019; Sustainable Urban Transport Project, 2017).

Researchers on parking have long advocated on-street parking pricing and management as a policy tool that can enhance sustainable urban mobility and economic vitality (Arnott & Rowse, 2013; Button, 2006; Gragera & Albalate, 2016; Khordagui, 2019; Mingardo et al., 2022). For instance, dynamic parking pricing is adopted in a program called SFpark in San Francisco. Pricing changes dynamically according to location and time, aiming to achieve an occupancy between 60% and 80% (Shoup, 2005). It has been claimed to reduce traffic congestion and pollution, both of which are caused by cruising for parking (Alemi et al., 2018; Shoup, 2013). The parking price scheme has been proven again both in developed and in developing cities, such as Stockholm and Nanning. It enhances the convenience of finding a vacant parking space by decreasing the average maximum occupancy rate and the time spent on cruising for parking in the city's urban center while discouraging demand for long-term parking (Cats et al., 2016; Wang et al., 2020). An effective on-street parking management can also provide local governments with an option to mandate real estate developers to supply costly off-street parking by adopting a minimum of parking regulations, thereby enhancing affordable housing (Lin & Guo, 2019; Shoup, 2013).

According to scholars in developed countries, the advantages of effective on-street parking management are a given conclusion. Professionals and academics have thus proposed that an effective on-street parking management requires three components.

(1) institutional and legislative frameworks that support all activities of an effective on-street parking management (Manville & Pinski, 2021; Sustainable Urban Transport Project, 2017);

(2) parking policies and programs that comprise the following components: a parking policy with a specified aim (Kodransky & Hermann, 2011; McShane & Meyer, 1982; Mingardo et al., 2015); a parking strategy and planning that assists in accomplishing the policy objectives (Mingardo et al., 2015; Rye, 2010; Thanh, 2017);

(3) implementation that comprises the following components: parking regulations and fine structures (Litman, 2021; Washington State University, 2015); physical infrastructures, signage, and equipment for fee collection. (DeBow & Drow, 2019; Rye, 2010); enforcement compliance with parking regulations (San Francisco County Transportation Authority, 2009; Sustainable Urban Transport Project, 2017); monitoring operations (DeBow & Drow, 2019; Institute for Transportation and Development Policy, 2021; Sustainable Urban Transport Project, 2017); regular evaluation of strategies to ensure they meet the objectives (DeBow & Drow, 2019); communication with the public (Institute for Transportation and Development Policy, 2021; Mingardo et al., 2015; Washington State University, 2015).

In developing countries, such as Asian cities (Thanh, 2017), on-street parking has received relatively little attention from researchers and policymakers (My Thanh & Friedrich, 2017; Parmar, Das, & Dave, 2020). Since traffic congestion is considered a highly critical issue by policymakers in many developing countries, on-street parking is viewed typically as an interruption to traffic flow. It was regulated with the primary objective of minimizing the delay caused by traffic congestion (Aderamo & Salau, 2013; Ajeng & Gim, 2018). Several notable contributions to research on on-street parking issues in cities of many developing countries demonstrate how challenging it was, such as widespread illegal parking on main roads, minor roads, bicycle lanes, and sidewalks (Eedan Al-Jameel & Muzhar, 2020; My Thanh & Friedrich, 2017; Yan-ling et al., 2016); insufficient on-street parking supply (Chen et al., 2016; Parmar, Das, Azad, et al., 2020); lack of a formal system of basic on-street parking regulations (Haider et al., 2021; Vasallo, 2015); inadequate on-street parking design and management (Bulactial et al., 2013; Fillone & Paringit, 2010; Putra & Hidayah, 2019); institutional fragmentation (Wang & Yuan, 2013); a disconnect between parking policy and urban transport planning (Institute for Transportation and Development Policy, 2014; Phuc et al., 2019; Thanh, 2017); lack of coordination among agencies (Vu, 2017); On-street parking space reservation (Barter, 2011); lack of political support (Barter, 2011; Shoup et al., 2016); and corruption (Fisman & Miguel, 2007).

Many studies on on-street parking examined the demand characteristics and efficiency of on-street parking, including parking volume, parking duration, parking occupancy rate, parking turnover rate, and parking index, calling for a better on-street parking management (Aderamo & Salau, 2013; Ajeng & Gim, 2018; Chen et al., 2016; Eedan Al-Jameel & Muzhar, 2020; Fillone & Paringit, 2010; Gandhi & Juremalani, 2019; Reza et al.,

2017; Ukam, 2020). For instance, Reza et al. (2017) examined the characteristics of on-street parking in a Bangladeshi shopping center and discovered that the facilities were overused, with a parking index of 105% and a turnover rate of 9 vehicles per hour throughout the weekday. Chen et al. (2016) analyzed parking characteristics in Shanghai. Land-use types included market areas, business areas, office areas, and food and beverage areas. They discovered that most on-street parking users parked for short durations and that several areas of Shanghai had an insufficient parking supply. Parmar, Das, Azad, et al. (2020) investigated the parking characteristics of many areas with different land use types. The parking indicators showed that most on-street parking spaces for cars were highly utilized and had a sufficient supply. The authors also discovered a significant spillover in the afternoon in the business district and an imbalanced utilization of on-street and off-street parking due to the lack of a significant difference in price between them.

Unfortunately, there are few studies on illegal parking in cities of developing countries (Fisman & Miguel, 2007; My Thanh & Friedrich, 2017; Vu, 2017). There are even fewer studies on the characteristics of illegal on-street parking (Aljoufie, 2016; Chauhan et al., 2020). For example, Aljoufie (2016) analyzed the legal and illegal demands for unpaid on-street parking in Jeddah's commercial area on weekdays and weekends and discovered that illegal parking peaked between 6:00 p.m. and 9:00 p.m. on weekdays and weekends in most study areas. Also, drivers chose to park illegally near their trip destination rather than further away or at a long-term parking zone.

The literature review on on-street parking policies and management in developed and developing cities revealed that the majority of the reviewed studies focused on the effects and benefits of implementing on-street parking policies and strategies in various contexts. Most of the studies were conducted in the context of developed cities. Nevertheless, there is a need for parking reform in developing cities based on a limited number of research findings on the challenges of on-street parking management that stem from various context-based factors, such as political factor. In addition, some problems of on-street parking have been linked to the off-street parking regulations, such as the availability and pricing of off-street parking spaces.

2.1.2 Off-street parking policy

Many cities in Asia, Europe, and the United States have introduced off-street parking policies and regulations, generally known as the Minimum Parking Requirements (MPRs) (Barter, 2011; Gabbe et al., 2020; Mingardo et al., 2015). The MPRs, which require a specified amount of parking spaces in building developments, have been a focal point of off-street parking policies and have been heavily criticized by researchers for a long time, arguing that such requirements inherently support car dependency as they help provide ample parking supply at minimal costs (Barter, 2010; Shoup, 2005). Typically, the MPRs aim to ensure that a building has sufficient parking spaces to meet demand, preventing street parking problems from spillover parking. (Barter, 2011). However, as the MPRs increase the density of parking spaces, they cause damage to the city due to a rise in the number of cars, resulting in increased traffic congestion and exhaust emissions (Shoup, 1999b).

Several scholars have found that the MPRs generate unused parking spaces that provide no value to the buildings. Rogers et al. (2016) found that among 115 multifamily residential buildings in Washington, D.C., barely 60% of parking was utilized. Rowe et al. (2011) found that parking demand was less than the amount supplied in urban centers, indicating that parking was overbuilt in the urban centers of First Hill–Capitol Hill and Redmond. Moreover, the parking demand found was less than the parking demand presented in the ITE report. Taylor (2020) examined residential parking utilization in Melbourne and found that 30% of parking spaces for flats and apartments were unoccupied and unused. McCahill (2017) assessed 80 multifamily residential sites in Madison and found an average occupancy rate of 66%. There was a significant relationship between parking occupancy and a building's location and the specific neighborhood characteristics, such as transit and walking accessibility.

Additionally, recent research has used several approaches to examine whether parking requirements are a binding constraint on development. In New York, McDonnell et al. (2011) examined developers' responses to parking requirements by comparing the actual and required parking spaces by zoning law. They found that developers tended to build only the bare minimum of parking required. 47% of them exactly met the level of the MPRs. This suggests that the MPRs are binding for these developers. The same pattern is also found in suburban areas. Cutter and Franco (2012) examined the effects of the MPRs on developers' decisions to provide parking space in buildings by comparing actual parking to required parking for properties and estimating the marginal parking cost and the marginal parking value. They found that the MPRs significantly influenced developers' decisions on parking supply in office, commercial, industrial, and retail properties in suburban Los Angeles. Some of them used qualitative methods to gain a deeper understanding of how minimal parking requirements affected the development of a project (Li & Guo, 2014; Manville, 2013). For instance, Gabbe (2018) compared baseline minimum parking regulations to the actual amount of parking in Los Angeles multifamily and mixed-use buildings and interviewed local planners and developers. They observed that developers took parking regulations extremely seriously. Chapin (2016) surveyed the perspectives of real estate developers regarding the present and past parking policies they had encountered during the development of their projects, including the minimum parking requirements.

In addition, a few researchers had examined the causal effects when the MPRs were eliminated or changed. A study by Li and Guo (2014) in London analyzed planning application records and found significant evidence for the effects of minimum parking requirements on market distortion. The number of parking spaces per unit in residential development applications decreased after the city implemented maximum parking regulations instead of minimum ones. Like Guo and Ren (2013), another study on residential parking supply before and after the minimum off-street parking standard was replaced with a maximum one in London from 2004 to 2010. The study found that the market-oriented approach to parking regulations led to a reduction in excessive parking. However, the effects depended on the particular sub-markets, such as higher parking supply in areas with high population density and better transit service than in the outskirts of urban areas. Gabbe et al. (2020) examined the relationship between parking requirements and actual parking provision of housing development in Seattle where policy reforms have reduced or eliminated parking

requirements in the majority of central and transit-oriented neighborhoods since 2012. They discovered that developers' actions were frequently influenced and constrained by minimum parking requirements and that reducing these requirements resulted in less parking provision.

The MPRs also affect housing affordability, since the parking requirements for each building type will increase the total cost of home construction, which may hinder the acquisition of these assets and impose an unfair financial burden on households without vehicles (Lehe, 2018). Moreover, this means that the development of Transit-Oriented Development (TOD) that aims at densification around transit stations and car-use reduction is hindered (Cervero et al., 2010; Institute for Transportation and Development Policy, 2014). A number of studies have shown that minimum parking requirements affect housing affordability. Jia and Wachs (1999) indicated that condominium prices in San Francisco significantly increased at an average of $38,800 if off-street parking was included. Jung (2009) found that the marginal price effects of parkade-style spaces were -$4,112 if a dwelling's parkade-style parking space was downgraded to a surface parking space. Greenberg (2005) estimated that each additional residential parking space increased typical of U.S. urban housing unit costs by $52,000 to $117,000, with a mid-range value of $85,627.

In developing countries, research on off-street parking policies was limited. The MPRs have been observed in all Asian developing cities with various designs and levels. Nonetheless, the majority of those cities apply conventional methods as parking is still considered a kind of infrastructure, with the objective of parking policies intent on fulfilling demand (Barter, 2011). Liu et al. (2018) revealed the problems of parking and the unintended consequences of off-street parking policies and regulations in Chinese cities, such as high parking density in central areas, unused residential parking spaces during the day, and parking that was saturated in some neighborhoods but underutilized in others. Few studies have examined the correlation between parking requirements and off-street parking provision. Wang and Liu (2014) found, through an analysis of parking supply mechanisms in Shenzhen, that the relationship between the willingness and concern of developers was a crucial component in determining the actual number of parking spaces. In addition, they found that the parking provision in each area varied considerably based on the neighborhood's characteristics. Liu et al. (2016) compared parking supply with the MPRs during each policy period and studied the geographical characteristics of parking available for office use conducted in Shenzhen. They discovered that just 31.17% of office projects in central and transit-rich regions provided parking within the MPRs range, while this proportion exceeded 60% for projects in other areas. In Mexico City, the Institute for Transportation & Development Policy's (2014) analysis of parking data from 251 real estate projects between 2009 and 2013 revealed that, on average, developers provided 10.4% more parking than was required, with the majority of projects providing less than 10% of extra parking. The study concluded that the amount of parking built was relatively equivalent to the minimum required but also cautioned that the city's parking regulations did not promote an inverse relationship between the added parking spaces and the zone's public transit coverage and quality.

2.1.3 Best practices of parking policies and management

Due to the on-street and off-street parking problems and challenges found in the literature, planners in many cities recognize the parking problems and propose several parking policies and strategies for managing parking demand and supply in a more efficient way. They are as follows:

On-street parking policies and management

- Proof-of-Parking & Overnight parking ban

Proof-of-parking rule requires access to a nighttime parking place to be secured before registering a car (Barter, 2011). The combination of proof-of-parking requirements and a prohibition on overnight street parking in Tokyo is an instance of social responsibility that ensures that parking is not a burden for society (Kato & Kobayakwa, 2019).

- Parking Benefit Districts

Parking Benefit Districts are a parking policy in which revenues from on-street parking fees are returned to the area where they were collected. Stakeholders also prioritize how the revenues are to be spent (Johansson et al., 2017). The City of Pasadena in California has begun using parking revenue to rebuild public services and improve the neighborhood's environment. Several other U.S. cities, including Austin, Houston, and San Diego, have committed parking revenue to funding public services on metered streets, following Pasadena's lead (Shoup et al., 2016). The City of Columbus in Ohio enacted this in 2020, aiming to reinvest parking revenue in order to improve the quality of life for residents and businesses, as well as encouraging walking, biking, and public transportation (The City of Columbus, 2020).

- Residential Parking Permit

Residents in eligible areas can acquire residential parking permits, exempting them from meter and time limit restrictions in the permit parking district of the area. A residential parking permit is standard in many American cities, such as Boston, Chicago, San Francisco, Washington, and Los Angeles (Schewe, 2019). Houston utilized residential parking permit schemes to ban non-residents from parking in densely-populated areas (City of Houston, 2022).

- Parking technologies

Today is a new era of curbside technology, which has the potential to revolutionize parking management. Automated scanning enforcement are used in Chicago and Santa Barbara, for example. Video analytics, license plate recognition (LPR), Bluetooth, automated scanning enforcement, and RFID tagging can assist with enforcement (DeBow & Drow, 2019; Weinberger et al., 2010). In Kuala Lumpur, display-parking meters for fee collection are also implement (Barter, 2011).

Off-street parking policy

- Elimination or Reduction of Minimum Parking Requirements

In recent years, many cities have lowered or removed minimum parking requirements for specific uses. Since 2012, Seattle has lowered or eliminated parking regulations in most central and transit-oriented neighborhoods (Gabbe et al., 2020). Portland and Oregon have reduced parking minimums and set maximums based on transit proximity (Metropolitan Area Planning Council, 2015). Over 30 Swedish cities have lowered residential parking restrictions by 10–25% if car sharing is available (Sprei et al., 2020). Honolulu, Phoenix, and Montgomery have provided a reduction in parking requirements for mixed-use buildings with shared parking (Urban Land Institute, 2022).

- Maximum Parking Requirements

Maximum parking requirements restrict the total number of parking spaces that can be built and set a ceiling or upper limit on parking supply. In 2004, the United Kingdom replaced minimum standards with maximum requirements in Greater London, which varied depending on the accessibility of public transportation (Greater London Authority, 2016; Guo & Ren, 2013). The Town of Bedford had maximum parking limits for specific uses, such as educational, senior living, mixed, and childcare facilities (Metropolitan Area Planning Council, 2015). In Parramatta, a suburb in Sydney, minimum parking requirements for residential parking have been transformed into maximum parking requirements (Litman, 2018).

- Unbundled Parking

Unbundled parking regulations restrict the inclusion of parking costs in unrelated fees, such as the inclusion of parking in the cost of housing or an office rent. Seattle, for instance, requires landlords to split the cost of parking spaces from residential and commercial rent rates(Urban Land Institute, 2022). San Francisco requires unbundling for all housing developments with more than 10 units in both downtown business and residential zones (Metropolitan Area Planning Council, 2015).

- In Lieu Fees

Fees-in-lieu allow developers to pay a fee into a municipal parking or traffic mitigation fund in lieu of providing the required parking, according to zoning requirements on site (Schleck, 2021). The Town of Oak Bluffs allows uses proposed for the Business District that are unable to meet the off-street parking requirements to make a payment in lieu of providing the spaces (Metropolitan Area Planning Council, 2015).

- Shared Parking

Shard parking means that parking spaces are shared for more than one purpose, allowing parking facilities to be utilized more efficiently (Litman, 2015). The cities of

Copenhagen and London permit citizens to park overnight in shared loading zones (Kodransky & Hermann, 2011). Barter (2018) proposed park-once-and-walk neighborhoods in which most parking is shared and publicly accessible, even if privately owned. As a result of the growth of the sharing economy, shared parking gives a new solution to the parking space shortage in urban areas.

- Integrated policy for on- and off-street parking

Some cities have recently adopted the concept of an integrated on-street and off-street parking policy. In Shenzhen, for instance, on-street parking is not allowed in areas where off-street parking structures are less than 70% during rush hours (Lin & Guo, 2019).

2.2 Background: Parking in Bangkok

This section provides background knowledge about parking in Bangkok, including on-street and off-street parking policies, regulations, and research.

2.2.1 On-street parking

Most on-street parking in Bangkok or Thailand is free and permitted if it does not violate the Land Traffic Act, B.E. 2522 (1979). The existing on-street parking management and regulations include parking bans and fee collection on certain streets. Loading zones and resident parking permits do not apply in Bangkok (Chalermpong & Ratanawaraha, 2019). Two independent agencies are involved in managing on-street parking; the Metropolitan Traffic Police and the Bangkok Metropolitan Administration (BMA). In locations where traffic congestion is severe, for example, on-street parking is banned according to the Land Traffic Act, B.E. 2522 by the Thai Traffic Police Division of the Metropolitan Police Bureau, which is under the Prime Minister's Office. The traffic police also have the authority to issue traffic citations and apply wheel clamps. The Bangkok Metropolitan Administration (BMA), as the local government, has authority over on-street parking through the Parking Management within Municipalities Act B.E. 2562. According to this law, municipalities, including the BMA, can designate curbside parking streets in a local ordinance, which specifies parking duration limit, parking fee for different types of vehicles, methods of fee collection, and enforce the parking regulations incorporated with the Traffic Police.

As of May 2022, The BMA has designated 66 streets, including the Ratchadamri Parking lot in the street's right of way as paid on-street parking areas, according to the City Ordinance on Parking Management B.E. 2564 (2021). Most of them are located in Bangkok's old town. These areas marked the parking spaces and installed the signage showing the parking fee to comply with the regulations. On most of these streets, parking is banned between 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 8:00 p.m. on weekdays and Saturdays, except Sundays and holidays. An alternate-side parking policy is applied on odd-numbered and even-numbered days on many streets. The parking price schedule (see Table 2-1) is uniform for all streets. These rates were updated in November of 2021 (City Ordinance on Parking Management, 2021). Fee collection is conducted when parking is allowed, outside the no-

parking period, according to traffic police's regulations: mostly 9:00 a.m. – 3:00 p.m. or 9:00 a.m. to 4:00 p.m.

The parking fee collection was done manually by parking wardens who are outsourced employees of the BMA Department of Finance's Division of Commerce. When a driver pulls over to park on the curbside, the parking warden would approach and ask how long the driver would park and collect the fee accordingly. The driver would then be issued a receipt that must be put on the windshield to show that they have already paid. In the 1950s and 1960s, parking meters were used to collect fees. They were eventually abolished and replaced with parking attendants (Chalermpong & Ratanawaraha, 2019).

Figure 2-1 Left to Right: Parking warden, Parking receipt, and Sign of on-street parking fee schedule (Source: author)

Table 2-1 The parking rate in accordance with the BMA Ordinance on Parking Management B.E. 2563 (2021)

Type of vehicles	First hour (THB)	Subsequent hours (THB/hour)	Remark
Motorcycle	10	15	Exceed minutes shall be considerate as an hour.
Tricycle	10	15	
Passenger car/Pick-up truck	20	30	
6-wheel truck	50	70	
More than 8-wheel truck	100	120	
4-wheel trailer/truck tractor	20	30	
6-wheel trailer/truck tractor	50	70	
More than 8-wheel trailer/truck tractor	100	120	

- On-street parking research in Thailand

Very little literature directly addresses on-street parking in Thailand. A few researchers studied the demand for free on-street parking (Eva Ayaragarnchanakul & Felix Creutzig, 2022; Chalermpong & Ampansirirat, 2011) and the impact of on-street parking on congestion (Wattanakul & Rongviriyapanich, 2018). Chalermpong and Ampansirirat (2011) interviewed drivers who parked in the unpaid curbside parking around Chulalongkorn

University regarding their parking behaviors and found that a substantial number of drivers parked on the curbside despite the availability of off-street parking as curbside parking is free of charge. Recently, Eva Ayaragarnchanakul and Felix Creutzig (2022) estimated on-street parking charges to discourage on-street parking cruising in the commercial areas of Bangkok where unpaid parking is now available. The problems of Bangkok's on-street parking were also mentioned. Chalermpong and Ratanawaraha (2019) underlined the weak traffic enforcement issues and the uniqueness of Bangkok's parking issue, which is the unauthorized reservation of parking spaces in front of buildings to claim de facto ownership and usage. Suksoi (2010) conducted a questionnaire survey of traffic police officers to determine the problems and obstacles to effectively enforcing parking regulations. The traffic police officers agreed that the difficulties originated from widespread illegal parking and present parking regulations, such as a lack of customer parking and loading zones designated for business.

2.2.2 Off-street parking

There are two types of off-street parking, which are public parking and private parking. Public parking provided by the BMA is very limited in Bangkok with only three facilities, featuring two parking buildings in the old city and one parking lot in Silom's central business district. Buddhist temples and government offices also provide public parking, except for a few locations where parking fees are charged (Chalermpong & Ratanawaraha, 2019).

Large private properties, including residential buildings, offices, and commercial buildings, are required by law to provide a minimum number of parking spaces, commonly referred to as "Minimum Parking Requirements (MPRs). The Building Control Act, enacted in 1979 and updated in 1992, outlines parking requirements and applies to every province in Thailand. In 2012, they were adjusted for hotels, banquet or event halls in restaurants, and large structures. The City of Bangkok enacted its own City Ordinance on Building Construction Control B.E. 2544 (2001), which includes parking regulations with specific minimum parking standards for 18 building uses (See table 2-2).

Recently, the BMA proposed to reduce the minimum parking standards for new developments within 500 meters of transit stations or within 800 meters of interchange stations in central Bangkok by 25% (See Figure 2-2) in the new Bangkok Comprehensive Plan that was scheduled to be implemented in 2020 but has not yet been implemented (City Planning Department Bangkok Metropolitan Administration, 2019; Pankaew, 2021). One of the objectives is to encourage urban development that is more efficient and aligned with the ongoing infrastructure and transit development plans. In addition, Bangkok's current Comprehensive Plan includes provisions for Floor Area Ratio (FAR) bonuses to be given to development projects within 500 meters of eight transit stations that provide additional parking space for the public, presumably to encourage more parking provisions for the park & ride transit users (City Planning Department Bangkok Metropolitan Administration, 2019).

Table 2-2 Summary of Minimum Parking Requirements in the City of Bangkok (Bangkok City Ordinance on Parking in Large Buildings, 2001)

Building Type	Minimum Parking Requirement
1) Theater	1 space/10 seats
2) Hotel	< 100 rooms: 10 space/30 rooms and 1 space/5 rooms in excess of 30 rooms > 100 rooms: 1 space/10 rooms in excess of 100 rooms
3) Multi-family residence with each dwelling unit larger than 60 sq.m.	1 space/1 unit
4) Restaurant with dining area from 150 sq.m.	10 space/150 sq.m. of dining area and 1 space/20 sq.m. in excess of 150 sq.m.
5) Department store with retail area from 300 sq.m.	1 space/20 sq.m. of building area
6) Office with a working area of 300 sq.m.	1 space/60 sq.m. of building area
7) Market with usable area from 300 sq.m.	1 space/120 sq.m. of building area
8) Factory with usable area from 300 sq.m.	1 space/240 sq.m. of building area
9) Warehouse with usable area from 300 sq.m.	1 space/240 sq.m. of building area
10) Storage	1 space/120 sq.m. of building area
11) Shop house	1 space/1 unit or 1 space/120 sq.m. for unit larger than 240 sq.m.
12) Hospital with a usable area of 300 sq.m.	1 space/120 sq.m. of building area
13) School with usable area in each building from 300 sq.m.	1 space/240 sq.m. of building area
14) Service building with usable area from 300 sq.m.	1 space/60 sq.m. of building area
15) Goods exhibition building with usable area from 300 sq.m.	1 space/20 sq.m. of building area
16) Large building except for liquid or chemical storage, silo, or reservoir	1 space/120 sq.m. of building area
17) Hall in hotel in (2) restaurant in (4) or large building in (16)	1 space/10 sq.m. of building area
18) Commercial building with usable area in each building from 300 sq.m.	1 space/60 sq.m. of building area

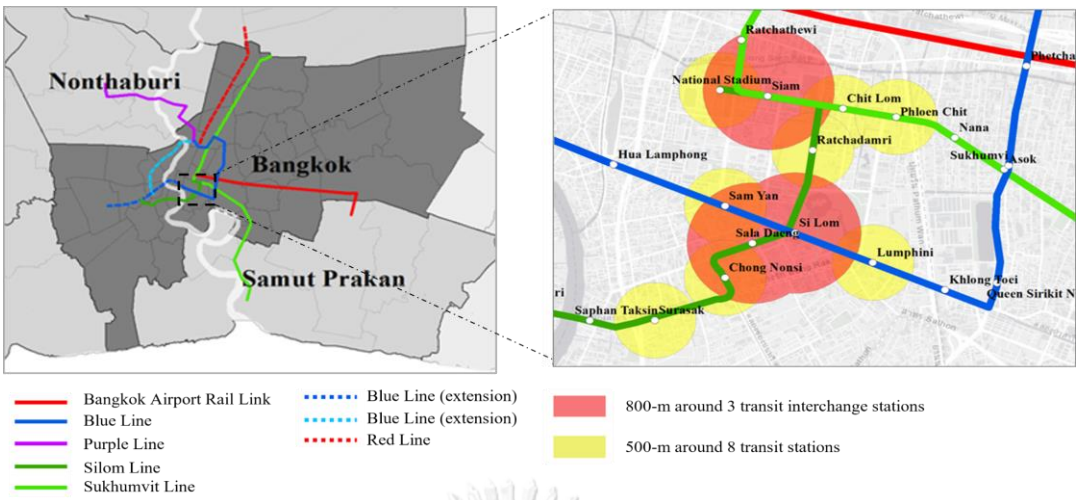


Figure 2-2 Map of the Bangkok Metropolitan Region (BMR) and areas of the proposed 25% reduction of MPRs in the Draft Bangkok Comprehensive Plan.
Noted: Figure adapted from Figure 1 in Chullabodhi et al. (2020)

- Off-street parking research in Thailand

Various aspects of off-street parking study have been undertaken in Thailand. The body of literature on off-street parking tends to focus on parking demand and supply in various building types. However, their analyses do not compare the number of parking spaces required by the MPRs. For instance, Piriyalertsak (2012) surveyed parking demand in the Chinatown of Bangkok and found a significant shortage of off-street parking supply. Hino et al. (2011) examined the situation of parking lot development in a large commercial building in Bangkok's commercial district. They found that parking in commercial centers was insufficient to fulfill demand, resulting in parking spillover that caused chaos on-street. Kittiwangchai (2006) studied potential impact from enforcing parking policies to offer guidelines for determining shopping centers' management policies.

Several researchers examined residential parking demand characteristics and parking utilization. Konkayan (2004) examined the parking behavior of low-income and middle-income condominium residents in the inner zones of Bangkok. This study found that five out of ten condominium projects lacked sufficient parking spaces. Most projects with sufficient parking spaces collected a parking fee and issued a windshield parking sticker to represent a parking permit. In contrast, other projects with insufficient parking spaces did not implement a parking fee or sticker. Thongin (2008) studied the parking provision and user behavior in an affordable housing project in Bueng Kum District. The author discovered a more significant number of bike and motorcycle parking usage than car usage, although the legislation did not mandate bike and motorcycle parking places. Furthermore, it was confirmed through interviews with the project's owner that the development of parking spaces affected a buyer's affordability, since the construction of parking lots had a direct impact on total construction costs. Tangmahasathikul (2010) examined the utilization of parking spaces in residential buildings along the BTS transit line and the residents' opinions on parking space reduction. The author found that the majority of sample groups commuted to work by private car rather

than by public transportation and that 73% of sample members were opposed to the idea of reducing parking space, even if it meant they could buy a cheaper unit.

Furthermore, some researchers examined large buildings' parking provisions and usage subject to the MPRs and called for their revision. For example, Mahattanatawe (1995) studied the parking characteristics and usage of 150 buildings on Silom Road between 1987 and 1994. They found that most buildings provided parking spaces equal to or close to the minimum number mandated by law. Chantragravee (2002) examined the parking lot utilization characteristics of two office buildings, which were the Bangkok Bank Head Office Building and CP Tower Building. More recently, Chullabodhi et al. (2020) calculated actual, required, and excess parking capacities from the condominium dataset to determine whether minimum parking requirements affected parking provision in condominiums and what factors determined condominiums' parking capacities. This research found that about 90% of sample condominiums in Bangkok and the surrounding municipalities in the Bangkok Metropolitan Region offered more parking places than the law required. Lertpradit and Charnwasununth (2020) examined the parking provision compared to the MPRs and the correlation between the parking provision and the distance to transit stations, using 280 condominium developments' Environmental Impact Assessment (EIA) report information. This study indicated that 80 % of projects provided parking spaces that did not exceed 105 % of the total number required by law and that condominiums located 1,500-1,999 meters away from of mass rapid transit stations tended to provide more parking spaces. Recent research by Chullabodhi et al. (2018) indicates that the MPRs significantly impacted lower-priced residential developments more than higher-priced ones. This implies that the MPRs have an impact on house affordability in the middle and low-price ranges, as they limit developers' ability to change actual parking ratios to fit purchasers' budgets.

Many researchers have studied the demand and supply characteristics of Park-and-Ride (P&R) facilities, such as user characteristics and behavior (Chalermpong et al., 2018; Krithayakrien, 2002; Rakdee, 2007); parking demand characteristics (Meepio, 2008) and supply and catchment area characteristic (Choontanom, 2016; Hansongkram, 2016). Apart from the studies relating to supply and demand of off-street parking, a few researchers investigated the satisfaction of users in parking management (Pankhuntod et al., 2021; Suksanguan, 2018).

2.3 The Summary of Literature Review and Research Gap

There is a substantial amount of research on parking in the existing literature. However, most of the research is based mainly on the experience and contexts of cities in developed countries. Despite the common problems of parking in cities of developing countries, such as Bangkok, Yogyakarta, and Manila, there is still limited research and scarce empirical evidence to give policymakers information on how to handle these problems. For example, the parking policies in Bangkok can hardly be improved due in no small part to a dearth of research evidence. The existing literature on parking lacks comprehensive works, with the majority of articles focused on specific aspects of parking or empirical findings. Several researchers have examined the characteristics of on-street parking demand, but no one has studied the demand for paid on-street parking. There is also limited empirical evidence

regarding the existing on-street parking policies and management, such as fee collection and enforcement. Some academics have researched the parking demand and supply of off-street parking, although some studies are outdated, with the most current studies limited to residential buildings. Given the lack of policies and academic research on parking in the country, policymakers are hesitant to implement any new parking-related initiatives (Chalermpong & Ratanawaraha, 2019).

Furthermore, many scholars have examined the situations and challenges related to parking policy in developing cities. The institutional structures and mental models of stakeholders regarding their attitudes, motivations, and incentives for parking policy have not been studied. This additional information may contribute to further developing a policy or strategy for resolving the parking issues in developing cities caused by the institution's organizational structures and mental models.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter describes the research methodology of the dissertation. We outline the conceptual framework, the method of data collection, and the research method.

3.1 Conceptual Framework

This research uses Bangkok as a case study as it has always been the first city in Thailand where new parking policies and regulations are implemented. The parking regulations implemented in Bangkok will serve as a model for legislation in other provinces, such as the revision of minimum parking requirements in several districts in Nonthaburi to match those of Bangkok in 2016.

To answer the research questions and accomplish the objectives of this thesis, we employ the conceptual framework depicted in Figure 3-1. This conceptual framework was modified by integrating the Iceberg Model of analysis by Ellis and Black (2018) and the Political Economics Analysis format by Andreas et al. (2021). The Iceberg Model is one of the systems thinking models that help identify the underlying causes of social issues in which only the tip of the iceberg is visible. As Ellis and Black (2018) mention, the Iceberg Model illustrates that the problem is frequently only the visible and superficial symptom of underlying trends, patterns, structures, and incentivized behavior. According to Ellis and Black (2018), the Iceberg Model includes the following four levels of thought:

1. The event level – is the level at which we view the world in terms of the problems and symptoms
2. The pattern level – is what is happening or the trends throughout time
3. The structure level – is what causes the pattern and event, such as organizations, laws, and regulations
4. The mental model level – is the attitudes, beliefs, morals, expectations, and values that allow structures to continue functioning. (Ecochallenge, 2022)

In addition, Political Economy Analysis (PEA) is a tool to address pressing policy challenges and seek better pathways for change by understanding society's overall political and economic processes. It has been adopted primarily to examine social issues (Andreas et al., 2021; Mcloughlin, 2014). According to Ellis and Black (2018), the PEA template includes the following:

1. Problem or challenge
2. Context and agency – are the interaction between structures, institutions, and agencies.
3. Routes for change – are a diagnosis of the problem's underlying causes and a list of action priorities for addressing the underlying diagnosis.

It is evident that the two methodologies are similar and complementary. Combining them into the conceptual framework as presented can result in a more comprehensive accomplishment of the objectives of the study. Therefore, the on-street and off-street parking situations were investigated by analyzing parking issues as the tip of the iceberg from empirical research and examining the root causes of parking issues in terms of patterns, structures, and mental models. Then, parking policies were proposed to address the findings and causes of the parking problems. The following part will cover the data collection and the method in detail.

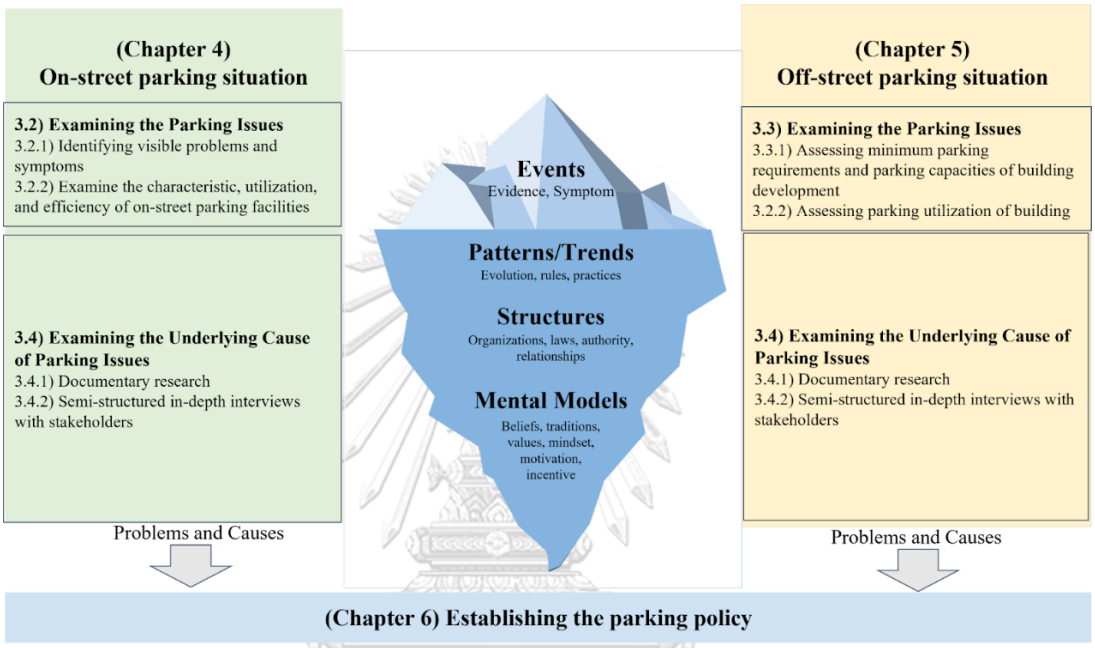


Figure 3-1 Conceptual framework

3.2 Examining the Parking Issues of On-Street Parking

This section describes the methodology used to examine Bangkok's current on-street parking facilities, including the identification of visible problems and symptoms of on-street parking management from the virtual and field survey and the examination of their characteristics and efficiency.

3.2.1 Identifying visible problems and symptoms of on-street parking management

As described in section 2.2.1, the BMA has designated 65 streets as paid on-street parking, according to the BMA Ordinance. We identified parking issues of on-street parking management by gathering information and evidence from a virtual survey of all 65 designated on-street parking streets via Google Street View in November 2020 and the field survey conducted in March-April 2021. The collected information and evidence from Google Street View include the estimated number of parking spaces, signage, traffic marking, parking regulation, and surrounding land use. In addition, because 65 specified on-street parking

places lacked geolocation data for use in Google Street View, the locations of all streets were geocoded as GIS data.

According to the virtual study, most paid on-street parking streets are located in Bangkok's city center where many neighborhoods are dominated by shophouse-style buildings and often feature a mix of commercial and residential land uses, as shown in Figure 3-2. In addition, each street has secondary land uses that can be classified into four groups: retail (32 streets), retail and restaurant (23 streets), business and office (2 streets), and retail and market (2 streets). During the daytime (9:00 a.m.-4:00 p.m.), parking was prohibited on six of these sixty-five streets, two of which were located on the outskirts of the city.

Following the study by Chen et al. (2016), sample study areas were selected for a field survey to explore the manifest problems and collect the parking demand characteristics of the area based on the secondary land use characteristics and parking regulations. The selected four study areas for the field survey to represent four groups of secondary land use characteristics, as shown in Figures 3-2 and 3-3, are located in Bangkok's inner districts, which contain five streets classified as paid on-street parking streets administered by the BMA, including:

A. **Wat Mangkorn** is located near Chinatown, a vital cultural, commercial, and dining zone. The Wat Mangkorn neighborhood consists of small restaurants, retail shops, and street food stalls at night.
B. **Thewet** is located close to Thewet Market, which sells fresh food and gardening materials, and where there is pier access to the Chao Phraya River.
C. **Paribatra** is an old community comprising residences, offices, and businesses.
D. **Ban Mo** is a sizable commercial center of electric appliances and gadgets.

The size of each study area is determined by the dominant land use type's boundaries and the transportation network (See Appendix C for an overview of each study area). The characteristics of each research area's on-street parking facilities are summarized in Table 3-1. As shown in Table 3-1, Ban Mo is a one-way street with 1.5 lanes, one-sided on-street parking, and a short length due to the fact that the main road cuts through it. This short length and low capacity of on-street parking are present on several streets designated as paid-parking zones, such as Boonsiri Road, Rambuttri Road, and Mahannaphob Road.

Moreover, the surrounding areas of these four study locations lack off-street parking facilities, since most buildings are shophouses constructed before the local government mandated onsite off-street parking. In most study areas, nearby off-street parking is not available, except for Ban Mo, where there is a nearby private off-street parking zone, which charges a higher rate than on-street parking, starting at 30 THB per hour. Based on our initial survey, we found a small number of illegally parked cars in no-parking zones in areas, such as Ban Mo and Thewet. This may have a minor impact on the use of on-street parking facilities in the study area, given that individuals prefer to park their vehicles close to their destination.

In Bangkok, curbside parking spaces are classified into two types, which are: (a) Marked parking spaces, which are marked with paint by the Traffic and Transportation Department, BMA; (b) Informal parking spaces, which are blank spaces on the streets.

Regarding informal parking spaces with no clearly defined parking slots, we counted the number of available parking slots by assuming that one parking slot equals 2.4 x 6.0 meters (referencing Ministerial Regulation No. 41, B.E. 2537), which is an approximate count during a field survey to consider the maximum capacity in each area as displayed in Table 3-1. This count excludes NO STOPPING or NO STANDING zones ("the red-white curbs marking"), particularly near intersections.

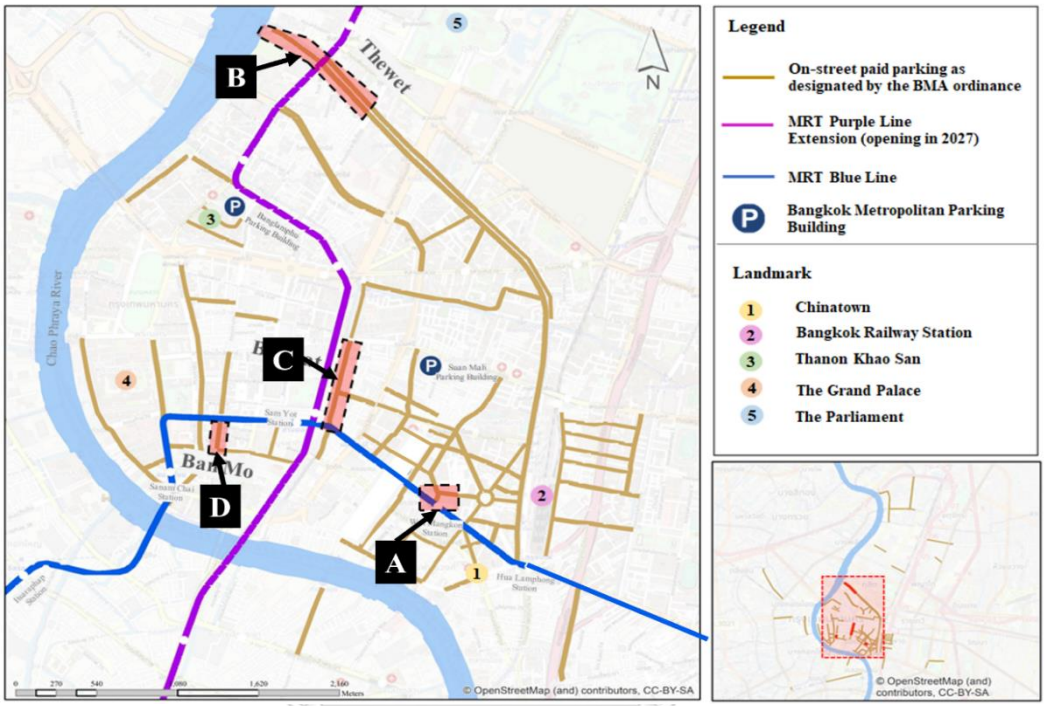


Figure 3-2 Locations of the selected survey areas in Bangkok are red box (Left), Map of designated streets where paid parking is allowed, according to the City Ordinance on Parking Management B.E.2564 (2021) (Right) Noted: Figure adapted from Figure 2 in Chullabodhi et al. (2022)

Table 3-1 Study areas' characteristics

Study area	**(A) Wat Mangkorn**		**(B) Thewet**		**(C) Paribatra**		**(D) Ban Mo**
Segment	W1	W2	T1	T2	P1	P2	B1
List of designated streets in the area	Phlapphla Chai Road	Santipab Road	Krung Kasem Road	Krung Kasem Road	Paribatra Road	Paribatra Road	Ban Mo Road
Surrounding land-use	commercial and retail (evening) restaurant (night)	commercia land retail	market and public utilities	governme nt office, commercia l and retail	residence, office, and small business	residence, office, and small business	commercial and retail
Survey lengths (total street lengths) (m.)	150 (4,000)	100 (520)	250 (3,100)	460 (3,100)	230 (1,265)	360 (1,265)	200 (725)

Study area	(A) Wat Mangkorn		(B) Thewet		(C) Paribatra		(D) Ban Mo
Street characteristics	2-way, 4-lane, road width 20-21 m.	2-way, 4-lane, road width 16 m.	2-way, 1.5 & 2-lane, road width 14-16 m., allowed to park on one side of the street	2-way, 4-lane, road width 17-21.5 m.	2-way, 2-lane, road width 14.5-15.5 m.	2-way, 2-lane, road width 14.5-15.5 m.	1-way, 1.5-lane, road width 14 m.
Parking capacity for automobiles	51	20	58	89	66	108	26
Regulatory parking signs	-	parking is prohibited on odd- and even-numbered days	-	parking is prohibited between 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 8:00 p.m., except holidays.	On odd- and even-numbered days, parking is prohibited; parking is also prohibited between 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 8:00 p.m.	On odd- and even-numbered days, parking is prohibited; parking is also prohibited between 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 8:00 p.m.	parking is prohibited between 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 8:00 p.m., except Sunday.

(A) Wat Mangkorn

(B) Thewet

(C) Paribatra

(D) Ban Mo

Figure 3-3 The characteristics of four study areas

3.2.2 Examining the characteristic, utilization, and efficiency of on-street parking facilities

To present the overall parking situation of on-street parking spaces in the areas where BMA actively manages parking by collecting the parking fee, we further examine the characteristics, utilization, and efficiency of on-street parking facilities in these four study areas. This study relies on license plate surveys proposed by Parmar, Das, Azad, et al. (2020), conducted in four study areas during March 20th - April 3rd, 2021, and only focused on vehicles, excluding motorcycles as they can be parked anywhere in Bangkok. As shown in Figure 3-3, we used survey paper forms to record the arrival and departure times of each car parked with its license plate at one-hour intervals between 8:00 a.m. to 9:00 p.m. This period is chosen, since it is the period of high road traffic, and when parking restrictions are applied. In addition, we have assigned the slot number of designated parking spaces and tracked the entry and exit times of each vehicle parked in each slot number, as well as the information regarding obstacles in the parking spaces. The license plate surveys in these four research areas can collect data on demand for on-street parking, including free parking demand, illegal parking demand, and paid parking demand, if applicable, during the fee collection period.

Although we only focused on passenger cars, in reality, both marked and informal, motorcycles are often parked in car parking spaces. For a marked parking space, we treat any number of motorcycles on a slot as one car as long as a motorcycle occupies that slot. If a passenger car and a motorcycle are parked together in one slot, we treat them as one car. Since motorcycles are primarily parked between cars, we do not consider them to occupy the space for informal parking spaces. However, in some areas where motorcycles are parked in groups, such as Wat Mangkorn, parking spaces are recorded as occupied when observed.

The data on parking demand and supply acquired from the field survey are used to compute parking statistics that indicate the characteristics and efficiency of on-street parking facilities to assess parking issues. These parking statistics include the following:

1. Parking volume: Parking volume gives the value of the total number of vehicles parked for a given time duration or survey period (Mathew, 2009).
2. Parking load: Parking load is the total area under the accumulation curve. It is also obtained by multiplying the total number of vehicles that occupies the parking space at each time. It is stated as vehicle-hours (Mathew, 2009).
3. Parking occupancy rate: It is the percentage of occupied parking spaces to the total capacity at a given time (Mathew, 2009).
4. Average parking duration: It is calculated as the sum of all vehicle parking durations divided by the total number of parked vehicles for the survey period (Chen et al., 2016).
5. Parking turnover: It is calculated by dividing the number of parked vehicles for a given duration by the number of available parking spots. Therefore, it can be expressed as the number of vehicles per bay per time duration to measure the occupancy of a parking space (Mathew, 2009).
6. Parking index: It is defined as the ratio of total number of vehicles parked in a time duration to the total space available. It gives an aggregate measure of how effectively the parking space is utilized (Parmar, Das, Azad, et al., 2020).

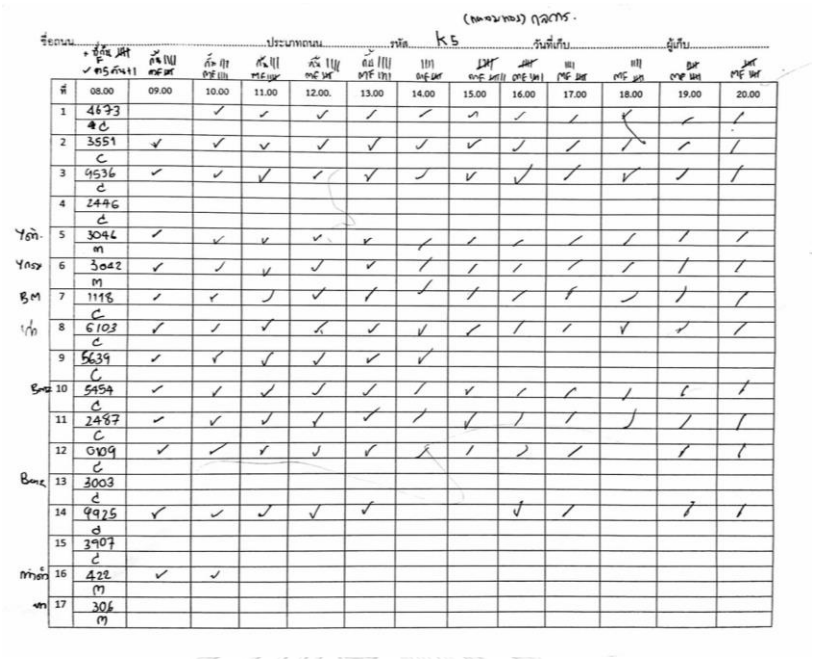


Figure 3-4 License plate survey form

3.3 Examining the Parking Issues of Off-Street Parking

This section outlines the methodology used to investigate Bangkok's off-street parking issues, including assessing minimum parking requirements, parking capacities, and parking utilization of Bangkok's large buildings.

3.3.1 Assessing the minimum parking requirements and parking capacities of building development

To examine the minimum parking requirements and parking provision of large buildings in Bangkok, we use Environmental Impact Assessment (EIA) datasets manually digitized from the EIA report on the EIA Information Center website, as depicted in Figures 3-5 and 3-6. (See https://eia.onep.go.th/site/eia.) The scope of the data collection includes all condominiums, hotels, offices, and mixed-use buildings in Bangkok contained in the website's database, whereas other building types have a minimal sample size. During the manual digitization process, we searched for and extracted the data in Figure 3-6, including actual parking spaces, required parking spaces, number of units, number of floors, usable areas, and report date.

This dataset only includes 912 of the approximately 1,200 EIA reports on the website that were proposed for Environmental Impact Assessment in Bangkok between 2001 and 2020 due to a lack of parking information in the report. We also geocoded the project locations in GIS and determined the various location characteristics, such as the distance to the nearest rail transit station, proximity to the central business district, and land use zones. The dataset includes 832 condominium projects, 45 hotel projects, 25 office projects, and 13 mixed-use projects. Figure 3-7 shows the geographical distribution of projects in our dataset.

We next computed the number of excess parking spaces from the difference between the actual number of parking spaces provided in a building and the minimum number required. The excess parking ratio was then calculated by dividing the number of excess parking spaces by the number of required parking spaces. For instance, a condominium with 130 parking spaces and 100 required spaces has an excess parking ratio of 0.3. This dataset is used for the empirical analysis examining the effects of the MPRs on developers' decisions to supply parking spaces in buildings, similar to what McDonnell et al. (2011) have done.

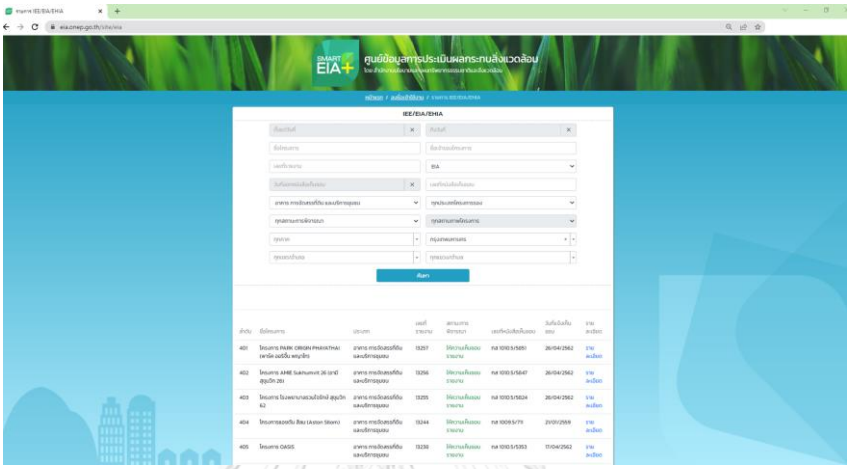
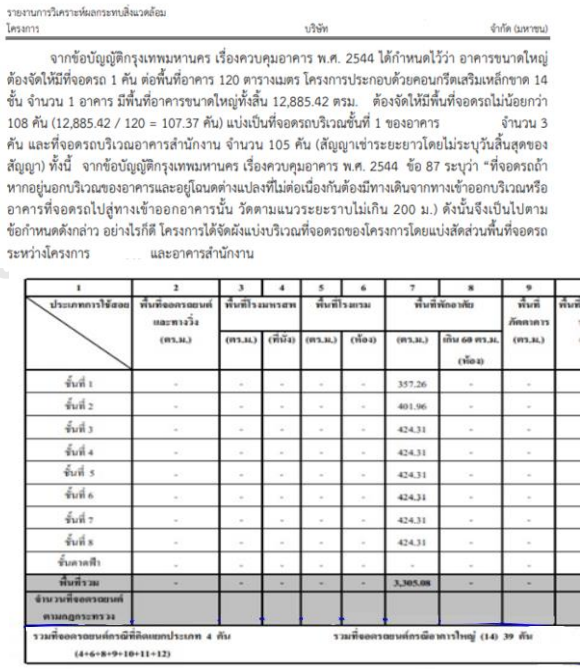


Figure 3-5 EIA Information Center website



รายงานการวิเคราะห์ผลกระทบสิ่งแวดล้อม
โครงการ บริษัท จำกัด (มหาชน)

จากข้อบัญญัติกรุงเทพมหานคร เรื่องควบคุมอาคาร พ.ศ. 2544 ได้กำหนดไว้ว่า อาคารขนาดใหญ่ ต้องจัดให้มีที่จอดรถ 1 คัน ต่อพื้นที่อาคาร 120 ตารางเมตร โครงการประกอบด้วยคอนกรีตเสริมเหล็กขาด 14 ชั้น จำนวน 1 อาคาร มีพื้นที่อาคารขนาดใหญ่ทั้งสิ้น 12,885.42 ตรม. ต้องจัดให้มีพื้นที่จอดรถไม่น้อยกว่า 108 คัน (12,885.42 / 120 = 107.37 คัน) แบ่งเป็นที่จอดรถบริเวณชั้นที่ 1 ของอาคาร จำนวน 3 คัน และที่จอดรถบริเวณอาคารสำนักงาน จำนวน 105 คัน (สัญญาเช่าระยะยาวโดยไม่ระบุวันสิ้นสุดของสัญญา) ทั้งนี้ จากข้อบัญญัติกรุงเทพมหานคร เรื่องควบคุมอาคาร พ.ศ. 2544 ข้อ 87 ระบุว่า "ที่จอดรถถ้าหากอยู่นอกบริเวณของอาคารและอยู่โฉนดต่างแปลงที่ไม่ต่อเนื่องกันต้องมีทางเดินจากทางเข้าออกบริเวณหรืออาคารที่จอดรถไปสู่ทางเข้าออกอาคารนั้น วัดตามแนวระยะราบไม่เกิน 200 ม.) ดังนั้นจึงเป็นไปตามข้อกำหนดดังกล่าว อย่างไรก็ดี โครงการได้จัดผังแบ่งบริเวณที่จอดรถของโครงการโดยแบ่งสัดส่วนพื้นที่จอดรถระหว่างโครงการ และอาคารสำนักงาน

1	2	3	4	5	6	7	8	9
ประเภทการใช้สอย	พื้นที่จอดรถยนต์และทางวิ่ง (ตร.ม.)	พื้นที่โรงมหรสพ (ตร.ม.)	(ที่นั่ง)	พื้นที่โรงแรม (ตร.ม.)	(ห้อง)	พื้นที่พักอาศัย (ตร.ม.)	เกิน 60 ตร.ม. (ห้อง)	พื้นที่จัดคาดการ (ตร.ม.)
ชั้นที่ 1	-	-	-	-	-	357.26	-	-
ชั้นที่ 2	-	-	-	-	-	401.96	-	-
ชั้นที่ 3	-	-	-	-	-	424.31	-	-
ชั้นที่ 4	-	-	-	-	-	424.31	-	-
ชั้นที่ 5	-	-	-	-	-	424.31	-	-
ชั้นที่ 6	-	-	-	-	-	424.31	-	-
ชั้นที่ 7	-	-	-	-	-	424.31	-	-
ชั้นที่ 8	-	-	-	-	-	424.31	-	-
ชั้นดาดฟ้า	-	-	-	-	-	-	-	-
พื้นที่รวม	-	-	-	-	-	3,305.08	-	-
จำนวนที่จอดรถยนต์ตามกฎกระทรวง								

รวมที่จอดรถยนต์การที่ที่ติดแยกประเภท 4 คัน (4+6+8+9+10+11+12)

รวมที่จอดรถยนต์การเมืองอาคารใหญ่ (14) 39 คัน

Figure 3-6 Example of parking details from the EIA report

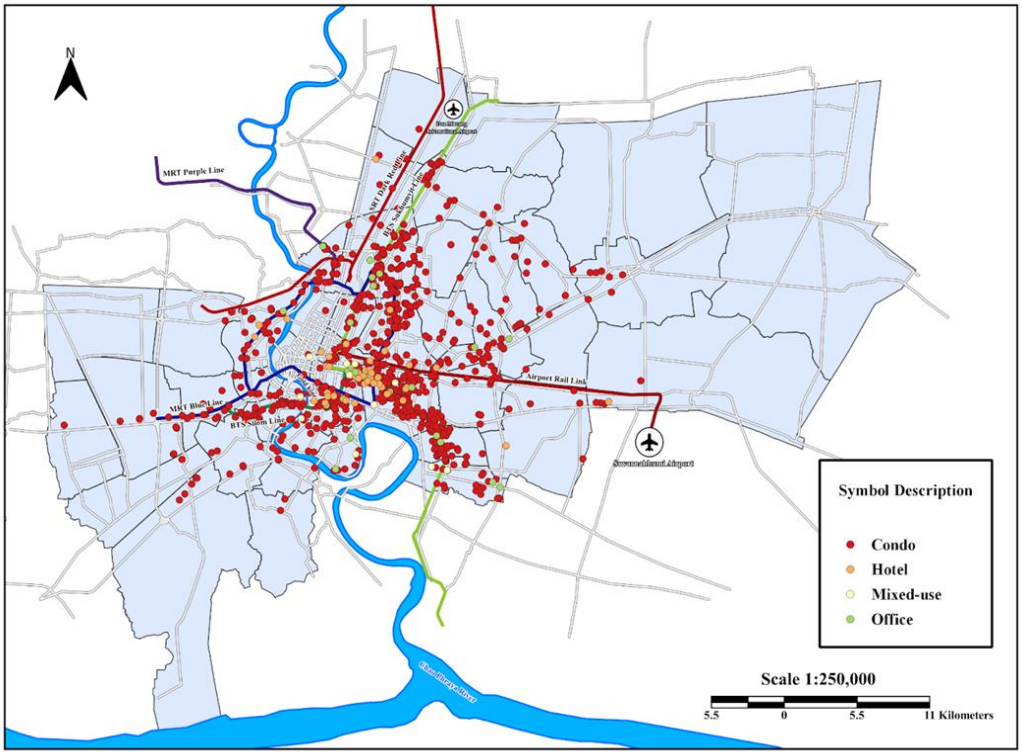


Figure 3-7 Map of geographical distribution of data on buildings

3.3.2 Assessing parking utilization of building

According to the list of buildings in the EIA dataset, we have conducted a field survey as proposed by McCahill (2017) to determine the parking utilization of residential buildings, hotels, offices, and mixed-use buildings. This was achieved by contacting the building's management office and requesting their data or permission to gather data by counting the number of cars in the parking lot between 8:00 a.m. and 10:00 p.m. (For the questionnaire and survey forms, see Appendix B). However, most building management offices refused to provide data or permit us to gather parking usage at the locations. Moreover, the Covid-19 pandemic in Bangkok caused the parking usage not to be typical. As a result, the sample size of hotels, offices, and mixed-use buildings is relatively small, consisting of only 1, 4, and 2 projects respectively, which is an exception for the 193 projects collected for condominium buildings. Figure 3-8 illustrates the distribution of buildings that can collect data on parking usage. Most condominiums are located near the rapid transit station. The empirical analysis of parking utilization is thus limited to condominium projects.

The condominium dataset includes the project name, actual parking provision, volume of parking usage during day and night, as shown in Table 3-2, parking policy, and occupancy ratio (owner-rent-empty) at the time of the data collection. We also used GIS to determine the various locational characteristics of condominiums, such as distance to the nearest transit station and proximity to the central business district. This survey was conducted between August 2018 - February 2019 and again between October 2019 - January 2020. The one-day survey was performed on weekdays and weekends.

Table 3-2 Example of parking usage data in condominiums

Time period	In	Out	Parking Space
0.00 - 1.00	3	1	183
1.00 - 2.00	2	0	181
2.00 - 3.00	2	0	179
3.00 - 4.00	1	0	178
4.00 - 5.00	0	0	178
5.00 - 6.00	1	5	182
6.00 - 7.00	1	28	209
7.00 - 8.00	2	20	227
8.00 - 9.00	1	4	230

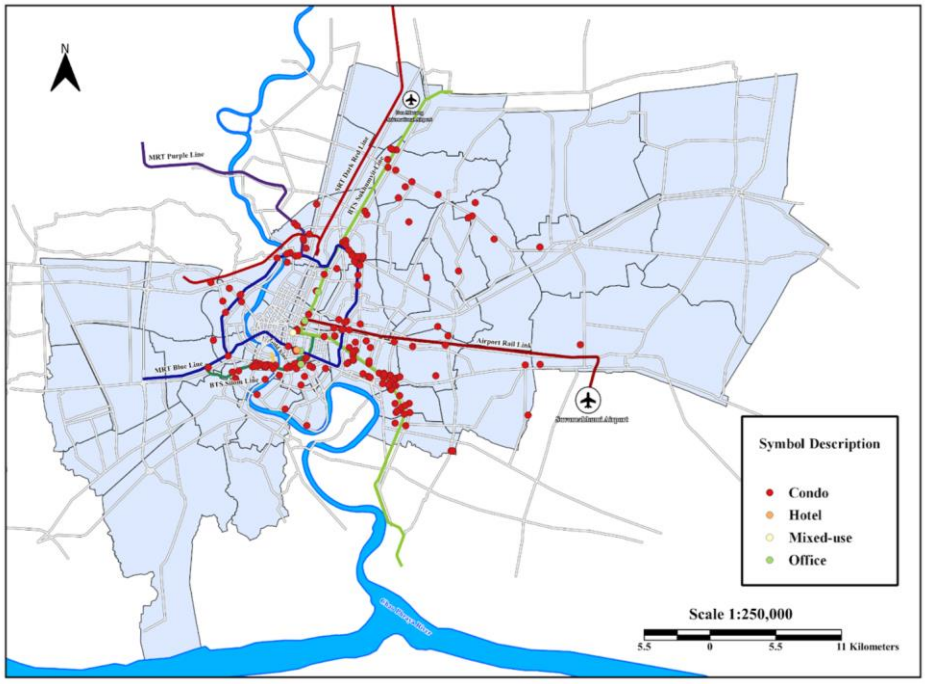


Figure 3-8 The distribution of buildings that can collect data on parking usage

3.4 Examining the Underlying Causes of Parking Issues

This part outlines the qualitative method used to examine the underlying cause of parking issues, as determined in sections 3.2 and 3.3 in response to the research question "Why do parking issues originate and persist?" According to the above-mentioned conceptual framework, this qualitative method covers the 3 primary aspects of trend and pattern, structure, and mental model. We explore these aspects using documentary research and semi-structured in-depth interviews. The particulars are as follows:

3.4.1 Documentary research

We conducted documentary research by reviewing academic literature, related legislation and regulations, government documents, and official records from the National Archives of Thailand, as depicted in Figure 3-9, to review the evolution, background, and challenges of past and present parking policies and regulations, including institutional and organizational structures. Next, the context and trends of Bangkok's transportation and urban development, which may have affected its parking policies over time, were examined. Thereafter, we analyzed and synthesized information to determine how these aspects contribute to parking issues.

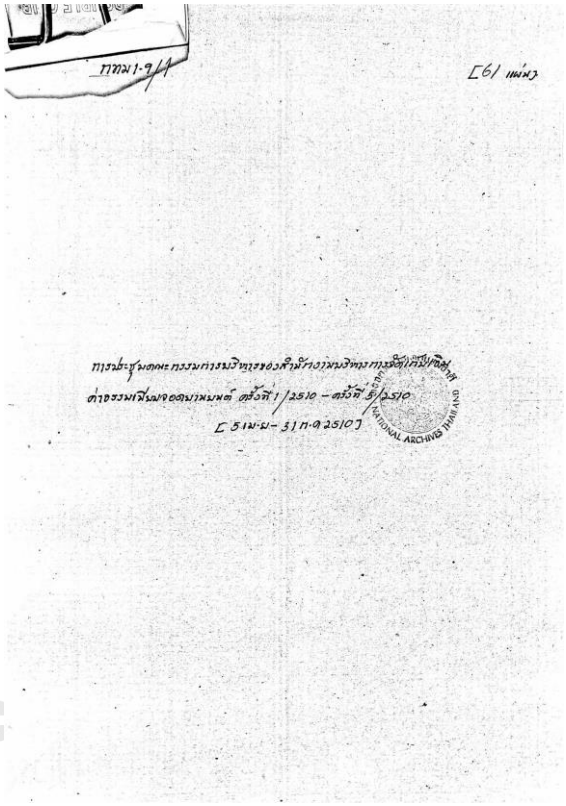


Figure 3-9 Example of a document from the National Archives of Thailand

3.4.2 Semi-structured in-depth interviews with stakeholders

To further investigate the underlying causes of parking issues, we conducted in-depth semi-structured interviews with key stakeholders. According to Markwell and Leigh-Hunt (2010), stakeholder mapping is the first step in every stakeholder interview process. Based on the findings of section 3.4.1 documentary research, the mapping was developed to identify the target groups who could influence or be influenced by the corresponding problems and provided as much information as possible about each stakeholder, including their missions and responsibilities. As seen in Table 3-3, the stakeholders have been divided into 3 groups: 'on-street parking stakeholders,' who play a role in policymaking, implement, or are affected by the on-street parking policies and regulations; 'off-street parking stakeholders,' who play a

role in policymaking or are affected by the off-street parking policies; and 'policy and strategy stakeholders,' who play a role in formulating policies and strategies. The initial stakeholder mapping yielded a list of at least 21 possible informants, as shown in Table 3-3. The study employed the snowball sampling technique by Susskind et al. (1999), in which the first interviewee referred to others who might be relevant to the issue, increasing the sample size to 39 stakeholders. This procedure ensures the inclusion of potential stakeholders and collecting relevant data and essential insight. According to Table 3-3, the only stakeholder that could not be interviewed was the Ministry of Transport because no one was accountable for or related to the parking policies, except for park-and-ride facilities (For additional details, see the list of interviewees in Appendix D).

The semi-structured in-depth interviews were performed over the phone and face-to-face between May 2021 - April 2022. The in-depth interview was conducted in 3 stages. In the first stage, respondents were asked to confirm the parking issues identified by the authors in the previous step and to explain how these issues emerge and persist using the five whys analysis method. This analysis is an effective technique for identifying the causes by investigating cause-and-effect interactions (Gurley et al., 2021; Mahto & Kumar, 2008; Serrat, 2017). We began with the reported parking issues and asked "why" to reveal systemic causes. The in-depth interviews were conducted to identify the systemic causes of the parking issues in several areas, including the organization's goals and structure, policy formation process, operation and execution process, organizational relationships, and mental models of each stakeholder. The impacts of parking problems were also discussed with stakeholders.

Second, we conducted interviews regarding the structure and mental models of stakeholders, including their beliefs, attitudes, motives, and incentives in relation to on-street and off-street parking policies. Finally, the best practices of parking policies and strategies were discussed with stakeholders to clarify the potential and concerns of implementing such policies in Bangkok. All interviews lasted between 60 - 90 minutes and were recorded and later transcribed. The inductive thematic analysis was applied to the qualitative data taken from the interview transcripts to analyze the discovered potential causes. This was accomplished via the inductive thematic analysis method outlined by Braun and Clarke (2006), which included data familiarization, coding, theme searching, subject review, theme definition, and labeling. A cause-and-effect graph was drawn to illustrate the relationship between parking issues and underlying causes, as shown in Figure 3-10.

Table 3-3 List of key interview participants

Group of stakeholders	Affiliation	Sample size	Actual
On-street parking stakeholders	BMA Department of Finance	1	1
	BMA Parking Services Unit	2	3
	District office	2	2
	Traffic Police	3	6
	Local business owner/resident	3	8
Off-street parking stakeholders	Department of Public Works and Town & Country Planning (DPWTCP)	1	2

Group of stakeholders	Affiliation	Sample size	Actual
	BMA Department of City Planning	1	2
	BMA Department of Public Work	1	2
	Mass Rapid Transit Authority of Thailand (MRTA)	1	2
	Real estate developer/ Parking management company	3	7
	Transport consultant	-	1
Policy and strategy stakeholders	Bangkok Metropolitan Council	1	1
	Ministry of Transport (MoT)	1	0
	Office of Transport and Traffic Policy and Planning (OTP)	1	1
	BMA Strategy and Evaluation Department	-	1
	Total	**21**	**39**

3.5 Establishing the Parking policies

The study in section 3.2, 3.3, and 3.4 has revealed the parking issues and their underlying causes. Based on these data, we analyzed and synthesized parking policies that could address parking difficulties, particularly their root causes, as shown in Figure 3-10. The proposed parking policies considered the literature review findings and the best practices from international research. The discussion points with stakeholders regarding their concerns and suggestions for the proposed parking policy are also described.

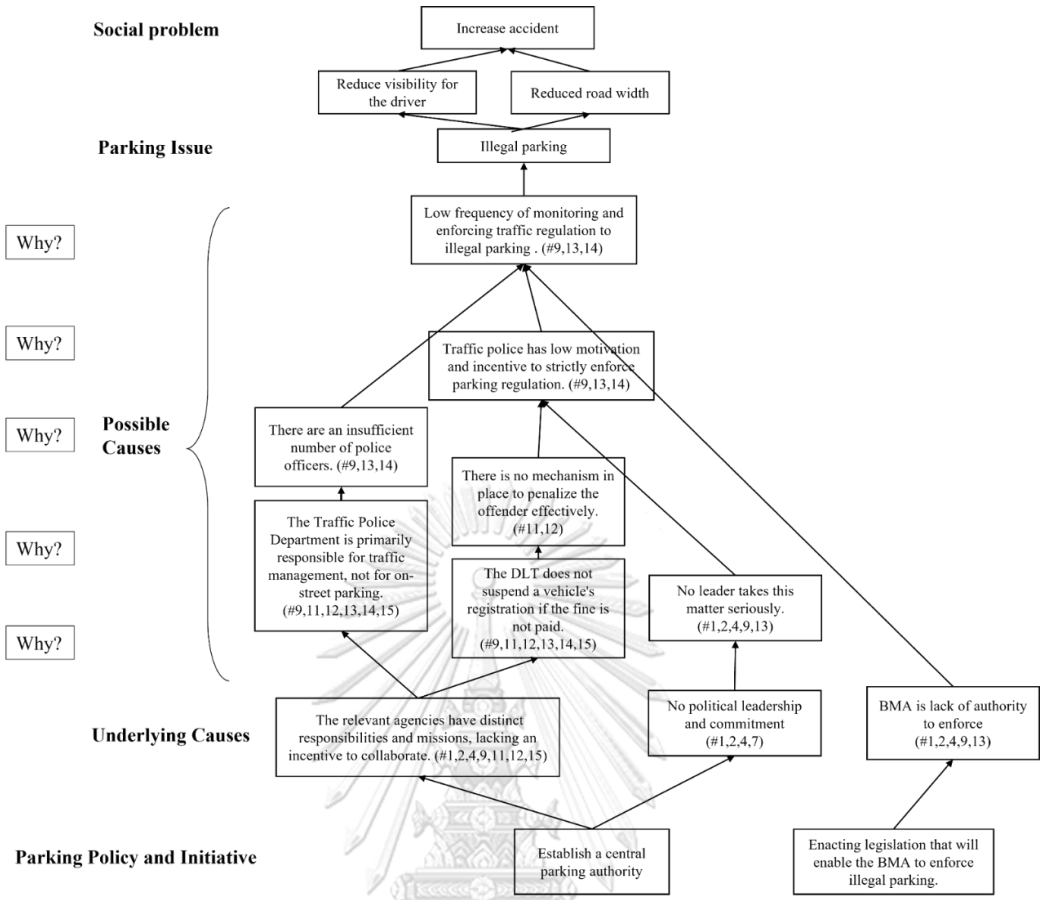


Figure 3-10 An example of cause-and-effect diagrams

CHAPTER 4

ON-STREET PARKING SITUATION IN BANGKOK

In this chapter, we provide several findings gathered and analyzed to demonstrate Bangkok's current on-street parking situation. We begin the chapter by highlighting the existing parking issues of on-street parking policies and management, using empirical research addressing the current characteristics, utilization, and effectiveness of on-street parking facilities. This is followed by the negative consequences of identified parking issues. Then, we examine the drivers, structures, and mental models underlying the current on-street parking policies and management to understand why on-street parking issues have arisen and persisted. The last section is the summary of this chapter.

4.1 Current Parking Issues: What, When, and Where?

This section provides a summary of the empirical evidence highlighting the issues of current on-street parking policies and management that are observable on the street using Google Street View, a field survey, and the findings of the analysis of the license plate survey data. Several findings reported in this section have been published by Chullabodhi et al. (2022).

4.1.1 Mismatch between regulations and reality

In the current management of on-street parking, we found a mismatch between what they observed in the field and what was supposed to be following regulation, which may be the source of conflicts. The field survey revealed two examples of misalignment between regulations and reality. First, the BMA must officially announce the roads or areas where on-street parking fees are charged, although our research found that the actual management of on-street parking does not always correspond with the BMA announcement. At the time of writing (May 2022), the existing BMA Ordinance designates on-street paid parking on only 65 streets, most of which are in the city center (City Ordinance on Parking Management, 2021). In practice, however, on-street parking is officially permitted, and fees are collected on only 53 of these streets, but not on the remaining 12 streets, where parking has been strictly prohibited since 2006 in response to requests from the Traffic Police. Heavy traffic congestion in many areas, especially near flyover bridges and rail transit stations, is the primary cause of the parking prohibition on those streets (Bangkok Metropolitan Administration, 2020). Despite these revisions, the BMA has not updated its list of designated on-street paid parking spaces since 2004.

The second issue involved on-street parking facilities that lacked proper signage and markings in designated paid-on-street parking zones. According to the BMA Ordinance, the BMA is responsible for installing signage and pavement markings for on-street parking spaces in areas specified in the BMA Ordinance. Our survey of all designated on-street parking spaces via Google Street View found that out of the 53 designated parking locations, 13 streets lacked parking signage while 49 streets had no or few street markings for an on-street parking slot. Furthermore, our field survey conducted in four study areas confirmed and

revealed the lack of signage and markings in some locations, as shown in Table 4-1. The ratio of on-street parking spaces with appropriate street markings to the total available on-street parking spaces ranged from 0% to 58%. In some areas, marked parking spaces were designed and implemented roughly, as seen by the traffic lane width being decreased from 2 to 1.5 lanes to facilitate on-street parking (See Appendix C).

4.1.2 Problems related to fee collection

Parking fee collection, for the most part, was done manually as a result of the elimination of parking meters. Nonetheless, areas designated as paid-parking areas lacked parking wardens who were in charge of collecting the fees. Consequently, parking wardens, who are currently outsourced employees of the BMA Department of Finance's Division of Commerce, must remain in assigned paid-parking areas, primarily from 9:00 a.m. to 4:00 p.m., except on Sundays. However, as shown in Table 4-1, our field survey revealed that some on-street paid parking areas lacked parking wardens on duty during permitted hours.

Moreover, parking wardens did not collect fees according to the BMA regulations. The parking fee schedule is uniform for all on-street paid parking streets due to the BMA announcement, with no parking duration limit. We found that the wardens did not collect the parking fees according to the specified rate but negotiated with drivers and often collected a flat fee, which was far less than the actual amount according to the rate established by the BMA Ordinance. In addition, we discovered that on several streets, wardens made an agreement with residents of nearby properties to charge a fixed amount on a daily or monthly basis in exchange for allowing them to park their vehicles for an unlimited duration.

Table 4-1 Parking management tool survey results and the BMA and Police officer operations

Study area	**Wat Mangkorn**		**Thewet**		**Paribatra**		**Ban Mo**
Segment	W1	W2	T1	T2	P1	P2	B1
Formal parking capacity for automobiles	0	0	26	53	32	7	15
Formal parking for motorcycles	0	0	0	0	0	0	36
Parking fee signs	No	No	Yes	Yes	Yes	Yes	No
Parking attendant found during the survey	Yes (8 a.m. - 6 p.m.)	Yes (8 a.m. - 6 p.m.)	No	No	Yes (8 a.m. - 4 p.m.)	No	Yes (8 a.m. - 4 p.m.)
Traffic police found during the survey to enforce parking regulations.	Yes (rarely)	No	Yes (rarely)	No	Yes	No	Yes

4.1.3 High proportion of long-term parker

The group of curb-parking users in Bangkok, most of whom are long-term parkers based on parking duration, differs based on land use characteristics. This shows that the present on-street parking management may not contribute effectively to the efficient utilization of on-street parking facilities for short-stay parking. Figure 4-1 illustrates the distribution of parking duration in each study area. While it demonstrates a high proportion of short-term parking of less than 3 hours, it also shows a high proportion of long-term parking. This figure clearly shows the variation of parking behaviors and curbside-parking user characteristics that were related to land-use characteristics. (A) Wat Mangkorn's land use is commercial and retail. The number of short-term parkers accounted for 73% of the total parked vehicles parked for less than 2 hours. At the same time, the percentage of long-term parkers who stayed longer than 3 hours was 23%. While most vehicles parked in this location were private vehicles, we also discovered many delivery cars and pick-up trucks in this neighborhood, since retail shops required on-street parking for loading and unloading goods.

Parking duration was more widely distributed in the commercial and electronic marketplace area of (D) Ban Mo than in any other study area, with long-term groups exceeding 3 hours (36%) and extreme long-term groups exceeding 10 hours (22%). At (B) Thewet, the land use includes a market, government offices, and small shops. Private cars account for a large proportion of curb-parking users. Short-term parking, identified as vehicles parked for less than 3 hours, accounts for 76% of total parked vehicles. (C) Paribatra's land uses include a private offices, commercial buildings, and residential buildings. Interestingly, the percentage of vehicles parked for at least 13 hours was high, accounting for 13% of the total parked vehicles. This could be because neighborhood residents used the on-street parking area as their private parking place.

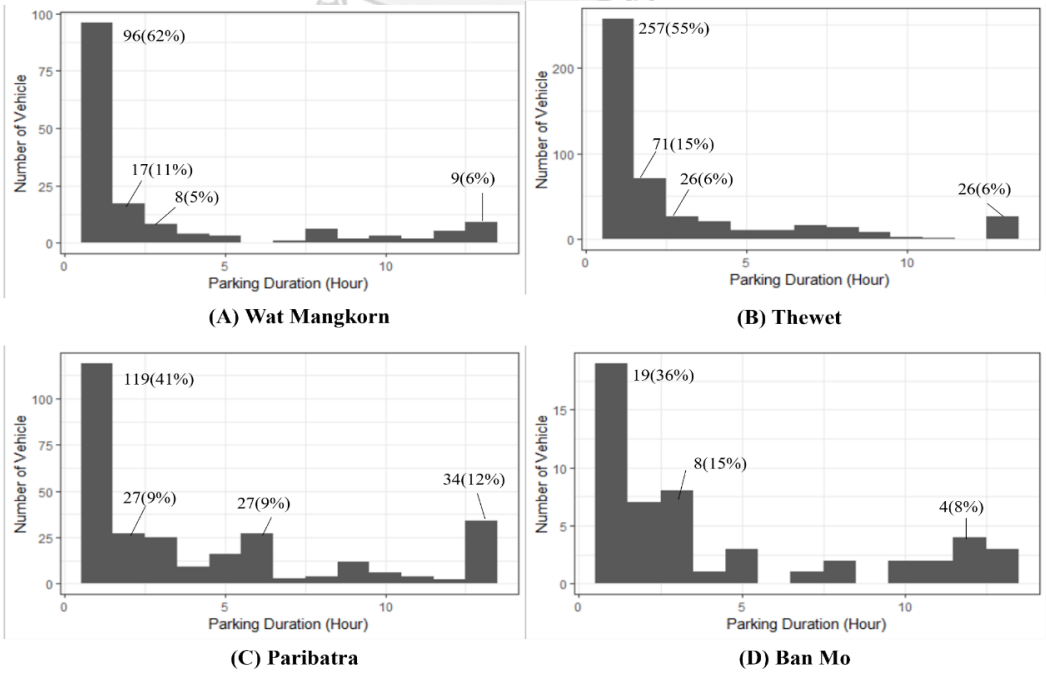


Figure 4-1 Parking duration distribution in four study area

4.1.4 Illegal parking, double parking, unauthorized parking reservation, and weak and irregular enforcement of the parking regulation

In all study areas, illegal parking, double parking, and unauthorized parking reservation were common. By the in-depth analysis of the characteristics and utilization of on-street parking, as illustrated in Figure 4-2, on-street parking regulations, including prohibited parking on odd- and even-numbered days or during peak hours, were mostly violated during prohibited parking periods. During the parking ban, the demand for illegal parking rose in several areas. In Ban Mo, illegal parking was close to or exceeded the parking capacity. This indicates the curbside-parking users' low perception of the seriousness of parking infringements. Note that the illegal parking in the Wat Mangkorn area was low, as most on-street parking spaces are unregulated.

In addition, shophouse owners frequently claimed de facto ownership and usage rights over the parking space in front of their buildings, as shown in Figure 4-3. They staked their claim by placing objects, such as chairs, tires, wooden barricades, and traffic cones, on the street parking space to reserve it without authorization. According to Table 4-2, the empirical evidence indicates that the percentage of unauthorized parking reservations ranges from 11.6% to 46.1% of the total legal parking supply. Furthermore, the barricading of parking spaces occurred throughout the day, both in the morning and in the evening, as shown in Figure 4-2. For instance, at Wat Mangkorn, the number of unauthorized parking reservations steadily increased throughout the day, accounting for 26% of total legal parking spaces. The average number of unauthorized reservations per hour, as shown in Table 4-2, indicates that the rate of unauthorized reservations tends to be higher in areas with low parking demand and after 8:00 p.m. This indicates that while those who made an unauthorized reservation are unlikely to live in the neighborhood, they nevertheless needed to secure parking for the next day.

Several locations have seen double parking without penalties from the Traffic Police, with Ban Mo having an exceptionally high rate. As indicated in Table 4-2, the longest double-parking duration is a shocking 13 hours. However, the Traffic Police did not issue any tickets. The Traffic Police did not take legal action against not only double parking but also illegal parking, unauthorized parking reservation, and drivers who did not pay for parking fines when parking cars beyond the parking period. Based on our observations, the police might only intervene intermittently and only selectively when a car was parked during the prohibited period, causing and worsening traffic congestion. During peak hours, the Traffic Police strictly enforced on-street parking regulations on major roads, although they were primarily ignored at night and on secondary roads.

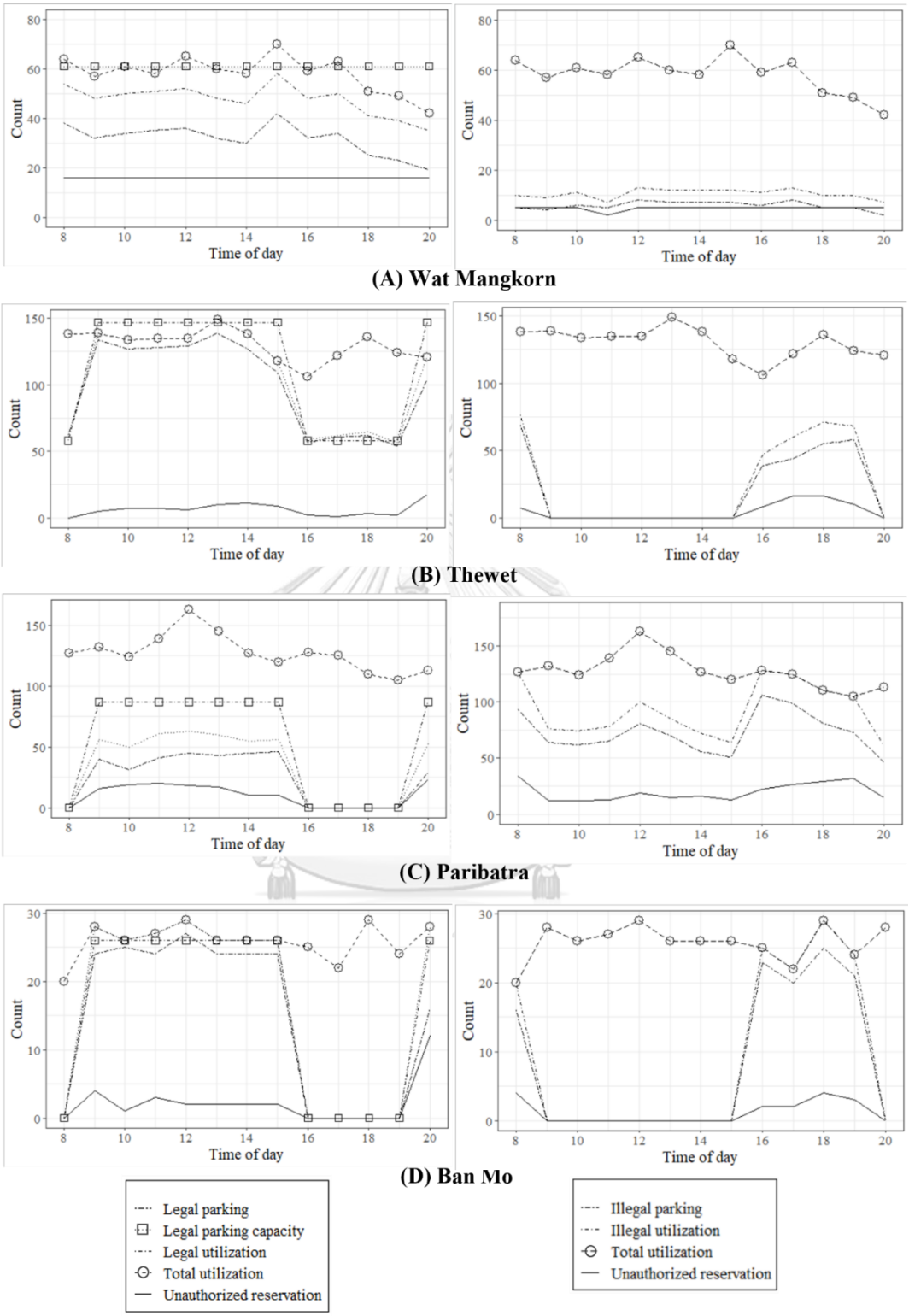
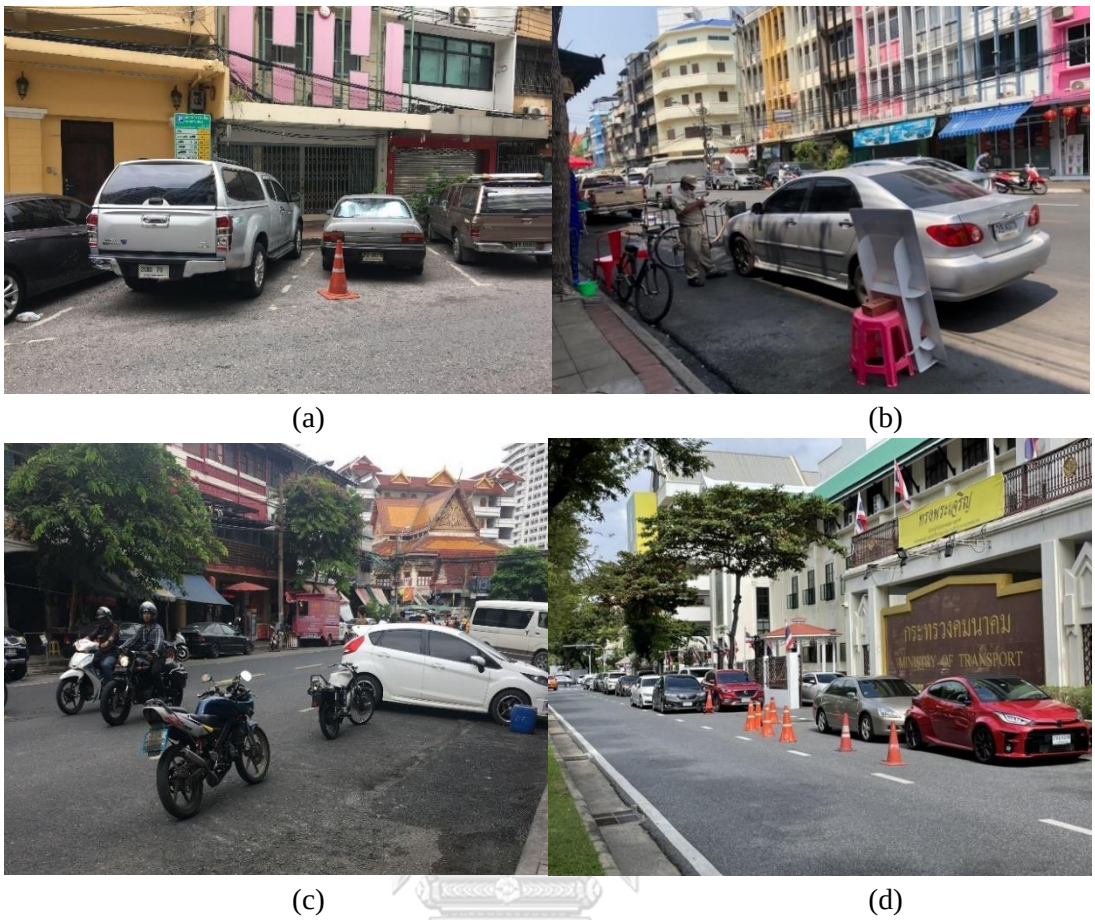


Figure 4-2 On-street parking accumulation by the time of day and type of parking demand.



(a) (b)

(c) (d)

Figure 4-3 Problems of on-street parking management in Bangkok (a) A parking fee schedule sign and faded markings in paid parking area (b) A parking warden and no-parking barricades put up by shophouse owners (c) Motorcycle barricades by shophouse owners (d) Double-parking and unauthorized reservation in front of the Ministry of Transport (Chullabodhi et al., 2022)

Table 4-2 Characteristics and utilization of on-street parking facilities in each study area

		Wat Mangkorn	**Thewet**	**Paribatra**	**Ban Mo**
Max. parking capacity		71	147	174	26
Total parking utilization (legal parking, illegal parking, and unauthorized reservation)	Peak time (o'clock)	15-16	13-14	12-13	12-13
	Peak number of parked vehicles	49.0	139.0	126.0	27.0
	Average number of parked vehicles	37.5	118.0	97.5	22.5
	Peak occupancy rate (%)	99.0	101.0	94.0	111.0
	Average occupancy rate (%)	82.0	87.0	73.0	99.0
Legal Parking Periods					
Max. legal parking spaces		61	147	87	26
Parking	Peak time (o'clock)	15-16	13-14	15-16	12-13
	Peak number of parked vehicles	42.0	139.0	46.0	27.0
	Average number of parked vehicles	31.7	98.3	40.0	23.5
	Peak occupancy rate (%)	68.9	106.9	52.9	103.8
	Average occupancy rate (%)	52.0	90.4	46.0	90.4
Unauthorized reservation	Peak time (o'clock)	8-21	20-21	20-21	20-21
	Max. count	16.0	17.0	23.0	12.0
	Average per hour	16.0	6.1	16.6	3.5
	% Max unauthorized reservation	26.2	11.6	26.4	46.1
Total legal utilization	Peak time (o'clock)	15-16	13-14	12-13	12-13
	Peak occupancy rate (%)	95.0	110.3	72.4	111.5
	Average occupancy rate (%)	78.2	95.2	65.1	103.8
Banned Parking Periods					
Parking	Peak time (o'clock)	12-13, 17-18	8-9	16-17	18-19
	Peak number of parked vehicles	8	69	106	22
Unauthorized reservation	Peak time (o'clock)	8-11, 12-21	17-19	8-9	20-21
	Max. count	5	16	34	12
Double parking					
Count		9	19	4	46
Average parking duration (hour)		2.2	6.89	2.5	1.15
Median parking duration (hour)		1	7	2.5	1
Max. parking duration (hour)		11	13	3	5

4.1.5 Insufficient supply of parking, underutilization, and low efficiency of on-street parking facilities

Problems with parking demand were discovered in the study areas, demonstrating both shortage and inefficiency of on-street parking facilities. Some study locations had a problem with insufficient parking, while some presented a problem of underutilization. As Table 4-2 shows, on-street parking was generally well utilized, with an average occupancy rate of 73% - 99% when legal parking, illegal parking, and unauthorized reservation were considered. The peak occupancy rate was close to or exceeded 100%, indicating an insufficient supply of parking to satisfy demand and possibly contributing to the parking problems through vehicles parked in no-stopping or no-standing areas. Nonetheless, it was heavily utilized but still available, where the number of parked vehicles fell short of the maximum capacity due to the unauthorized reservation. During the legal parking period, we also found that legal on-street parking was underutilized at Wat Mangkorn and Paribatra, with approximately 50% of vehicles occupying the spaces, as shown in Table 4-2. In comparison, Thewet and Ban Mo had an average occupancy rate close to 100% of capacity, implying that on-street parking adjacent to market land uses was more heavily utilized than other types of land uses.

Moreover, as shown in Table 4-3, the efficiency indices of on-street parking facilities indicates that on-street parking facilities in study areas have low efficiency in both scenarios: those that included only legal parking and those that considered both legal and illegal parking. In the first scenario, the results indicate a significant loss in public access to legal on-street parking due to unauthorized reservations. Each hour, this loss amounts to at least 4.8% of the total legal parking spaces and can reach 26.2%. Furthermore, the average parking duration values show around 3 hours, which demonstrates that on-street parking facilities were mainly occupied by people who parked for a long time. The average parking turnover rate in the study area ranged between 1.3 and 2.6 vehicles per parking space for the duration of survey. Paribatra, a residential neighborhood, has the lowest average parking turnover rate. The overall parking index for the study area is less than 80%. This means that less than 80% of available on-street parking spaces were utilized, highlighting the low efficiency of on-street parking facilities. At Wat Mangkorn and Paribatra, the parking index is only 52% and 45% respectively, indicating extremely low efficiency.

In the second scenario, in which the capacity of illegal parking spaces was also considered, the results indicate that efficiency of on-street parking is not much different from the first scenario and that some indices are worse, such as the average parking duration, which increases to a maximum of 4.4 hours. The highest loss due to unauthorized reservations is close to 30% of the total parking spaces. In addition, the average parking turnover is faster than in the first scenario, ranging between 1.7 and 3.2 hours. The efficiency of on-street parking remains low, as evidenced by a parking index of less than 80%.

Table 4-3 Efficiency results of on-street parking facilities

Scenario	Efficiency Index	Wat Mangkorn	Thewet	Paribatra	Ban Mo
1st: Legal parking	Average loss from unauthorized reservation per hour (%)	26.2	4.8	19.1	13.5
	Average parking duration (hour)	3.2	3.0	2.9	3.5
	Average parking turnover (vehicles/parking space)	2.2	2.6	1.3	1.5
	Parking Index (%)	52.0	75.1	45.0	66.8
2nd: Legal and illegal parking	Average loss from unauthorized reservation per hour (%)	29.3	7.2	17.3	12.7
	Average parking duration (hour)	3.1	2.9	4.4	4.4
	Average parking turnover (vehicles/parking space)	2.6	3.2	1.7	2.0
	Parking Index (%)	52.8	71.0	55.6	67.5

4.1.6 Informal and illegal governance of on-street parking space

In neighborhoods where on-street parking is currently free, it was regulated by persons identified as unauthorized attendants who collected parking fees from drivers. The amount of information regarding unauthorized parking governance came from media reporting, which frequently revealed incidents of on-street parking on various streets of Bangkok, which were subject to unauthorized and illegal governance in areas with high parking demand, such as those surrounding public parks and commercial areas. This repeatedly occurred in some areas, such as the parking space near Saranrom Park (Thairath, 2016).

4.2 Negative Impact of On-Street Parking Issues

According to evidence from news reports, field surveys, and in-depth interviews, the parking issues described in the earlier section have adverse effects on individuals and communities. Among the problems, traffic congestion is the one that manifests itself most frequently. The negative impacts are as follows:

4.2.1 Traffic congestion

Parking issues significantly impact Bangkok's traffic congestion. The existence of parking issues, including the fee collection problem, a large number of long-term parkers, and unauthorized parking reservations, leads to the inefficiency and insufficiency of on-street parking facilities, which in turn increases the behavior of cruising for parking. The cruising for parking creates a moving queue of cars waiting for vacant parking spaces, slows down vehicles, and increases traffic congestion.

Moreover, illegal parking and double parking contribute to traffic congestion. Illegal parking and double parking, which are most widespread where and when street parking spaces are scarce, diminish the road's width and capacity, sometimes blocking traffic flow and causing traffic congestion. This also causes public transit services to be delayed.

4.2.2 Social violence

The conflicts between drivers and other people, including residents, business owners, and public officers, often arise due to these parking issues. For instance, in a recent incident widely reported in the news, residents smashed an illegally parked car blocking their driveway. Several residents and business owners also assert that illegal parking frequently obstructs access to their buildings. Due to the absence of signage and markings indicating paid-parking locations, parking wardens frequently come into conflict with drivers who refuse to pay the parking fee, resulting in physical altercations.

4.2.3 Accident

According to the Traffic Police, illegal parking is considered a cause of accidents. This is because illegal parking reduces the driver's visibility, especially when exiting a building driving out of a distribution road (Soi), leading to accidents. However, the empirical evidence is not conclusive on this point.

4.2.4 Public insecurity

The public safety issue was created by parking issues associated with the informal and illegal governance of on-street parking spaces and unauthorized parking reservations. For example, drivers who refuse to pay parking fees to unauthorized parking attendants risk having their vehicles damaged while they are away. This also happens when drivers park in restricted parking spaces where ownership is claimed de facto.

4.2.5 Air pollution

The shortage of available on-street parking spaces generates air pollution in the neighborhood by encouraging drivers to cruise for empty parking spaces near points of attraction. Searching for a vacant parking place induces cruising and frequent stops, which generate greenhouse gas emissions, particularly carbon monoxide emissions. (Tsai & Chu, 2011)

4.3 The Underlying Causes of Parking Issues

The last section describes the current difficulties and issues with on-street parking policy and management and their negative impacts on society. Using the Iceberg model, this section examines the contexts, trends, structures, and mental models connected with on-street parking policies and management to determine the root causes of parking problems. Figure 4-4 illustrates the causal relationship between negative impacts, parking issues, and

underlying causes. Please note that the number (#) corresponds to the interviewees indicated in Appendix D.

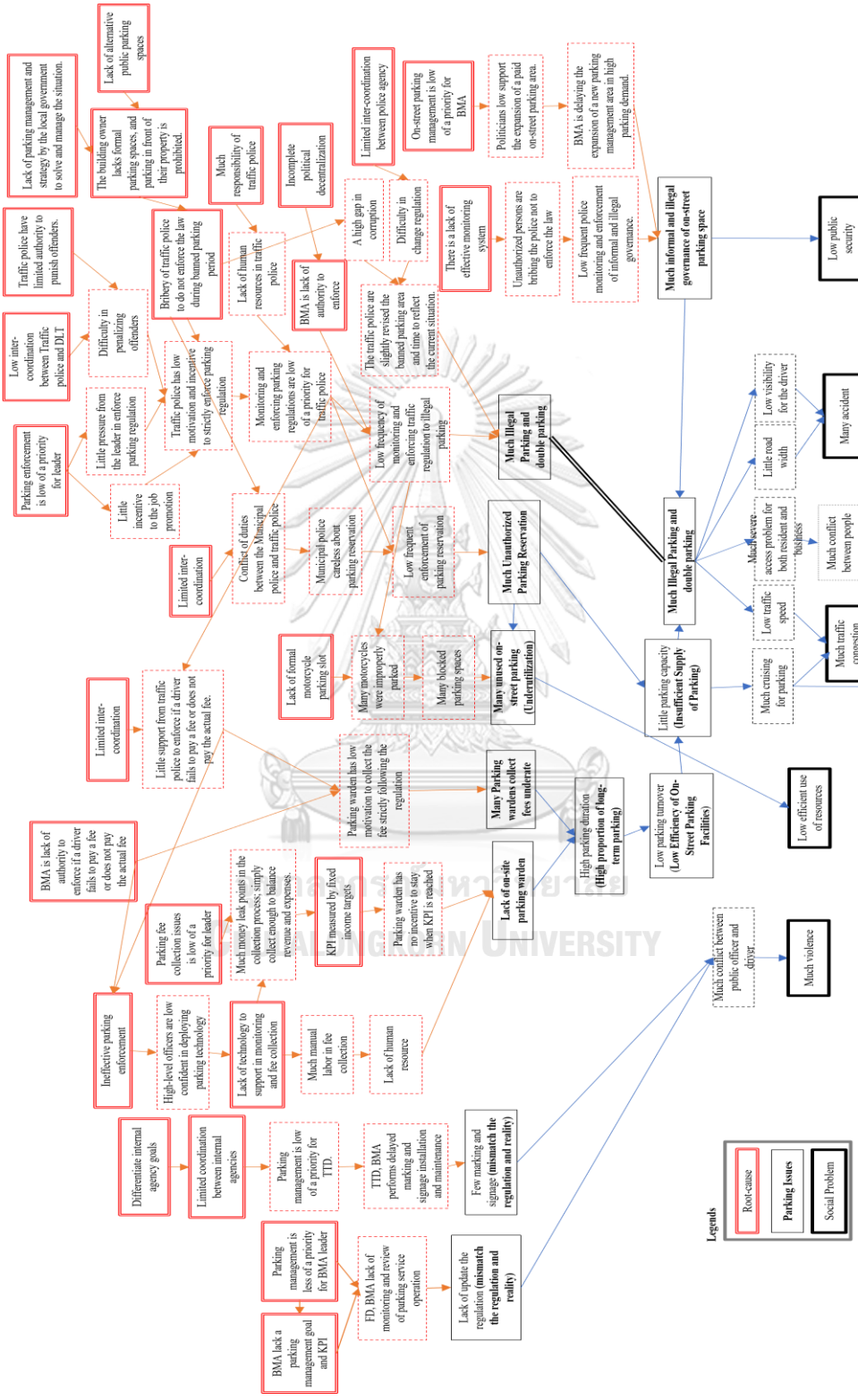


Figure 4-4 Causes and effects of on-street parking policies and management

4.3.1 Context and trends

- **Car-oriented city development with poor public transit**

Bangkok was established as the capital of Thailand in 1782. The city is located in the fertile lower Chao Phraya River delta in the country's Central Plain. This area has a network of canals that makes transport and shipping easy and economical (Thumpthong, 1975; Tipatas & Phongsathat, 1982). As the country's capital, Bangkok is the focal point of all aspects of the economy, such as manufacturing, shipping port, and airport (Ouyyanont, 2017). Bangkok's population was estimated to be between 50,000 and 100,000 in 1850 (Wyatt, 1990) and 5,700,000 in 2021 (National Statistical Office, 2021).

Since the 1960s, Bangkok's traffic congestion has been a concern for policymakers (Kakizaki, 2014). Due to the poor quality of bus services and the lack of reliable public transportation options that respond to the public travel demand, people were encouraged to shift to using private vehicles (Chalermpong, 2019). To alleviate traffic congestion in the 1980s and early 1990s, the government prioritized the construction of infrastructures that favored car use. Those infrastructures included roads, expressways, motorways, overpasses, and flyovers, which took precedence over public transportation (Chalermpong & Ratanawaraha, 2019). With this and poor urban planning, the urbanization pattern is characterized by urban sprawl, notably the extension and densification of built-up regions along major roads (Yamashita, 2017).

The era of urban rail transit began in 1999 when the BTS Silom Line (National Stadium - Saphan Taksin) and the Sukhumvit Line (Mo Chit - Onnut) were launched (Chalermpong, 2019). Prior to that, the development of rail transportation was slow due to the government inconsistency and frequent changes (Samart Ratchapolsitte, 2007). Subsequently, the government shifted its focus from the highway construction to the rail development by creating the "M-MAP" master plan for the rail transit system, which was to be constructed within a twenty-year development period. (For more information about the history of urbanization and the transportation system in Bangkok, see Chalermpong, 2019).

- **Previous parking management with numerous difficulties**

The first step in implementing the management of on-street parking spaces was triggered by the recognition by policymakers that illegal street parking led to traffic congestion (National Archives of Thailand, 1960). Before 1960, on-street parking in Thailand was controlled by the Road Traffic Act B.E. 2477 (1934), which prohibited parking or stopping vehicles on specified streets. However, widespread illegal parking demonstrated that this legislation was insufficient (National Archives of Thailand, 1960). The Parking Management within Municipalities Act B.E. 2503 (1960) was enacted to permit municipalities, including the BMA, to designate parking-permitted street segments and levy on-street parking fees within their respective jurisdictions. The rationale was that drivers who parked their cars on the streets should contribute to the costs of street construction, operation, and maintenance by paying municipal parking fees. It has been demonstrated that Bangkok's parking management has multiple benefits, such as reducing traffic congestion, lowering

accident rates, boosting parking turnover in commercial and business areas, and producing revenue for the local government (National Archives of Thailand, 1970a). The Ordinance (No. 1) of B.E. 2503 (1960) designated 4 streets in Bangkok's central district as parking-permitted. The number increased to 23 in 1971, as illustrated in Figure 4-5. These streets were concentrated in the old town and business districts of Bangkok. The number of designated on-street parking spaces increased between the 1970s and 1990s, reaching 123 in 1994. Subsequently, parking restrictions have been enacted on many streets where street parking had previously been permitted, especially on Bangkok's most congested streets, presumably to alleviate traffic congestion. This demonstrates that on-street parking was not a component in terms of travel demand management. On-street parking spots were reduced to 65 by 1995. The number has remained unchanged until now (BMA Announcement (No. 1) B.E. 2537, 1994; Parking Management within Municipalities Act B.E. 2563, 2020).

In the era of urban rail transit development since the 2000s, which is expected to be a significant turning point in the transformation of parking management, there have been no significant changes to on-street parking to accommodate new transportation networks. Moreover, in 2005, the City Council rejected the BMA governor's efforts to expand the number of streets where on-street paid parking was allowed, believing that it would negatively impact people's lives (Bangkok Metropolitan Administration, 2005).

From the past to the present, the agencies responsible for managing on-street parking have transformed the structure many times. In 1960, the Committee of Municipal Parking Regulation, made up of BMA officers and Metropolitan police officers, was responsible for setting up on-street parking spaces and rates (National Archives of Thailand, 1960). Some Metropolitan police officers were hired as Municipal police (National Archives of Thailand, 1967a). Later in 1967, due to the ineffectiveness of on-street parking management and in order to streamline the bureaucracy, Bangkok Parking Fee Collection Agency was formed as a BMA's municipal enterprise, with BMA and the Traffic Police officials as members of its executive board that monitored the parking management and fee collection (Ministry of Interior Act 206/2509, Bangkok Ministerial rule B.E.2509; National Archives of Thailand, 1967b). The Traffic Police officers were also rewarded monthly for their additional duties in parking enforcement as inspectors (National Archives of Thailand, 1967c). Nonetheless, this new enterprise's performance remained ineffective because of poor coordination and misaligned incentives between the BMA and Traffic Police officers in law enforcement (National Archives of Thailand, 1967c).

Figure 4-5 Locations where paid on-street parking is implemented in Bangkok as of 2022.
Noted: Figure adapted from Fig 12.1 in Chalermpong and Ratanawaraha (2019)

- **Lack of a concrete on-street parking policy**

Despite the fact that the on-street parking management is underway, Bangkok does not have a consistent on-street parking policy. Moreover, there is no clear parking policy objective. The current objective is to reduce traffic congestion. The existing on-street parking regulations, including on-street parking bans and fee collection on designated streets, do not constitute a comprehensive parking strategy to optimize curbside parking use or comply with the urban transit policy (#1,4,7,8,11,13). In addition, the on-street parking planning and management were not incorporated into other urban transportation plans and the off-street parking policy (#1,4,7,25,28,29). This is partly due to the constraints of the BMA Department of Finance's technical capacity. The Department of Finance's primary responsibility is to focus on revenue collection, including local income and tax, rather than transportation management pertaining to parking planning and strategies (#1,2,4,7). It is not surprising that this organizational setup has led to the neglect of managing and reviewing on-street parking plans, resulting in on-street parking locations that do not comply with the BMA announcement. The announcement has become unenforced on-street paid-parking areas, with no assessment and almost no updates on parking areas.

Additionally, Bangkok lacks a parking policy and strategy in response to the rise of digital platforms, such as e-commerce, ride-hailing, food delivery, and car-sharing services that have become an integral part of city life and have increased on-street parking demand.

For example, loading and unloading zones for goods and passengers are required for ride-hailing and delivery vehicles, motorcycles, and cars to prevent problems. Figure 4-6 shows the distribution and density of Bangkok restaurants without onsite parking. In central Bangkok, where a high proportion of restaurants lack parking, food delivery drivers may park in legal and illegal on-street parking areas to pick up orders.

Moreover, as the global trend toward electric vehicles, such as automobiles and motorcycles, has piqued the interest of Thai people in switching from petrol to electric cars (Bangkokbiznews, 2022b), this may necessitate the addition of on-street parking spaces to accommodate the transition. Several scholars from various countries have also investigated the impacts of autonomous vehicles on parking policies, which could potentially change urban parking (Bahrami & Roorda, 2022; Millard-Ball, 2019; Nourinejad et al., 2018). The problems may arise in the future due to the absence of a concrete on-street parking policy that accounts for future changes.

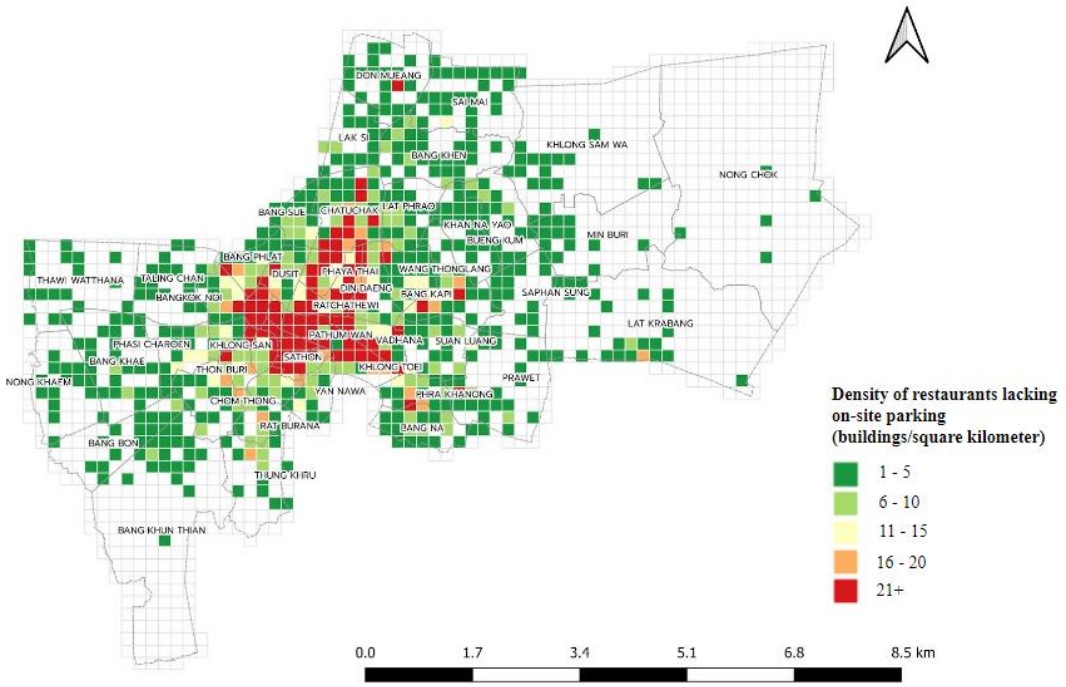


Figure 4-6 The distribution of restaurants without onsite parking (data from a restaurant review website as of January 2020)

- **Manual base fee collection and enforcement**

Public officers collect parking fees manually, since no parking-related technology has been implemented. In the early phase of parking management, parking charges were collected manually by BMA workers who were parking attendants. However, complications arose as these officers failed to collect the fees following the law and instead negotiated a flat rate drivers (National Archives of Thailand, 1960). This problem led to the installation of imported parking meters in 1961 to minimize the need for parking attendants and prevent the corruption associated with manually collecting parking fees (National Archives of Thailand, 1961). Between 1967 and 1971, however, many parking meters were intentionally broken so

that drivers of parked vehicles could avoid paying fees. It was suspected that the vandalizers were shop-owners or residents who parked for extended periods without paying (National Archives of Thailand, 1967c). The ineffectiveness of traffic law enforcement and the inability to penalize violators due to legal obstacles created a critical problem associated with the implementation of parking meters. According to the Archives, police in the past had the same problem they now confront; traffic violators who do not pay the fees. In 1969, only 5% of people who came to the police station to pay for their tickets did so since the enforcement procedure was largely manual. It was also more challenging to track down offenders than it is today (National Archives of Thailand, 1970b).

Because parking meters were frequently broken, the BMA were requested to remove all of them (National Archives of Thailand, 1970c). In 1970, an investigation comparing parking meters and manual collection concluded that manual collection generated 4 times more money than parking meter collection. This resulted in eliminating all meters in 1971, except at Rajdamri and Surawong Roads. However, following the return to manual collection, old problems returned, including corruption by parking wardens who struck deals with frequent drivers to make daily, weekly, or monthly payments or altogether neglected to issue tickets after collecting fees (National Archives of Thailand, 1971).

In Bangkok, the parking technology has advanced significantly and is widely used, but mostly in private off-street parking building operations, such as the provision of parking availability information, automatic license plate recognition, and electronic payments. The Internet of Things (IoT) smart parking system has been initially implemented, allowing online reservations of outdoor parking spots and parking in buildings (Voice TV, 2017). Nevertheless, the technology for managing on-street parking spaces and enforcing the parking ban is very little used by the BMA and the Traffic Police. A parking meter represented the most recent innovation in fee collection. Traffic police deployed an automatic traffic violation camera to detect traffic violations. However, for the parking enforcement, traffic police manually issue paper tickets and clamp wheels. Due to legal and financial constraints, illegally parked vehicles were rarely towed (#9, 15). Several interviewees (#1,2,4,7,11,12,13,14,15) agreed that their operational processes lacked appropriate monitoring mechanisms. This was partly due to a lack of equipment and technology that could be used to monitor operations, such as CCTV cameras. In addition, the Police and the Department of Land Transport are still developing a vehicle registration database and a point reduction program to improve the effectiveness of law enforcement (Bangkokbiznews, 2022a).

4.3.2 Structures: organizations, laws, authority, and relationships

- **Institutional fragmentation**

One of the underlying drivers of Bangkok's on-street parking policies and management's problems is the highly fragmented institutional structure. Each agency had independent responsibilities and missions. In addition, there was no centralized authority to plan and manage on-street parking (#1,2,4,7,9,11,12,13,14). Figure 4-7 and Table 4-4 illustrate that at least 14 national and local government agencies are directly and indirectly

involved in the on-street parking management in Bangkok. On-street parking management responsibilities were shared among the departments under three ministries of the national government: the Ministry of the Interior (MoI), the Royal Thai Police (RTP), and the Ministry of Transport (MoT). The BMA, as a local government, reports to the MoI. In principle, the BMA should be entirely accountable for planning and executing the on-street parking management. However, it is only responsible for the planning, signage, road marking, and fee collection of on-street parking. The Traffic Police under the Metropolitan Police Bureau of the RTP is responsible for designation of on-street parking prohibition zones and parking enforcement. In addition, two department-level agencies indirectly support the on-street parking management. The first is the Office of Transport Planning and Policy (OTP) under the MoT, which is responsible for developing policies on traffic management. The other supporting agency is the Department of Land Transport (DLT) of the MoT, which oversees motor vehicle registration. The Department's cooperation is indispensable for parking enforcement. This illustrates the fragmented institutions of on-street parking governance and at the same time the dominance of central government agencies over the BMA.

Interagency coordination of parking management in Bangkok has been difficult due to this institutional fragmentation, despite the establishment of the inactive joint committee of the BMA and the police for parking management. Because each agency reports to a different ministry of the national government and has separate and independent responsibilities and missions, they lack incentives to collaborate (#1,2,4,7,9,11,12,13,14). For instance, the Parking Services Unit (PSU) is a subdivision of the BMA's Finance department responsible for the daily operation of formal on-street parking spaces. Since traffic police officers' primary responsibility is traffic management, with limited human resources, they do not prioritize enforcement of on-street parking regulations in line with the BMA's PSU, which reports to a different ministry (#9, 13, 14). In another example, in the case of owners of vehicles cited by police for traffic offenses, the DLT continues to renew the vehicle registration for those who fail to pay fines, citing their legal duty to renew registration regardless of outstanding fines (#9,11,12,13,14,15). According to the Office of the Council of State (2015), the DLT could be sued for not carrying out its legal duty, as stipulated by the Motor Vehicles Act B.E. 2522, if it refused to renew the registration of vehicles cited for violation of the Road Traffic Act B.E. 2522 by the police. As a compromise, the DLT agree to accept payment of fines on behalf of the RTP when drivers pay their annual tax, although drivers can still renew their vehicle registration even if they do not pay the fines. As one interviewee mentioned, "The legal process for suing for failure to pay the fine is problematic, including the court process and limited staff. In addition, traffic violations are minor offenses with a one-year prescription; thus, most cases expire before the litigation ends." For these reasons, the police have no recourse to compel drivers to pay fines and voluntary compliance is low—only 18% of reported traffic violators paid fines in 2020 (Thairath, 2021).

At both the national and local government levels there is a lack of intra-agency coordination resulting from fragmented institutions. According to interviewees, collaboration across departments of the BMA was difficult due to their disparate responsibilities and missions, even within the same organization (#1,2,4,7,11). For example, the Finance Department of the BMA is the primary agency responsible for on-street parking management, including developing an on-street parking policy and collecting daily fees at paid parking

locations. They do, however, require assistance from the BMA Department of Traffic and Transportation for installing and repairing signage and painting markings in on-street paid parking areas. Yet, because the Traffic and Transportation Department was already overburdened with their core responsibilities of installing and maintaining traffic signs and markings across Bangkok, requests for the installation or repair of signage and markings for on-street parking regulations were frequently delayed or denied (#1, 4, 7, 11,13,15).

Moreover, interviewees stated that no authority or lead agency oversaw the on-street parking management. They instead focused on their primary responsibilities and day-to-day jobs (#1,2,4,9,11,12,13,14). As a result, no one acts as a leader with the power necessary to completely plan and manage on-street parking, making it more difficult to implement policies and push for the improved on-street parking management.

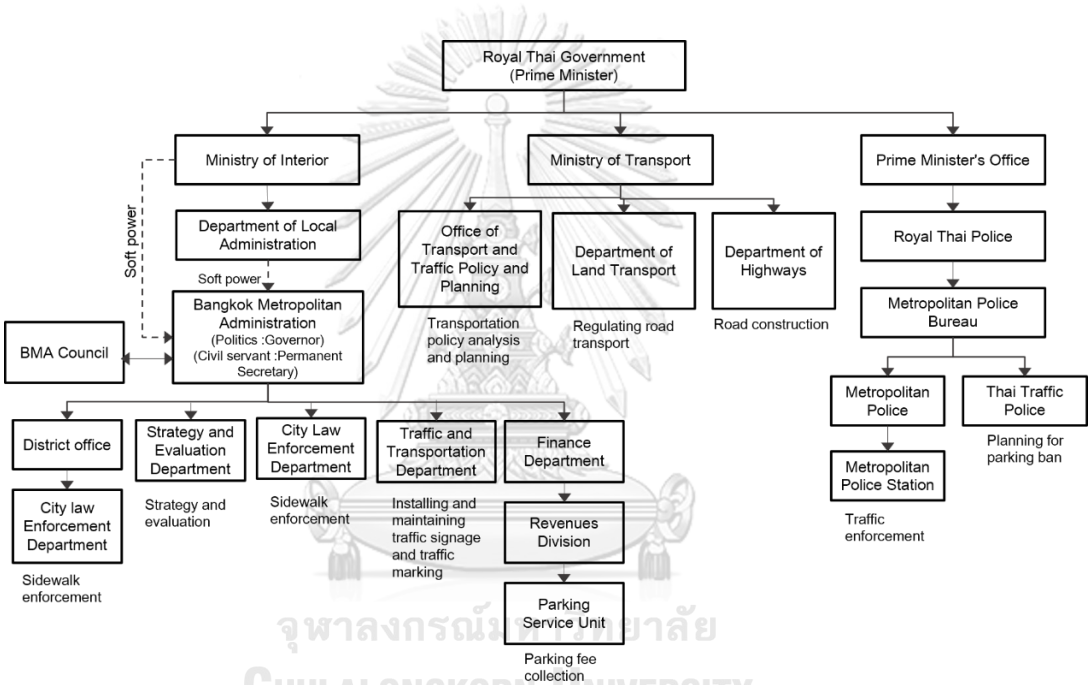


Figure 4-7 Hierarchy and relationships of government bodies related to on-street parking
Noted: Figure adapted from Figure 2 in Chullabodhi et al. (2022)

Table 4-4 Bangkok's agencies responsible for on-street parking management

Agency	Under	Responsibilities
Department of Local Administration	Ministry of Interior (MoI)	- Lead the development of the Parking Management within Municipalities Act B.E. 2562 and ministerial regulations
Bangkok Metropolitan Administration (BMA) BMA Council City Law Enforcement Department (CLED) Traffic and Transportation Department (TTD) The Finance Department (FD) Parking Services Unit (PSU)	MoI	- BMA Council is responsible for regulating, inspecting, and monitoring the Bangkok Executive Committee's Political and Civil Servants. - City Law Enforcement Department is responsible for sidewalk enforcement to ensure compliance with applicable laws, such as the Cleanliness Control Act. - Traffic and Transportation Department is responsible for installing and maintaining traffic signage and traffic markings. - The Finance Department collects taxes and works with the BMA council to determine on-street parking locations and rates. - Parking Services Unit is responsible for operating formal on-street parking areas daily and collecting parking fees from parked vehicles on the streets.
City law Enforcement Department, District office	District office, BMA	- Control and regulate following the district's authority and responsibilities, including cooperating with the Department of Law, BMA.
Thai Traffic Police	Metropolitan Police Bureau, Prime Minister's Office	- Plans and approves the implementation of the on-street parking restrictions. Responsible for traffic control and enforcement in support of the Metropolitan Police Station's Traffic Police.
Traffic Police, Metropolitan Police Station	Metropolitan Police Bureau, Prime Minister's Office	- Control and regulate the safety of road users and traffic flow, such as enforcement of illegal parking on streets where no parking is allowed; issuing traffic citations, clamping wheels, or towing away vehicles.
Office of Transport and Traffic Policy and Planning (OTP)	Ministry of Transport (MoT)	- A transportation "think tank" engaged with developing transportation policy, infrastructures planning, transportation and traffic analyses, and traffic management schemes for Thailand's cities.
Department of Land Transport (DLT)	MoT	- Motor vehicle registration, regulations of vehicle, and formal and informal transport operations.

Noted: Table adapted from Table 1 in Chullabodhi et al. (2022)

- **Limited legislative authority and ineffective enforcement**

The BMA lacks the legislative authority to implement effective on-street parking management, as the national government has not delegated the necessary legislative powers to the BMA. According to the Parking Management within Municipalities Act B.E. 2562, the

national government has authorized the BMA and other local governments to enact municipal laws establishing paid-parking locations, parking regulations, fee collection methods, and maximum parking fee rates. The Act empowered both the Traffic Police and the BMA officials to enforce on-street parking laws. In practice, however, only the Traffic Police enforces traffic-related parking rules. If a driver fails to pay a fee for parking on a designated street, the BMA employees have no legal authority to issue a parking citation (#1,2,3,4,10). Additionally, the Traffic Police has the authority to determine the rate of traffic fines and ban on-street parking on the Bangkok streets, including the time period of the ban. With limited legislative authority, the BMA cannot function effectively and is compelled to have a parking warden on duty in paid-parking locations to ensure that drivers pay parking fees. The process requires massive labor resources. This restricts the BMA's ability to install parking collecting technologies, such as parking meters and electronic payments (#1,2,4).

Furthermore, the Traffic Police have no power to coerce or punish a vehicle owner if they do not pay fines for violations of traffic rules. Due to the police's inability to penalize offenders through tickets, Bangkok's on-street parking management has suffered various negative consequences. For instance, the police must immobilize vehicles with wheel clamps to guarantee that drivers who park illegally pay fines for removing the wheel clamp. This procedure consumes more time and human resources than issuing a ticket (#9,11,12,13,14,15).

Another difficulty with the existing legislation and regulation enforcement is that fines do not fully cover the cost of enforcing them effectively. For instance, the fines for towing illegally parked vehicles do not reflect the actual cost of towing and storage, creating no motivation for police to tow-away vehicles unless necessary (#9, 15). According to one key informant: “There is a practical problem with towing the car; the lack of storage and the low fines discourage the private sector from participating since they believe the income is not worth the risk. Furthermore, we have no idea when the vehicle's owner will return to get the vehicle. Additionally, the fee is set at a fixed amount that does not grow as the number of storage days increases.”

4.3.3 Mental models: beliefs, traditions, and values

- **Lack of interest and commitment from national and local policymakers**

Our in-depth interviews reveal that policymakers, both at the national and local levels, who govern on-street parking policies and management demonstrate a lack of interest in and commitment to on-street parking management. Tensions between the government agencies and local government contribute to this disinterest, especially because governance of on-street parking in Bangkok is only partially decentralized. Several interviewees said that BMA leaders, such as the governor and heads of the department responsible for on-street parking management tasks, are generally not interested in the issue (#1,2,4,5,6,7). They noted, for example, that on-street parking was not emphasized in the BMA's mission and that there are no key performance indicators for on-street parking management in the Bangkok development plan's 20-year outlook (#1,4,7). Even though the Bangkok Metropolitan Council established a study committee to study the curbside parking management and submitted

reports and recommendations to the relevant agencies, no action has been taken (#1,4). As a result, little systematic effort has been made by national and local policymakers to improve the effectiveness of on-street parking management.

- **Misalignment of stakeholders' mindsets, motivations, and incentives**

We found that stakeholders' mindsets, motivations, and incentives are not aligned, resulting in behavior that contributes to parking issues, as illustrated in Table 4-5 Several stakeholders are opposed to managing on-street parking and have no incentive to do so. The primary enforcers of regulations are the municipal police and traffic police officers. The municipal police manage illegal parking on walkways, while traffic police officers cover on-street parking violations. Both fear public complaints because they may negatively affect their promotion to management levels. For example, wheel clamping a car owned by a politician, a high-ranking government official, or someone who has connections with a high-ranking government official could have adverse impacts on a police officer's job security (#4,13,14). In addition, traffic police and parking wardens can benefit from unregulated on-street parking regulations through bribes as there is a low incentive for the public to report corruption. The public is largely willing to bribe public officials when the incentive aligns with their motivation and mindset. When bribery occurs, the traffic police abstain from taking action against infringements, such as parking during the prohibited period.

Table 4-5 The stakeholders' mindsets, motivations, incentives, and behaviors

	Mindset	**Motivation**	**Incentive**		**Behavior**
			Non-monetary	**Monetary**	
Policymakers					
OTP, MoT	The local government is the primary host for on-street parking management, while OTP is a think-tank for the MoT.	To ensure that people access convenient, safe, on-time, and affordable transportation options.	None (Because it is not to be the primary focus of the MoT)	None (Because it is not to be the primary focus of the MoT)	OTP acts as a supporter. The on-street parking policy is not part of the transportation policy and planning.
FD, BMA	Managing on-street parking is a minor task that demands a huge amount of effort.	To maximize Bangkok's revenue and tax collection.	None (Because it is not emphasized in the BMA's plan)	None (Because profits are breaking even)	A lack of interest since they operate just to the extent necessary to comply with the law.
Thai Traffic Police	To support the Metropolitan Police Station regarding traffic management.	Smooth traffic, no traffic congestion, and no public complaints.	Recognition from the management level, career development, and promotion	None (Because it is a policymaker level)	They lack regular updates on no-parking regulations and avoid policies that harm influential people, politicians, and individuals who have connections with powerful people.

	Mindset	Motivation	Incentive		Behavior
			Non-monetary	Monetary	
Policy implementers					
PSU, BMA	The civil servants acting harshly against people for on-street parking violations would be perceived strictly as unreasonable. People are not afraid of BMA employees because they do not have the same powers as police officers.	To organize on-street parking following the law and provide parking more accessible to people.	Career development and promotion	None (Because profits are negligible and all revenue must be remitted to the municipality)	They operate just to the extent necessary to comply with the law and only coordinate with the traffic police when a problem arises.
Parking warden	People are not afraid of BMA employees because they do not have the same powers as police officers.	To work as fast as possible to achieve KPIs.	None (They are personal outsourcing)	Bribes or other goods from local residents or business owners.	They collect the parking fee in whatever way possible. For example, they negotiate a deal with residents to provide unlimited parking for a monthly charge.
Law enforcement					
Traffic police	Traffic enforcement is a minor task. Some officers oppose on-street parking because it impedes traffic.	Smooth traffic, no traffic congestion, and no public complaints.	Recognition from the management level, career development, and promotion	50% share of traffic fines and bribes for avoiding penalties for car owners for violating the on-street parking regulations.	They enforce parking regulations intermittently and selectively, only when a car is parked, causing or worsening traffic congestion.
Municipal police	Municipal police are responsible for the walkways, and the traffic police are responsible for the roads.	To keep the city well-organized, minimize public complaints, and ensure that the law is followed.	Recognition from the management level, career development, and promotion	50% share of fines	They occasionally penalize cars and motorcycles parked on the sidewalk, especially when people complain.
Public					
Resident	They have de facto use right in front of residential properties.	To have convenient parking.	To secure vehicle parking, avoid obstruction by a parked vehicle, and receive superior	Not to pay fines when parking illegally	They block the on-street parking spaces with objects and are willing to bribe the officer to allow parking

	Mindset	Motivation	Incentive		Behavior
			Non-monetary	Monetary	
			treatment from the officers.		during the prohibited period.
Shop-owner	They have de facto use right in front of properties for commercial and personal purposes.	To have convenient parking for clients and employees, as well as loading and unloading goods.	To secure vehicle parking, avoid obstruction by a parked vehicle, and receive superior treatment from the officers.	Not to pay fines when parking illegally	They block the on-street parking spaces with objects and are willing to bribe the officer to allow parking during the prohibited period.

Noted: Table adapted from Table 3 in Chullabodhi et al. (2022)

4.4 Summary of Bangkok's On-Street Parking Situation

The results of the empirical investigation reveal the problems and causes of the poor on-street parking situation in Bangkok. The on-street parking situation is currently plagued by various parking issues, some of which are Bangkok's unique cultural features, such as unauthorized parking reservations and unauthorized governance. Illegal parking, double parking, and unauthorized reservation are allowed for a long period without being cited by traffic police officers. Parking regulations, such as those prohibiting parking on odd- and even-numbered days or during peak hours, are completely ignored by drivers who remain to park illegally, demonstrating the curb user's low perception of the seriousness of parking violations.

The efficiency-related evaluations, such as turnover rate and parking index, indicate that paid on-street parking in Bangkok is highly inefficient. Comparatively, parking turnover rates ranged from 6.9 to 13.1 vehicles per parking space in Shanghai, Calabar, and Dhaka, while the parking index ranged from 78% to 105%. (Chen et al., 2016; Reza et al., 2017; Ukam, 2020). One of the causes of Bangkok's inefficient on-street parking is the high rate of unauthorized reservations that occupy available parking spaces. Moreover, unauthorized parking governance by individuals was also discovered in Bangkok, as was reported in some cities like Jakarta (Barter, 2011) and Pretoria (Hoye, 2015). These identified on-street parking issues have contributed to Bangkok's severe social problems, which have also been reported in other cities, such as Delhi (Sustainable Urban Transport Project, 2017) and Makassar (Basri Said & Syafey, 2021). Other issues include traffic congestion caused by illegal parking, accidents, and physical violence. In addition, unauthorized parking attendants in Bangkok may harm a vehicle if the driver does not pay the fee.

Using an Iceberg framework shows multiple causes for on-street parking problems, which can be summarized into six root causes, as presented in Figure 4-8. Subsequently, we rank the impacts of root causes based on which is most likely to improve the situation if handled first, as measured by the number of causal links leading to parking problems and their association with other causes. The list of the root causes, from most significant to least significant, is shown below:

1. The lack of political support at both the local and national levels is the primary obstacle to Bangkok's effective on-street parking policies and management. It demonstrates neither an awareness of on-street parking problems as a serious issue nor a commitment to manage them effectively. Consequently, the current parking management lacks policy goals and a plan for on-street parking. Despite the emergence of current and future urban trends that change people's behavior, such as food delivery, shared mobility, on-demand transport, electric mobility, and autonomous vehicles, the on-street parking management has improved little over the previous two decades.
2. The incomplete decentralization of functions related to on-street parking management has left local governments incapable of managing on-street parking facilities effectively.
3. Effective parking planning, monitoring, enforcement, and parking technologies were absent from the public works' current on-street parking management. Thus, most work is performed manually, requiring a great deal of time and human resources.
4. Stakeholders' mindsets, motivations, and incentives are not aligned, resulting in the behavior that contributes to the ineffective on-street parking management. For example, all policymakers are inactive for the on-street parking management as their mindsets and motivations are irrelevant to it. In addition, several stakeholders are opposed to managing on-street parking and have no incentive to do so.
5. Corruption behaviors, such as bribery, were also discovered in the on-street parking management due to the operational process's inefficiencies. This problem is related to shop-house building owners who lacked parking spaces. The government has no parking strategy to address this issue. Therefore, building owners must pay bribes to secure parking spaces.
6. Fragmented parking governance institutions hinder the effectiveness of the on-street parking management due to poor inter- and intra-agency cooperation. Institutional fragmentation has also been observed in other developing countries, such as Chinese cities (Wang & Yuan, 2013), posing considerable barriers to the successful on-street parking management.

In addition, some of these parking issues and underlying causes have been documented in official government records from the National Archives since 1971. On-street parking problems were the rationale for the demand for an off-street parking policy discussed in detail in Chapter 5. This demonstrates that the on-street parking problem has not been effectively resolved for a long time and must be addressed properly to diminish its impact on society, as discussed in Chapter 6.

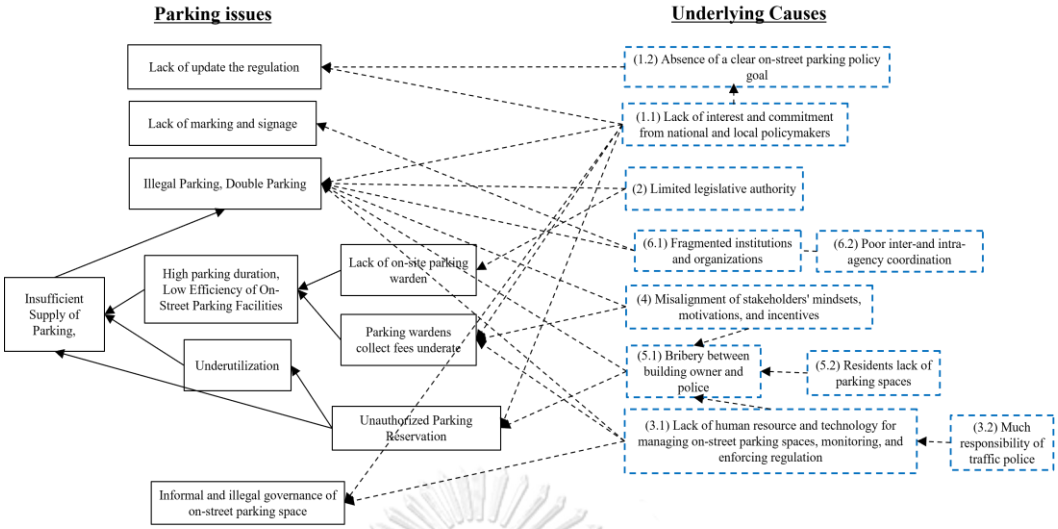


Figure 4-8 Linkage between on-street parking issues and their root causes

CHAPTER 5

OFF-STREET PARKING SITUATION IN BANGKOK

This chapter describes the off-street parking situation in Bangkok. We open the chapter by examining the parking provision and utilization of buildings in relation to the existing minimum parking requirements. The negative impacts of identified off-street parking issues are then described. The study then analyzes the underlying causes of problems and issues that have arisen and persisted. The last section provides a chapter summary.

5.1 Current Parking Issues: What, When, and Where?

This section provides a summary of the empirical evidence related to the minimum parking requirements, which are the off-street parking policy instrument, based on the parking provision data from the EIA report and the parking demand in the building, which reveal the following parking challenges.

5.1.1 Existing minimum parking regulations impede the development of projects that encourage transit use

The empirical evidence regarding the distribution of excess parking ratio indicates that the MPRs affect developers' decisions to provide parking spaces for large building projects in Bangkok. Even though the excess parking ratio may not explain developers' decisions on the parking provision, it is indicative of how binding the MPRs are to developers as they consider the amount of the parking provision. From 2000 to 2020, 86% of the sample projects provided the bare minimum or exceeded the legal minimum by less than 10%. As shown in Table 5-1, the average actual parking spaces of all building types is higher than the average number of required parking spaces, indicating that the actual parking spaces are greater than the required amount in most projects—the excess parking spaces over the required parking range from 0 to 433. The average excess parking spaces in condominiums and hotels are significantly smaller than in the office and mixed-use buildings.

The excess parking ratio distribution shown in Figure 5-1 demonstrates that the MPRs has a stronger effect on developing condominiums and hotels than on offices and mixed-use buildings. Note that two observations provide fewer parking spaces than the minimum required parking. Also, we consider those observations to be equivalent to the minimum parking requirements. In our dataset, only 12% of condominiums and 18% of hotels have an excess parking ratio greater than 0.1. In comparison, 33% and 50% of office and mixed-use buildings have an excess parking ratio greater than 0.1. This result indicates that condominiums and hotels in Bangkok generally have a lower excess parking ratio, with the majority providing less than 10% of the minimum standards. In contrast, more than 30% of office and mixed-use buildings provide parking spaces more than 10% over the standard. In addition, a few projects exceed the standards by more than 90%.

This study's results also reveal that the locational characteristics of a building affect the developers' decisions regarding the provision of excess parking spaces. More than half of

the condominiums within a one-kilometer walking distance of the transit station provide parking exactly equal to the minimum standards. Nevertheless, a large number of condominiums exceed 25% of the required standards, as shown in Figure 5-2(a). As presented in Figure 5-2(b), there is a trend for office buildings in urban areas close to transit stations to provide parking close to the minimum standards and more parking spaces in locations farther than 10 kilometers from the Silom area. Several hotels within half a kilometer of the nearest transit station provide parking spaces exceeding 10% of the minimal requirements. In addition, many mixed-use constructions provide parking spaces over the minimum requirements. For example, a hotel-office mixed-use development near a transit station provides 120% more parking spaces than the minimum requirements, as shown in Figure 5-2(d).

Using the same dataset, we can also capture the parking provision trend from 2000 to 2020. As shown in Figure 5-3, developers' decision to provide parking in condominiums with a high excess parking ratio of more than 0.20 was a trend between 2009-2011 and 2018-2019. However, due to the insufficient data, there is no apparent trend for other building types.

Table 5-1 Descriptive parking statistics of condominiums, hotels, offices, and mixed-use buildings in Bangkok, 2001–2020

Variable	No. of obs.	Mean	SD	Min.	Max.
Condominium					
Number of actual parking spaces	829	233.71	213.35	27	1598
Number of auto parking spaces	12	226.33	173.3	37	643
Number of required parking spaces	829	221.59	198.89	26	1591
Number of excess parking spaces	829	12.13	33.21	0	433
Excess parking ratios (excess parking spaces per required parking spaces)	829	0.05	0.11	0	1.21
Parking capacity ratios (parking spaces per dwelling units)	829	0.56	0.36	0.11	2.84
Hotel					
Number of actual parking spaces	44	154.18	170.99	27	1144
Number of required parking spaces	44	144.2	151.74	20	1002
Number of excess parking spaces	44	9.98	24.63	0	142
Excess parking ratios (excess parking spaces per	44	0.08	0.18	0	1

Variable	No. of obs.	Mean	SD	Min.	Max.
required parking spaces)					
Office building					
Number of actual parking spaces	24	328.58	148.58	88	567
Number of required parking spaces	24	279.83	127.69	77	567
Number of excess parking spaces	24	48.75	79.2	0	307
Excess parking ratios (excess parking spaces per required parking spaces)	24	0.2	0.34	0	1.41
Mixed-use building					
Number of actual parking spaces	14	750.93	558.82	71	1844
Number of required parking spaces	14	629.14	492.4	70	1820
Number of excess parking spaces	14	121.79	158.53	0	423
Excess parking ratios (excess parking spaces per required parking spaces)	14	0.22	0.32	0	1.15

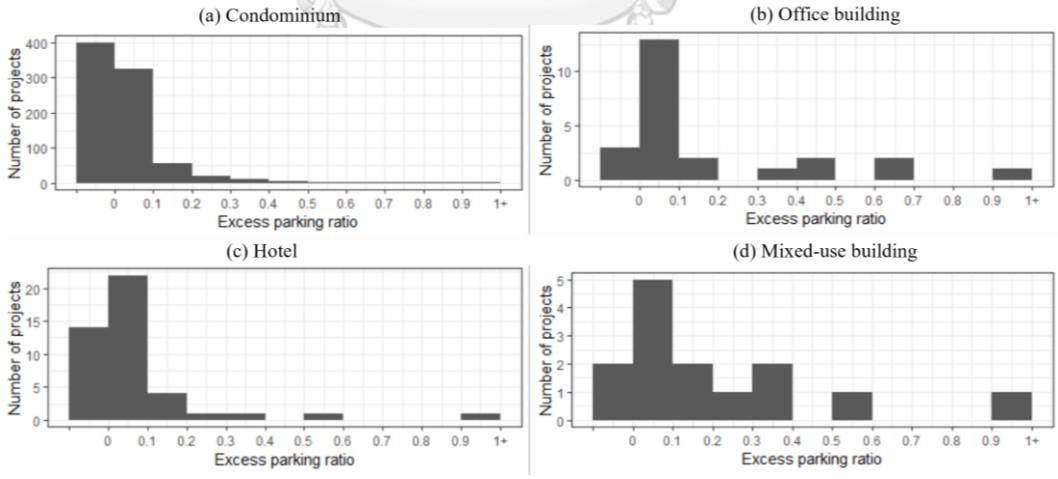
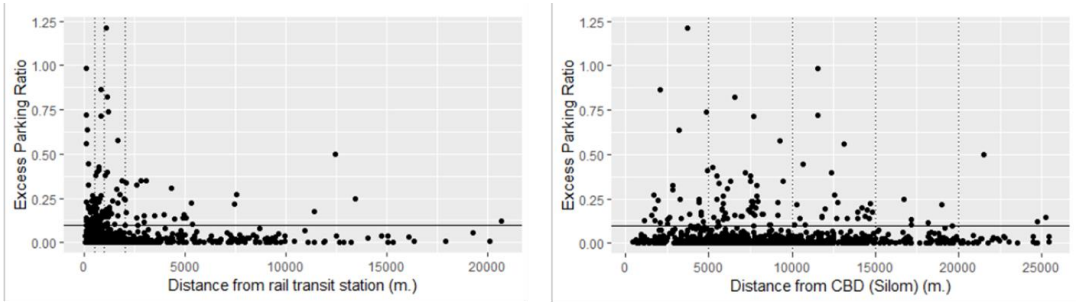
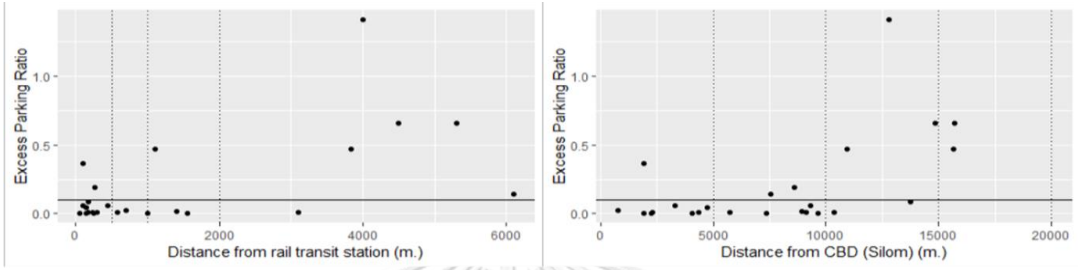


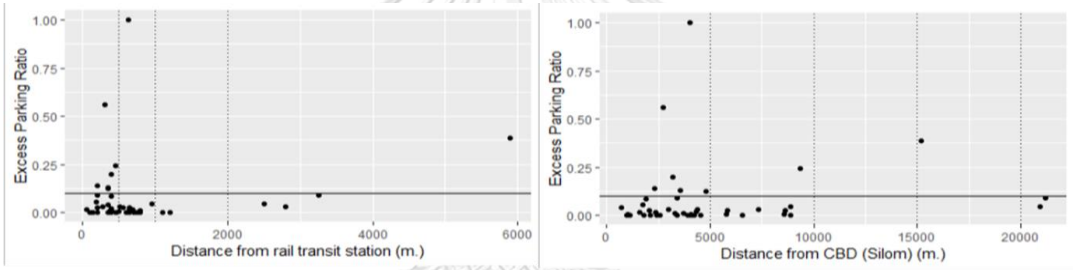
Figure 5-1 Distribution of excess parking ratio of large building projects



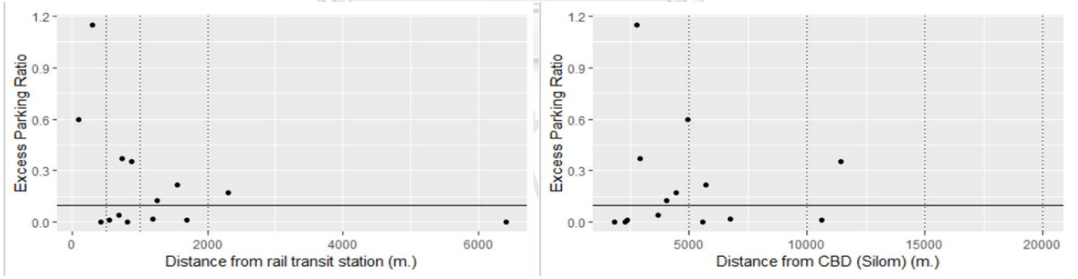
(a) Condominium



(b) Office



(c) Hotel



(d) Mixed-use building

Figure 5-2 The distribution of excess parking ratio with (left) distance from rail transit station (right) distance from CBD.

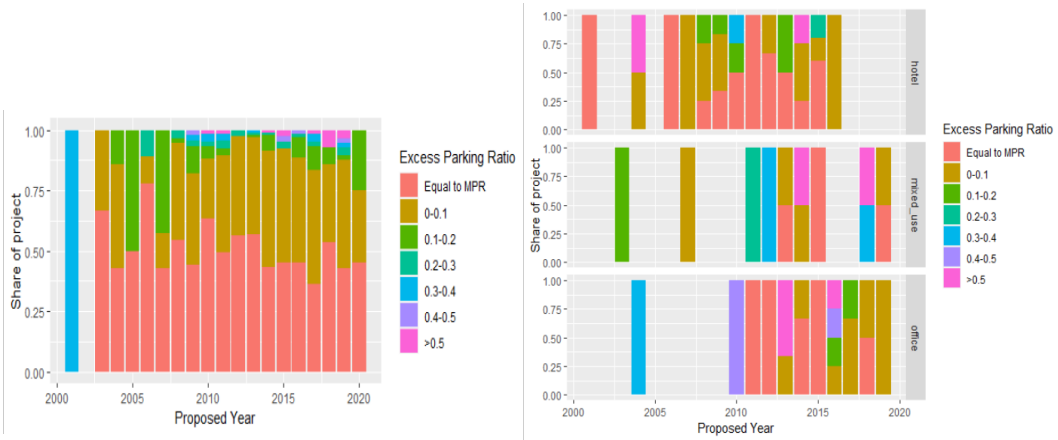


Figure 5-3 Trend of excess parking provision during 2001-2020

- **Characteristics of projects that meet the legal minimum or exceed it by less than 10%**

We further examined the characteristics of samples without excess parking spaces or exceeding the minimum standards by less than 10% and found that the MPRs may affect project developments with some building characteristics, including the transit access and distance from the central business district as mentioned above. As illustrated in Table 5-2, the MPRs may affect the segmentation of each building type, such as condominiums with fewer than 500 units and low-rise buildings with up to 9 floors within one kilometer of transit stations in high- to medium-density zones and within a 10-kilometer buffer from the Silom area. The office buildings that may have been affected by the MPRs are high-rise buildings with a usable area between 20,001 and 60,000 square meters and are located in high-density residential areas within 500 meters of a transit station and 10 kilometers from the Silom area. The MPRs also have affected a relatively small-scale hotel project with a usable area of less than 20,000 square meters, located within one kilometer of a transit station and a buffer zone of 5 kilometers from the Silom area. The minimum standards appear to have affected the large mixed-use project with a usable area exceeding 60,000 square meters in a high-density and transit-rich zone.

Table 5-2 Characteristics of samples that build less than 10% or equal minimal parking requirements

Characteristics		Condo	Office	Hotel	Mixed use
No. of obs.		726	16	36	7
High-rise building		47%	100%	56%	86%
Dwelling unit	1-100	7%			
	101-500	60%			
	501-1,000	23%			
	>1,000	10%			
Usable area (sq.m.)	1-20,000		8%	61%	33%
	20,001-40,000		38%	31%	0
	40,001-60,000		38%	8%	0
	> 60,000		15%	0	67%
Land use	commercial areas	25%	56%	64%	71%
	high-density residential areas	37%	31%	30%	14%
	medium-density residential areas	31%	13%	6%	14%
Distance to the transit station (m.)	<500	30%	63%	50%	14%
	501-1,000	25%	19%	36%	43%
	1,001-2,000	20%	12%	5%	29%
	>2,000	24%	6%	8%	14%
Distance from CBD (Silom) (km.)	<5	21%	50%	72%	57%
	5-10	41%	38%	22%	29%
	10-15	26%	12%	0	14%
	15-20	8%	0	0	0
	>20	4%	0	6%	0
Within the transit-rich area		8%	25%	36%	43%

- **Characteristics of projects that provide more 10% of excess parking spaces than the law requires**

Examining the characteristics of projects that provide over 10% more parking than the minimal regulations reveals that many owners of large buildings in urban high-density areas and even in close proximity to transit stations provide a high number of excess parking spaces. For example, more than half of condominiums, hotels, and mixed-use buildings in

high-density zones within 10 kilometers of the central business district have more parking spaces than the minimum guideline of 10%, as shown in Table 5-3. Due to the building owners' ample provision of parking places, this phenomenon will encourage people to enter the city center by private automobile. Consequently, public transportation may become less attractive.

Table 5-3 Characteristics of samples that build more than 10% of parking spaces than the law requires

Characteristics		**Condo**	**Office**	**Hotel**	**Mixed use**
No. of obs.		103	8	8	7
High-rise building		65%	75%	38%	100%
Dwelling unit	1-100	6%			
	101-500	53%			
	501-1,000	24%			
	>1,000	17%			
Usable area (sq.m.)	1-20,000		29%	57%	50%
	20,001-40,000		43%	29%	0%
	40,001-60,000		14%	0%	0%
	> 60,000		14%	14%	50%
Land use	commercial areas	29%	38%	50%	57%
	high-density residential areas	39%	12%	25%	43%
	medium-density residential areas	23%	50%	12%	0%
	low-density residential areas	6%	0%	12%	0%
	others	3%	0%	0%	0%
Distance to the transit station (m.)	<500	22%	25%	75%	29%
	501-1,000	28%	0%	12%	29%
	1,001-2,000	26%	12%	0%	29%
	>2,000	23%	63%	12%	13%
Distance from CBD (Silom) (km.)	<5	24%	12%	75%	71%
	5-10	44%	25%	12%	14%
	10-15	23%	38%	0%	14%
	15-20	6%	25%	12%	0%
	>20	3%	0%	0%	0%
Within the transit-rich area		13%	13%	25%	29%

5.1.2 A mismatch between parking supply in condominiums and transit provision

There is a mismatch between parking supply and transit provision. For example, condominium developers near the transit station in the urban area provide a large number of

parking spaces for residents, whereas developers in suburban areas far away from transit stations supply a small number of parking spaces. As depicted in Figure 5-4, a large proportion of the condominiums in our sample located in urban areas and near transit stations offer more than one parking space per dwelling unit. While in suburban areas more than 15 kilometers away from Silom, the average ratio of parking spaces to residential units ranges from 0.32 to 0.39, as shown in Table 5-4. This outcome is unexpected because individuals in a low-accessibility suburban neighborhood should own cars, although the developer has decided to supply very few parking spaces, possibly causing parking issues.

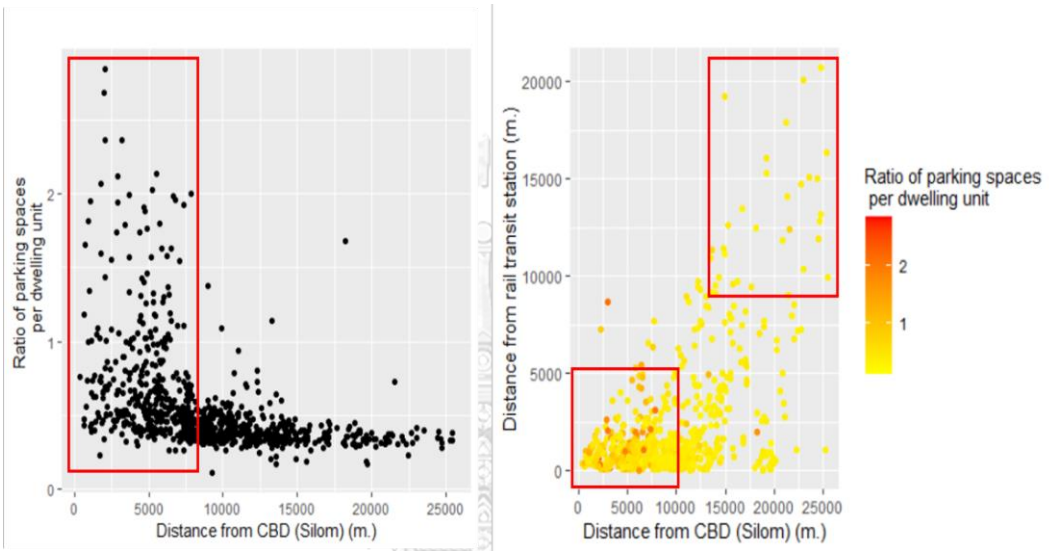


Figure 5-4 Distribution of parking capacity ratios of condominiums related to distance from a transit station and CBD

Table 5-4 Average parking capacity ratios of condominiums by distance from a transit station and CBD

Parking capacity ratios (parking spaces per dwelling units)	**Distance from CBD (Silom)**	**Distance from a Transit Station**			
		<500m.	501-1,000m.	1,001-2,000m.	>2,000m.
Condominium	transit-rich (<3km.)	0.85	1.03	0.67	1.26
	<5km.	0.83	0.86	0.79	0.78
	5-10km.	0.54	0.54	0.6	0.65
	10-15km.	0.45	0.43	0.4	0.37
	15-20km.	0.35	0.35	0.32	0.39
	>20km.	NA	0.34	0.32	0.35

5.1.3 Insufficient parking supply and unused parking spaces in the condominiums

Parking utilization surveys have found that many condominiums face the issue of insufficient parking space and underutilization. An 85% utilization rate was used to determine whether the parking lot was fully utilized (Smith, 2013). As indicated in Figure 5-5, 92 of 135 projects have a utilization rate of more than 85%. 89 projects have utilization rates equal to or greater than 100%, indicating a shortage of parking availability in condominiums. Also, nearly half (42%) of these condominiums provide double parking to fulfill the demand. The following explanation was given to interviewees on the parking issues in condominiums with insufficient parking: "Condominiums in some areas have parking issues due to the insufficient parking supply, since developers provide a small number of parking spaces, primarily in areas far away from transit stations. This causes spillover to neighboring on-street parking and makes the problem neighborhood-wide."

In addition, the survey reveals that 14% of all surveyed projects have parking utilization rates below 60%, indicating that condominiums may have provided more parking than was utilized and have unused parking spaces comprising more than 40% of the total parking supply.

We further examined the characteristics of projects that have underutilization with less than 85% of parking utilization and found that the parking utilization varies according to condominium characteristics, such as the number of units and years of construction, as well as location characteristics, such as transport proximity and distance from the central business district. Approximately 73% of them have fewer than 500 residential units. Figure 5-6 demonstrates that although newer condominiums have a lower maximum parking utilization than older projects, some older projects have a relatively large number of vacant parking spaces. 78% of them are within half a mile (800 meters) of the nearest transit station. However, comparing Figures 5-4 (right) and 5-6 (right), the relationship between parking capacity ratios and utilization is inconclusive due to the lack of data on condominiums located 15 kilometers away from the central business district and those located 10 kilometers away from the transit station. Moreover, the percentage of vacant rooms was also investigated, although no correlation was found with parking utilization.

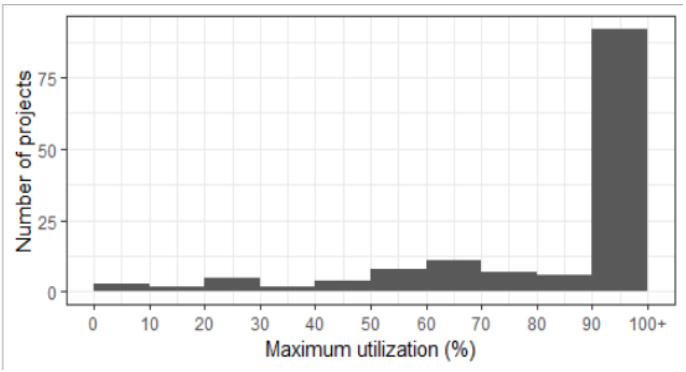


Figure 5-5 The distribution of parking utilization in condominium

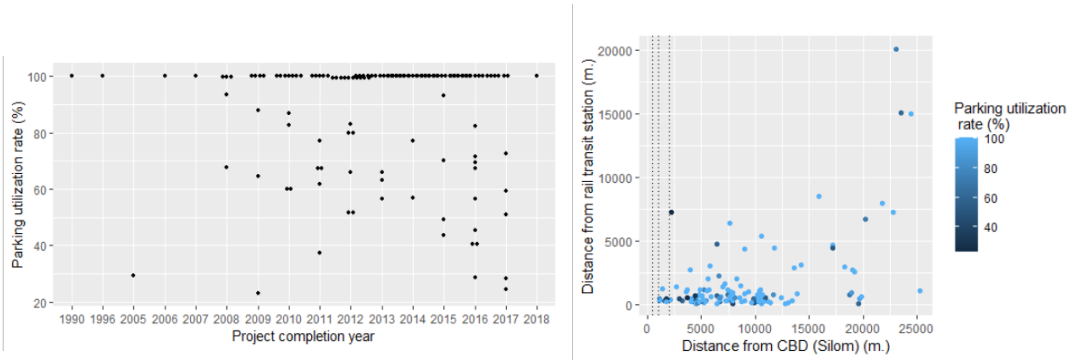


Figure 5-6 Condominium parking utilization in relation to project completion year (left) and proximity to the transit station and the central business center (right)

- **Many unused condominium parking spaces in the daytime**

Further examination of parking utilization throughout the day and night reveals that parking spaces in condominiums are mostly underutilized and have a large number of unused parking spaces in the daytime, especially on weekdays and then are fully utilized in the nighttime. As indicated in Figure 5-7, the average (mean) parking utilization rate is 42% on weekdays and 54% on weekends during the day. On the other hand, the parking spaces are well-utilized, with an average parking usage rate of 85% during the night on weekdays and weekends. The condominium, located within 1-kilometer walking distance of the nearest transit station, has several unused parking spaces in the nighttime, as illustrated in Figure 5-8. Furthermore, our observation and in-depth interviews also reveal unused parking spaces in several buildings, such as office and government buildings, during non-business hours.

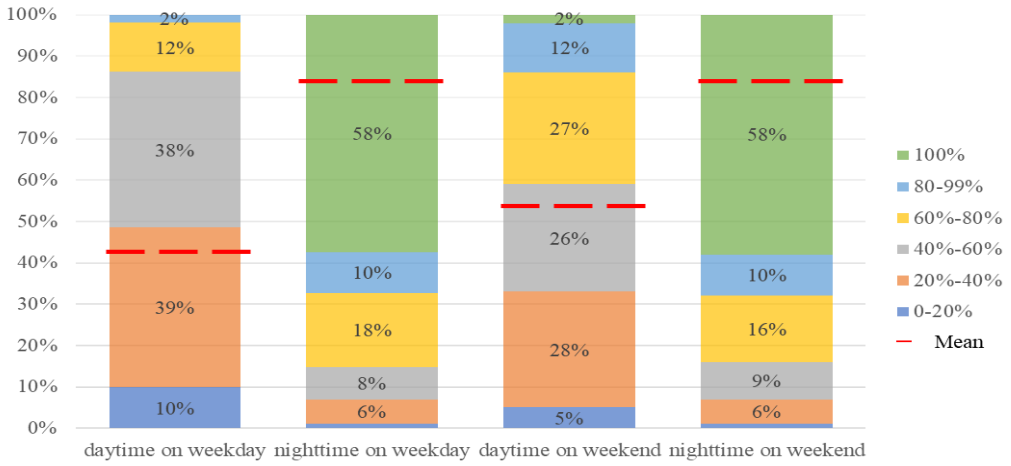


Figure 5-7 Weekday and weekend parking utilization during the day and night

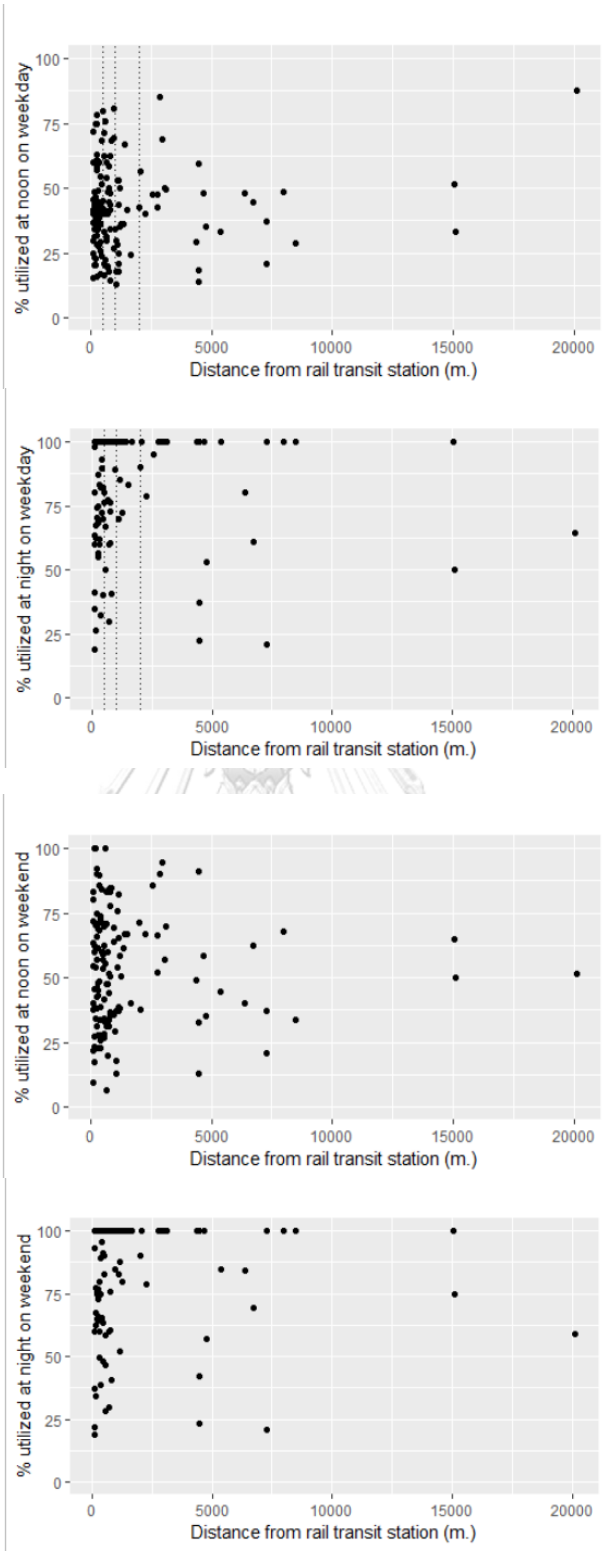


Figure 5-8 Condominium parking utilization by time of day and proximity to the nearest transport station

5.1.4 Minimum parking requirements may require more parking spaces than necessary

By examining the number of required parking spaces and their utilization in each condominium building, we found that the existing minimum parking requirements may be excessive for some condominium characteristics and locations, resulting in unused parking spaces. As demonstrated in Figure 5-9, at the time of the survey, many Bangkok condominiums does not meet 85% of the city's parking requirements. The parking utilization rate also varies depending on the time the building is operational. For example, several condominium buildings completed before 2013 have not met 85% of the city's parking requirements, as illustrated in Figure 5-10. Moreover, as shown in Figure 5-10, a large portion of condominiums within one kilometer of the nearest transit station do not meet the 85% utilization rate of required parking.

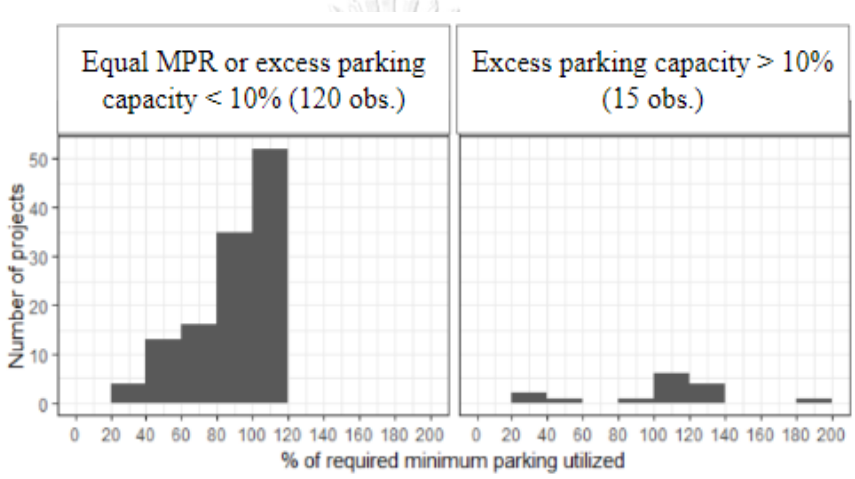


Figure 5-9 The comparison between parking utilization and minimum required parking

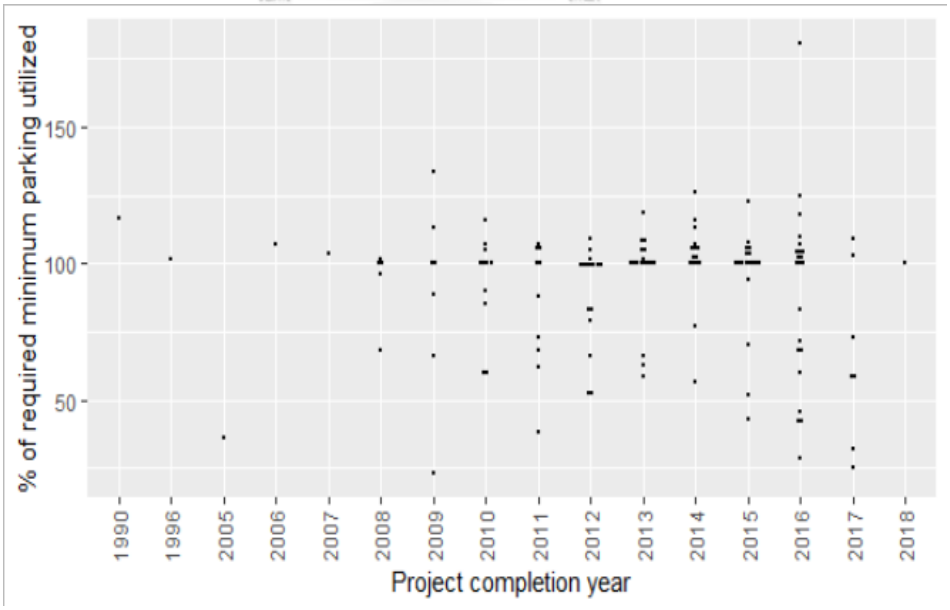


Figure 5-10 Utilization of required parking in different project completion years

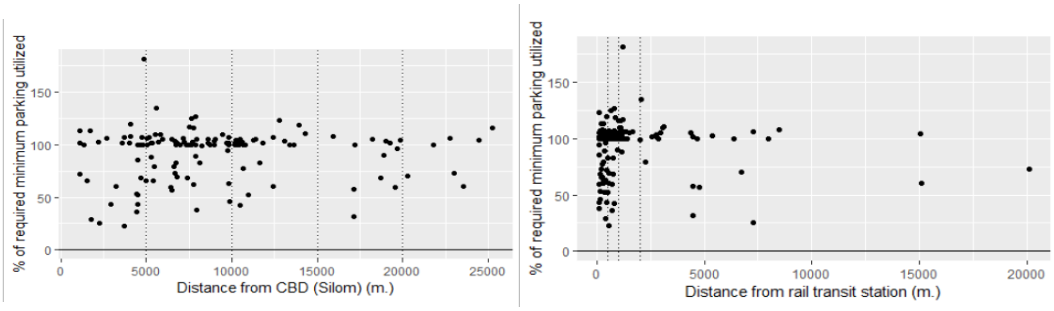


Figure 5-11 Utilization of required parking based on proximity to the Silom area (left) and the nearest trail transit station (right).

5.2 The Negative Impacts of Off-Street Parking Issues

Examining the impacts of off-street parking issues reveals several negative ones related to the minimum parking requirements. They are as follows:

5.2.1 Traffic congestion

As the city requires developers to supply parking spaces in large buildings in Bangkok, and many of these buildings have provided more parking spaces than are required in urban areas and near transit stations, the traffic congestion problem has worsened. With abundant parking, drivers perceive that it is always easier to drive. This perception encourages automobile use, discourages the use of public transportation, and increases traffic congestion, reducing overall urban mobility.

Furthermore, some buildings have insufficient off-street parking due to a low number of parking spaces, which may not correlate with the accessibility of public transportation and contribute to traffic congestion problems. Insufficient off-street parking has caused some vehicles to be attracted to properties to park on surrounding streets. Moreover, if adjacent curbside parking is free or unmanaged, this spillover parking may produce illegal parking in the areas, restricting neighborhood access and narrowing the roads, resulting in increased traffic congestion. As one interviewee explained, "Insufficient parking in condominiums is the primary cause of spillover parking in the area, and illegal parking in the neighborhood seriously affects the neighborhood's life and causes traffic congestion."

5.2.2 Expensive housing and rents

As the parking issues of current minimum parking regulations are the obstacle to some building developments and may require more parking than is needed, they have led to higher construction costs for developers, which are then passed on to residents and renters. According to one interviewee, "Providing parking spaces according to the MPRs in buildings is an enormous cost for development, making it difficult to develop a project that encourages walking and transit use or that is more affordable in the city. As a result, they decide to provide more parking spaces and increase the unit prices, making it less affordable for those

with low and middle incomes. This phenomenon is harmful to home buyers and renters, who must spend more money when purchasing or renting properties.

5.2.3 Air pollution and climate change

Mandatory minimum parking requirements and the provision of additional parking spaces contribute to harmful environmental impacts. A more significant number of parking spaces encourage driving and increase automobile dependency. This dependence on automobiles has contributed to increasing greenhouse gas emissions (United States Environmental Protection Agency, 2022), air pollution and climate change, and significantly impacting public health.

5.2.4 Mental health issues and social violence

When parking spaces in condominiums are scarce, parking-related stress can lead to resident conflicts. Several interviewees have stated that residents of condominiums with insufficient parking spaces experience higher stress levels because they worry about finding a parking space upon their return or about the danger of their vehicles being damaged when double-parked. However, if illegal parking occurs due to spillover parking, this issue affects not only the building's residents but also the surrounding neighborhoods.

5.3 The Underlying Causes of Off-Street Parking Policy

In this section, we describe the underlying causes of off-street parking issues uncovered by the investigation using an Iceberg Model, as presented in Figure 5-12. Please note that the number (#) corresponds to the interviewees indicated in Appendix D.

5.3.1 Context and trends

- **The growth of mass transit and the uncontrolled demand for private automobiles**

The government's substantial investment in the mass rail transit system over the past decade has significantly impacted the Bangkok real estate market. Throughout the city, the concept of transit-oriented development (TOD) is also taking shape (Chullabodhi et al., 2020). Condominiums, hotels, and office buildings have been constructed around Bangkok's mass-transit stations in the city's central, midtown, and suburban areas along the rail transport lines. In 2017, there were 570 hotels, 2,909 condominium projects, and nearly 9 million square meters of office buildings. (Kongcheap, 2020; Lunkam, 2019; Thanakitsombat & Chulasai, 2020) Mixed-use real estate developments are popular in this decade due to the scarcity of land along with Bangkok's mass rail transit and downtown areas, particularly in the Central Business District (CBD), and the significant increase in land prices over the past decade (Colliers Thailand, 2019; Real Estate Information Center (REIC), 2021). In developing these buildings in Bangkok, the legislation requires the provision of parking proportional to floor areas or the number of units. This is referred to as minimum parking requirements that contain parking regulations with specific minimum parking standards for 18

building uses (see Table 2-2). In practice, however, it is only implemented in the case of large buildings, generally with a total floor space of 2,000 sq.m. or more (#40).

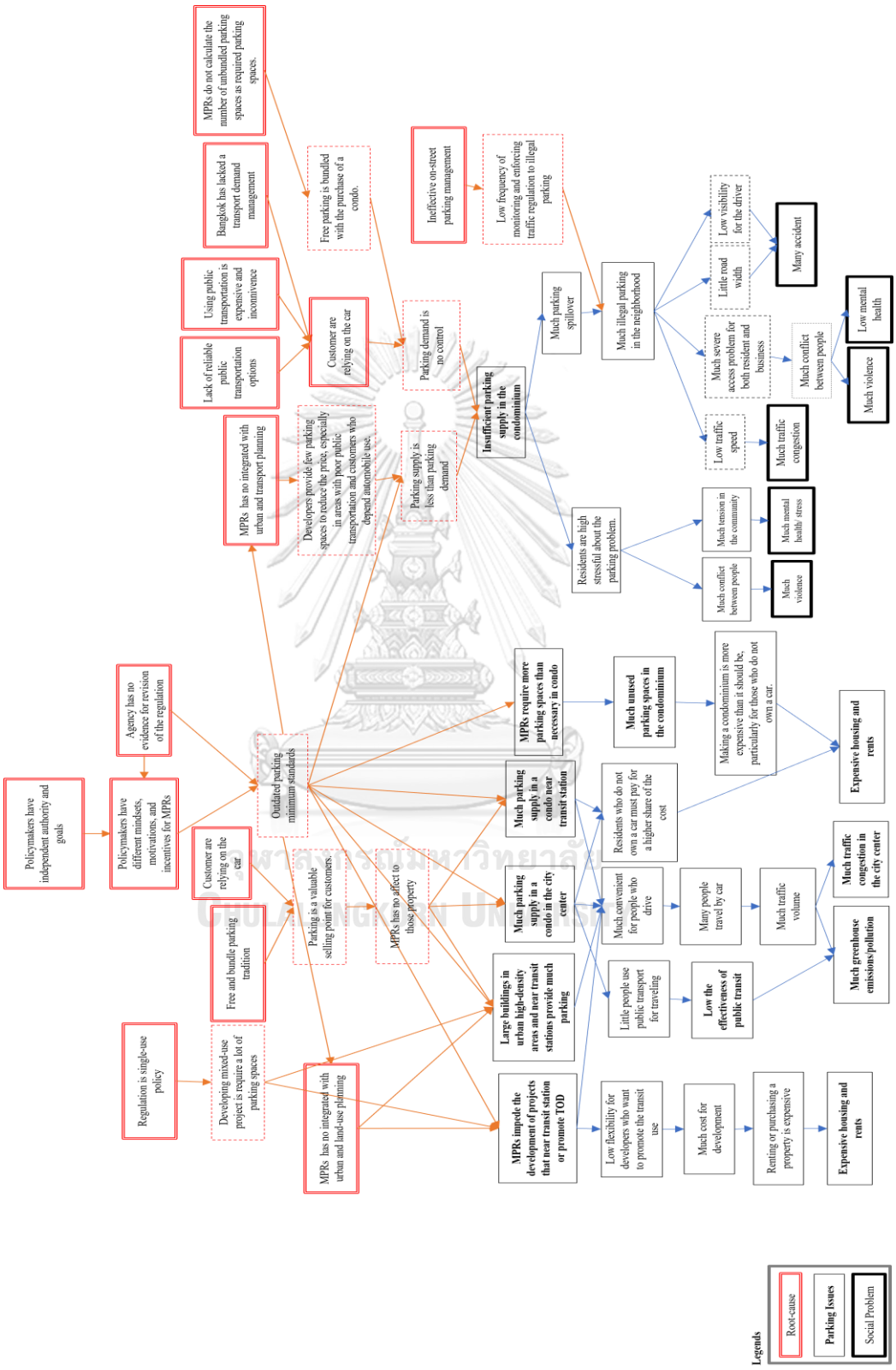


Figure 5-12 Causes and effects of minimum parking regulations

Despite this expansion in the rail transit development, the number of passengers using these rail transport services continues to fall short of the forecasts in the master plan. People continue to rely heavily on private automobiles, indicating that traffic congestion problems have not been resolved and may worsen (Vichiensan et al., 2022). This is partly due to a lack of transportation demand management strategies from the government that disincentivize automobile use, such as congestion pricing and parking space limitations (Marks, 2020).

- **Outdated parking minimum standards**

Minimum parking requirements are an essential policy instrument for off-street parking in Bangkok. However, their context has remained mostly unchanged over the past four decades. Those minimum requirements are mandated by the National Ministerial Order and the Local Ordinance according to the Building Control Act enacted in 1979 (later revised in 1992). The parking regulations originated from traffic congestion caused by buildings that do not accommodate parking spaces for customers, such as movie theaters and restaurants. As a result, the customers use the road as a parking lot (National Archives of Thailand, 1960). The ineffective on-street parking management that has been in place since 1960 is also the reason that has constantly increased the need for parking regulations (National Archives of Thailand, 1969).

The Ministerial Regulation No.7 B.E.2517 (1974), issued and implemented in all over Bangkok and other provinces, stipulates minimum parking requirements for eight types of buildings. However, the concept and origin of the minimal requirements in the Ministerial Regulation are a clear empirical basis for how the numbers were determined (#27,28,41,42,43). According to Inthamara (1974), a significant hint is that department store parking regulations were copied from German law. Therefore, it is possible for Germany to participate in developing the parking regulations. This is consistent with the fact that the German government helped Thailand in 1971 in studying and planning to resolve Bangkok's traffic congestion issues (Mass Rapid Transit Authority of Thailand, 2022).

In 2001, the BMA issued the City Ordinance on Building Control B.E. 2544 (2001), which included parking regulations with specific minimum parking requirements for 18 types of building uses. However, the main content of this set of regulations is primarily based on a history that has been heavily automobile-oriented since 1974 in the Ministerial Regulation No.7 (B.E.2517), which may conflict with the current urban development plan that encourages the growth of mass rail transit networks. The parking standards in both Ministerial Regulation No.7 B.E.2517 and BMA Ordinance on Building Control Act B.E.2544, as shown in Table 5-1, for the types of buildings that are hotels, residentials, shopping malls, offices, and large buildings, are the same.

- **The delay in revising the minimum parking requirements**

During the previous two decades, there have been occasional calls for revising minimum parking requirements in Bangkok, although no significant changes have been made. In 2007, for instance, real estate developers urged the National Legislature to revise the Building Control Act to eliminate the minimum parking requirements, arguing that doing so would cut the price of condominiums by 20 to 30% due to the decrease in construction costs

(Prachachat Turakij Newspaper, 2007). The Engineering Institute and the Real Estate Association supported these calls for reform, stating that Bangkok's central business district's reliance on cars causes traffic congestion and urging the elimination of the MPRs in these locations (HomeBuyerGuide, 2013). On the other hand, there was a request to adjust the MPRs to require more parking spaces in buildings as the number of parking spaces in condominiums was insufficient for the number of residents (Sappaisal, 2018).

Therefore, local academics and policymakers occasionally have had conversations about the relevance and effects of minimum parking requirements and demanded that they be revised. The Department of Public Works and Town and Country Planning (DPWTCP) set up a task force to study the revision of parking regulations in 2003 and again in 2015, although nothing significant has been done to revise them. Some city officials and the Traffic Police are poised to oppose the move, fearing that the removal of parking requirements will cause parking from development projects to spill over onto nearby streets, causing traffic congestion because of a lack of effective on-street parking management and enforcement (#38, #28). Moreover, there is a lack of empirical evidence to support the move (#25,28). As noted by one informant, "The rate of minimum parking requirement reduction in the draft Bangkok comprehensive plan was determined based on the judgment of the city's leaders." Therefore, the task force has made no progress in revising the parking regulations.

Table 5-5 Summary of minimum parking requirements for selected building types in the city of Bangkok

Building Type	**Building Size/Floor Area**	**Ministerial Regulation No.7 B.E.2517 (1974) in Bangkok**	**Bangkok Metropolitan Administration Ordinance on Building Control Act B.E. 2544 (2001)**
Residential/Condominium	The floor area of a room larger than 60 sq.m.	1 space per dwelling unit	1 space per dwelling unit
Hotel*	(1) Less than 100 rooms (2) Larger than 100 rooms	10 spaces per 30 rooms and 1 space for every 5 rooms in excess of 30 rooms* follow (1) for 100 rooms 1 space for every 10 rooms in excess of 100 rooms*	10 spaces per 30 rooms and 1 space for every 5 rooms in excess of 30 rooms follow (1) for 100 rooms 1 space for every 10 rooms in excess of 100 rooms
Hall in a hotel		1 space per every 10 sq.m. of floor area*	1 space per every 10 sq.m. of floor area
Shopping Mall	Retail area larger than 300 sq.m.	1 space per every 20 sq.m. of floor area	1 space per every 20 sq.m. of floor area
Office Building	Office area larger than 300 sq.m.	1 space per every 60 sq.m. of floor area	1 space per every 60 sq.m. of floor area
Commercial Building	Commercial area larger than 300 sq.m.		1 space per every 60 sq.m. of floor area

Building Type	Building Size/Floor Area	Ministerial Regulation No.7 B.E.2517 (1974) in Bangkok	Bangkok Metropolitan Administration Ordinance on Building Control Act B.E. 2544 (2001)
Large Building	Total floor area from 2000 sq.m. or total floor area larger than 1000 sq.m. if building is 15 stories or above	1 space per every 120 sq.m. of floor are	1 space per every 120 sq.m. of floor are
Row House	Smaller than 240 sq.m. Larger than 240 sq.m.		1 space per unit 1 space per every 120 sq.m. of floor area

* The condition was repealed and replaced with the new provision according to the Ministerial Regulation No. 64 (B.E. 2555)

5.3.2 Structures: organizations, laws, authority, and relationships

- **Institutional fragmentation**

Similar to the difficulty with on-street parking policies and management, institutional fragmentation is the underlying cause of Bangkok's off-street parking issues. Each agency had separate and independent missions and authorities, as shown in Figure 5-12. Furthermore, collaboration between divisions requires committee approval. Currently, the responsibility of off-street parking policies and regulations is shared among the departments under three ministries of the national government: the Ministry of the Interior (MoI), the Ministry of Natural Resources and Environment (MNRE), and the Ministry of Transport (MoT). The leading actors in setting policy and regulations related to minimum parking requirements are limited to the agencies associated with building control, including DPWTCP's Building Control Bureau, which is responsible for developing the MPRs at the national level for every province in Thailand, and the BMA's Public Work Department, which is responsible for developing the MPRs in Bangkok. The BMA's City Planning department, responsible for preparing Bangkok's comprehensive plan, has recently proposed to incorporate a reduction in the MPRs into Bangkok's new comprehensive plan. This illustrates the fragmentation between divisions that hinders their collaboration and leads the BMA's City Planning Department to use its authority to integrate parking policies into the urban planning rather than revising the BMA Ordinance to address the MPRs.

In terms of regulating and enforcing parking regulations, there is a function overlap in that the parking provision of large buildings was reviewed not only during the application procedure for a building certificate but also during the Environmental impact assessment process conducted by the MNRE. As one interviewee mentioned: "If the project has a small parking lot, the MNRE can only suggest monitoring measures or observations for the project owner to manage the parking lot as efficiently as possible."

Due to this institutional fragmentation, the task committee in charge of revising parking regulations is led by the DPWTCP and consists of at least 11 parties, including police and university professionals, which may make the reform process lengthy (#28). The institutional fragmentation also contributed to difficulties in implementing minimum parking standards that building owners can provide actual parking spaces fewer than the law mandates. Currently, the minimum parking requirements in Ministerial Regulation and Local Ordinance are governed by the Building Control Act, limiting their implementation during construction only. This problem has existed since 1974, when the parking regulations were first implemented (Office of the Council of State, 1974). As this law is only strictly enforced during construction, building owners can avoid declaring the actual use when the buildings are completed or renovated because there is no verification from some other agencies that the building were used for the purpose for which they were originally constructed and whether the number of actual parking spaces has been reached or not.

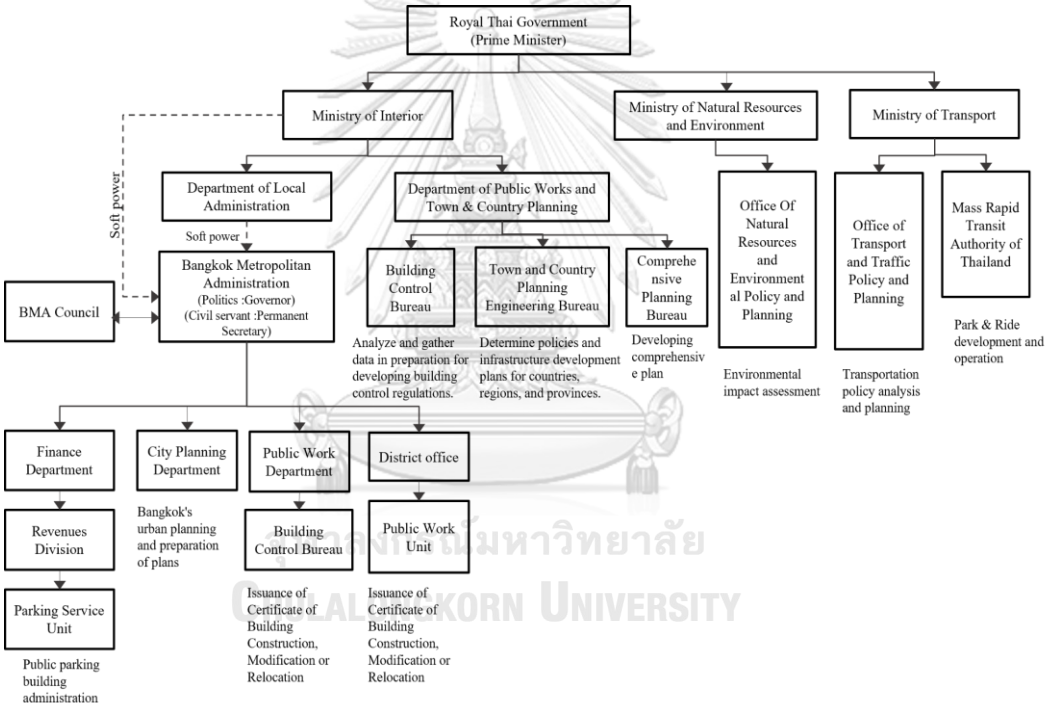


Figure 5-13 Hierarchy and relationships of government bodies related to off-street parking policies

- **One-size-fits-all parking regulations with no shared parking for the different land uses**

Existing parking standards in Bangkok lack not just integration with urban and transportation planning but also consideration of on-street parking policies and management (#1,4,7,25,28,29). The minimum parking requirements in Bangkok are determined by building types but not by land use or transportation networks, such as accessibility of public rail transit stations. This indicates that the regulations do not reflect differences in land-use and transportation network-related activities and traffic volumes. As a result, the minimum parking regulations restrict developers' flexibility in adjusting actual parking ratios to match

buyers' affordability. Even if they want to develop projects close to transit stations in urban areas where walking and transit use can be encouraged, they are required to provide parking spaces (see section 5.1.2). As one interviewee explained, "If you want to make affordable housing in an area near a train station, it is difficult because you have to build many parking spaces".

The one-size-fits-all parking regulations also create an imbalance between the number of parking spaces mandated by law and the land use in each location, causing insufficient parking and unused parking spaces in condominiums. (See sections 5.1.3 and 5.1.4) In addition, because it does not account for traffic volume, there is no parking strategy to regulate the number of parking spaces in metropolitan areas, since developers are free to construct parking sites to their preferred level, such as providing more than one parking space per dwelling and providing low parking capacity in the area where there is no on-street parking management. According to one key informant: "Some buildings require more parking than necessary, resulting in unused parking spaces because the target audience is not car users. At the same time, fewer parking spaces can be created as some condominiums than expected without looking into the context of their target audience because the government has not revised the law to relate to land use or zone designations."

In addition, the number of required parking spaces is determined by the type of single-use building. This indicates that minimum parking requirements do not consider the fact that different land uses attract people at different times of day. For example, an office whose parking demand peaks during the day can share parking spaces with a residential building whose parking demand peaks at night. As one interviewee explained, “The MPRs are now a barrier to the development of mixed-use and large TOD projects because they require many parking spaces, despite the fact that these parking spaces can be shared from different peak periods”. Consequently, the minimum parking requirements could be high for projects with several land-use types, resulting in unused parking spaces.

5.3.3 Mental models: beliefs, traditions, and values

- **Free and bundling parking traditions**

In large buildings where parking is required by law, such as office buildings and commercial buildings, most parking facilities provide reserved parking spaces to tenants as a bundle package. As one interviewee explained, “The tenant is entitled to at least one free parking space for every 100 square meters of the rented office space. Some places have a parking quota for employees. During the Covid-19 pandemic, the parking lot was used as a selling point.” Therefore, the developers must still consider providing more parking spaces as a strong selling point under this tradition, as described in Table 5-6. Meanwhile, parking in condominiums is allocated exclusively for tenants as part of the property purchase, although residents must share parking unless they have certification of parking ownership. This results in severe parking issues when parking was at full capacity, requiring tenants to struggle for parking rights.

In addition, as described in section 2.2.1, most parking spaces on Bangkok's roads are free. Many retail businesses, such as shopping centers, also offer customers free parking for a

few hours with proof of purchase. For instance, Siam Paragon Department Store, one of Bangkok's largest shopping malls located in the central business district, offers 2 hours of free parking without condition.

- **High automobile demand and parking**

In Bangkok, buildings still provide a large number of parking spaces because customers value them (#25, 34). People in Bangkok have a high demand for automobiles due to the city's public transportation system, which encourages people to buy and use automobiles if they can afford them. Bangkok lacks public transportation services that are both reliable and inexpensive, such as buses that are of poor quality and unreliable and a rail transit system that is rather costly for multiple-trip travel. In addition, there are restrictions on private vehicles in the city to discourage automobile use. Consequently, most Bangkok people continue to rely on their cars and value parking space.

As a result, several project developers continue to supply many parking spaces in the building if the target customers are wealthy individuals who typically own a car (#32,33,34,35). As one interviewee explained, " The MPRs do not affect developers' decisions to provide parking capacity in condominium buildings in Bangkok's premier areas because land prices are high, and potential buyers are limited to those with high incomes who usually own more than one car."

Due to the rising demand for parking in Bangkok, several technological and digital platforms relevant to off-street parking have been established. In the past five years, in response to the high demand for parking in areas with high land costs, developers have considered installing automated parking in the buildings or constructing a stand-alone automated parking structure, as mechanical systems enable the efficient use of land through the multi-level stacking of cars and eliminate the need for ramps and driveways. As shown in Figure 5-13, automated parking is available in various land uses, with condominiums being the most popular type. Furthermore, as the number of electric vehicles in Thailand increases, the demand for charging stations for these vehicles tends to rise. In recent years, charging stations for electric vehicles have been installed in condominium and residential projects to fulfill the demands of homebuyers (Matichon Online, 2022).

In addition, parking reservations can now be made via websites and apps, such as Thailand-parking.com, park2go.co.th, and jordsabuy.com. Due to the 2020 online parking database, as presented in Figure 5-14, many off-street parking spaces, both surface and in-building, are available for lease in the inner city of Bangkok. The majority of these spaces are rented on a monthly basis. Numerous office and hotel buildings have leased parking because they have vacant parking spaces that are underutilized. The unused parking spaces in condominiums are also available for lease through the website. However, this is a grey market as many property management companies prohibit it.

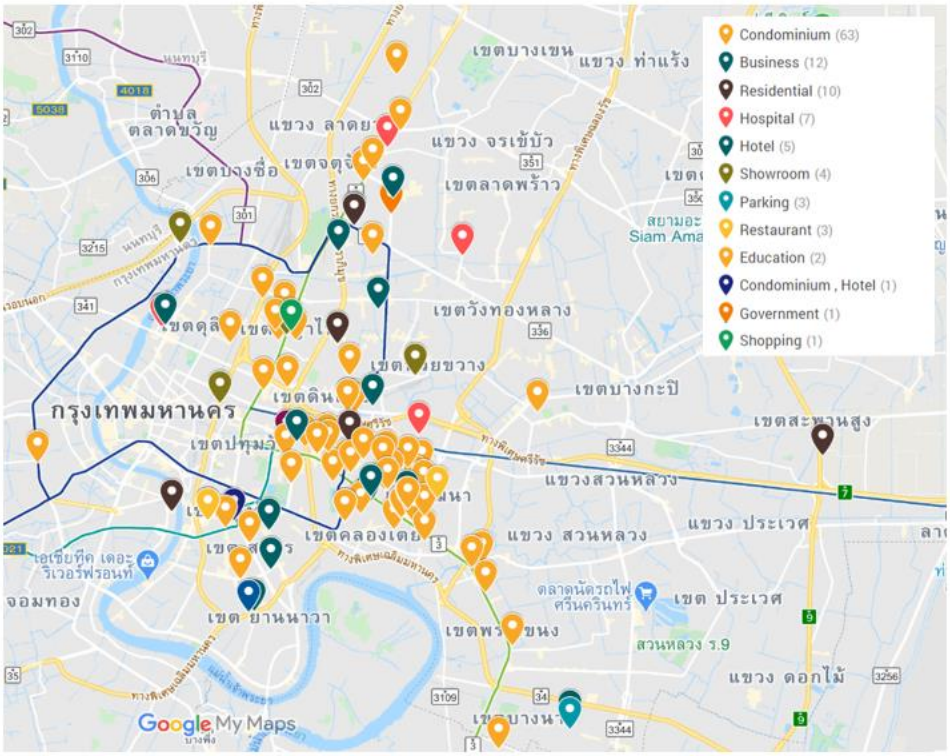


Figure 5-14 Location of automated parking in Bangkok as of January 2020

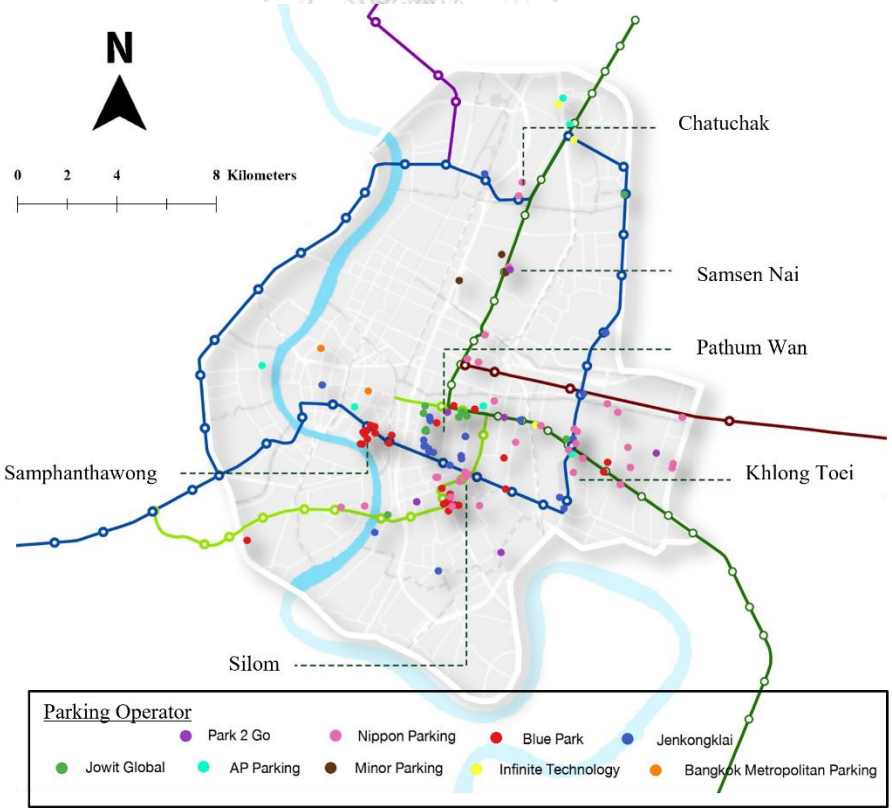


Figure 5-15 The distribution of off-street parking for rent through online parking platforms as of January 2020.

- **Misalignment of policymakers' mindsets, motivations, and incentives**

Among policymakers, they have different mindsets, motivations, and incentives that are related to the minimum parking requirements. According to Table 5-6, the in-depth interview demonstrates that there are two groups of policymakers: those who support the current parking regulations and those who demand the revision the regulations to meet their city development-related mindsets and motivations. The group that supports the current parking regulations is concerned that if the regulations were changed, it could cause problems, such as traffic congestion and fear that public complaints may negatively affect their promotion to management levels. The lack of empirical evidence also explains why both parties cannot share the same objective.

Table 5-6 The stakeholders' mindset, motivation, incentive, and behavior

	Mindset	**Motivation**	**Incentive**		**Behavior**
			Non-monetary	**Monetary**	
Policymaker					
OTP, MoT	Another agency is the primary host for off-street parking regulations, while the OTP is a think-tank for the MoT.	To ensure that people access convenient, safe, on-time, and affordable transportation options.	None (Because it is not to be the primary focus of the MoT)	None	The off-street parking policy is not part of the transportation policy and planning. They support the existing MPRs.
Building Control Bureau, Department of Public Works and Town & Country Planning	The building codes are appropriate for the current development city.	The building is safe and stable.	Development of the city, Career development and promotion (Since the government and the MoI do not view parking issues as urgent, there is less incentive to address them).	None	The agency has made efforts to change the parking regulations to keep up with urban growth. However, it has been delayed due to a lack of reference data for consideration and fear that the removal of parking requirements will cause parking from development projects to spill over onto nearby streets.
BMA Department of City Planning	Parking policy tools are vital to Bangkok and serve as a mechanism to promote the use of public transportation systems.	To develop a comprehensive plan, a special project plan, and a plan to support and promote Bangkok's	Development of the city, Career development and promotion	None	Under its authority, the agency aims to incorporate the parking policy that reduces the MPRs in the urban area into the new Bangkok Comprehensive Plan draft.

	Mindset	Motivation	Incentive		Behavior
			Non-monetary	Monetary	
		development in terms of safety, public health, the welfare of society, and city management that can respond to global trends.			
Traffic Police	To support the Metropolitan Police Station regarding traffic management.	Smooth traffic, no traffic congestion, and no public complaints.	Recognition from the management level, career development, and promotion	None (Because it is a policymaker level)	The agency is concerned that reducing or eliminating the minimum parking requirements could lead to parking spillover and traffic congestion.
Public					
Condominium developer	Due to customer demand, parking is one of the key selling features of condominiums. However, parking is a high cost for the development of the project.	To develop products that fulfill customer needs while maximizing profitability.	The growth of the city	Revenue and Profit	The company develops condominiums to meet customers' expectations regarding functionality and budget for the highest profits. If the parking lot is unnecessary in terms of selling features, the company will attempt to develop less to lower the project's selling price and attract a large number of customers.
Office, Commercial, and Mixed-use building developer	Some building types still need parking, influencing renters' renting decisions. Furthermore, forcing developers to provide a parking lot is a project development cost.	To develop products that fulfill customer needs while maximizing profitability.	The growth of the city	Revenue and Profit	The developers must provide sufficient parking spaces to meet the customer's needs because tenants' decisions to rent an office or commercial buildings are also heavily influenced by parking,

5.4 Summary of Bangkok's Off-Street Parking Situation

Due to the ineffective on-street parking management that caused the illegal parking problems in the past, Bangkok's off-street parking policy has consisted of establishing minimum parking requirements for many years to ensure an adequate number of parking spaces for each building. (Barter, 2011) explained that the parking policy trajectory was likely closely linked with ongoing city traffic crises, especially in developing countries. This study found that minimum parking regulations affected the parking provision decisions of large building developers in Bangkok during 2001-2020, similar to the findings of Mahattanatawe (1995) and Lertpradit and Charnwasununth (2020), which discovered that a large percentage of condominiums and office buildings provided nearly the same number of parking spaces as required. However, contrary to Lertpradit and Charnwasununth's finding, condominiums located between 1,500 and 1,999 meters from the street did not provide significantly more parking spaces than those located closer to the streets.

The empirical result indicated that the existing minimum parking requirements may hinder or require more parking than needed in some projects that aim to promote public transportation by constructing a building with few parking spaces within walking distance of transit stations. For instance, the minimum parking requirements affect small-scale, low-rise condominium developments within one kilometer of a transit station in high-density and medium-density areas. This finding is similar to those Chullabodhi et al. (2020) reported. The exceptions were buildings located in Bangkok's densely populated urban areas where minimum parking requirements do not affect the developers' decision to provide more parking spaces in the buildings.

In addition, the analysis of the parking provision demonstrates that parking provision is inconsistent with urban planning and transportation plans. For example, parking capacity is high in high-density areas with good transit accessibility, but parking capacity is low in suburban areas with limited transit accessibility. The findings regarding parking utilization in condominiums indicate that insufficient and underused parking is an issue. It is associated with the locations and physical qualities of condominiums. According to a study, several condominiums in the area with limited access to transit stations have insufficient parking, which is a problem for the neighborhoods because it leads to illegal parking. The parking spaces in most condominiums are highly occupied at night, while during the day, particularly on weekdays, they are underutilized.

All identified parking issues, as previously described, have harmed the city by worsening traffic congestion, pollution, property purchase and rental costs, and social violence. The Iceberg framework analysis revealed that off-street parking issues are complex problems and uncovered four root causes of Bangkok's parking issues that must be addressed to alleviate urban issues. However, when assessing the impact of causes based on the number of causal linkages leading to parking issues and their association with other causes, we discovered that not all root causes are equally important. The root causes are described in the following sequence, from the most significant to the lowest. First, as depicted in Figure 5-15, this study identifies the outdated minimum parking regulations and barriers to revising parking standards as the primary root cause. Similar to what Augnistasat (2021) argued in their analysis, the current parking regulations are still based on the automobile-dependent city

setting. The delay in updating the regulations was due to the misalignment of government bodies among policymakers and a lack of data and empirical research for consideration.

Second, the existing parking regulations do not account for urban and mobility planning and the on-street parking policies and management, resulting in parking regulations that do not differentiate between land use types and the availability and accessibility of public transportation and on-street parking facilities. Third, the tradition of free parking in retail facilities, bundled parking in condominiums and office buildings, and the lack of reliable, affordable, and convenient transportation options in Bangkok encourage people to own more cars. Therefore, developers decide to continue providing many parking spaces in high-density and high-accessibility areas to attract customers, especially wealthy people who typically own more than one automobile. Fourth, the single-use parking regulation disregards the possibility of parking sharing during peak hours. This chapter's findings on parking issues and their underlying causes were considered to create parking policies for Bangkok, which are discussed in Chapter 6.

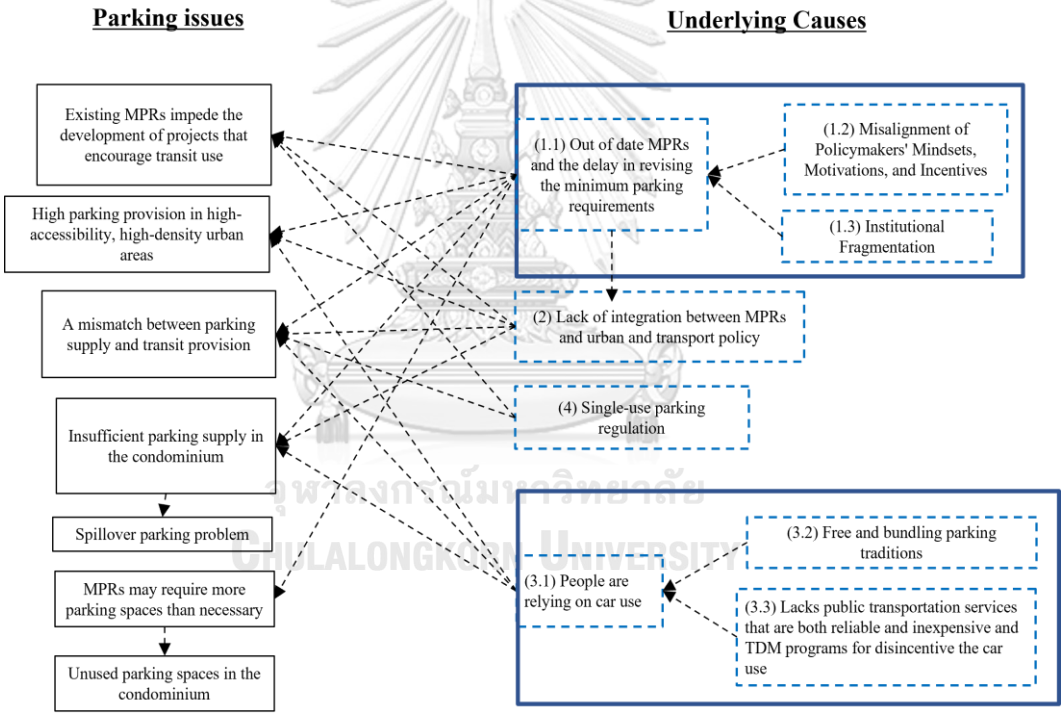


Figure 5-16 Linkage between off-street parking issues and their root causes

CHAPTER 6

PARKING POLICIES FOR SUSTAINABLE MOBILITY IN DEVELOPING CITIES: CASE STUDY OF BANGKOK

This chapter lays out the foundation for new initiatives to parking policy targeted at addressing the parking challenges mentioned in the previous two chapters and promoting sustainable mobility in developing cities and Bangkok. This chapter begins by summarizing the findings on parking issues and the mechanism of on- and off-street parking problems in Bangkok. The parking policy and actions to solve these issues and encourage sustainable mobility are described in the last section.

6.1 A Summary of Bangkok's Parking Problems and Their Underlying Causes

Even though efforts to manage on-street parking in Bangkok began more than six decades ago, the city's streets are still plagued by various parking issues, such as widespread illegal parking, low efficiency, unauthorized parking reservation, and illegal fee collection by unauthorized parking attendants. While off-street parking issues are highlighted in the problem of the existing minimum parking requirements that impede transit-friendly development and are misaligned with land use and transportation development, there is a need to address these challenges. Also, the uncontrolled development that results in a high parking provision in the urban center and transit-rich areas and insufficient parking spaces must be deliberated.

According to an examination of the underlying causes of parking problems, both on-street and off-street parking has many parking issues resulting from the political-economic, institutional and legal frameworks, policy formulation, policy strategy and planning, and mental model variables. Some root causes affect both on-street and off-street parking issues, including the misalignment of stakeholders' mindsets, motivations, and incentives. This demonstrates the institution's vulnerability, as everything is set separately without a joint arrangement. It is a notable characteristic of developing cities, especially Asian cities (Phuc et al., 2019; Thanh, 2017; Wang & Yuan, 2013). The primary cause of on-street parking issues is a lack of concrete on-street parking, legal obstacles to effective enforcement, a lack of formal parking spaces at shophouses, a lack of parking technology promotion, and a lack of interest and commitment from both political and local leaders. Some of these root causes are unique in literature from developing cities and represent Bangkok's culture. One is a lack of interest and commitment from national and local governments, which is also apparent in Bangkok's Bus Rapid Transit project (Wu & Pojani, 2016). Bangkok also lacks a policy and strategy in response to the new urban trends driven by the digital revolution, including food delivery and e-commerce, which leads to an uncontrolled increase in the demand for on-street parking. Consequently, illegal parking of delivery vehicles is widespread in Bangkok. In addition, the corruption, including petty bribery, persists and appears to be deeply ingrained in the parking management in Bangkok as the root cause of parking issues (Fisman & Miguel, 2007).

Furthermore, most off-street parking issues stem from outdated and uniform minimum parking standards across Bangkok that conflict with the urban and transportation plan. As a result, the off-street parking policy lacks integration with urban and transportation planning. The current parking requirements do not also account for the potential of sharing parking in a building for diverse land uses, reducing the needed parking spaces. The unique tradition of bundled parking in residential and office buildings and the auto dependency culture exert the most significant pressure on developers to provide excessive parking spaces. Moreover, in Bangkok, the charging stations for electric vehicles and off-street parking for car sharing are the trends that are still not governed by the current off-street parking policies and regulations.

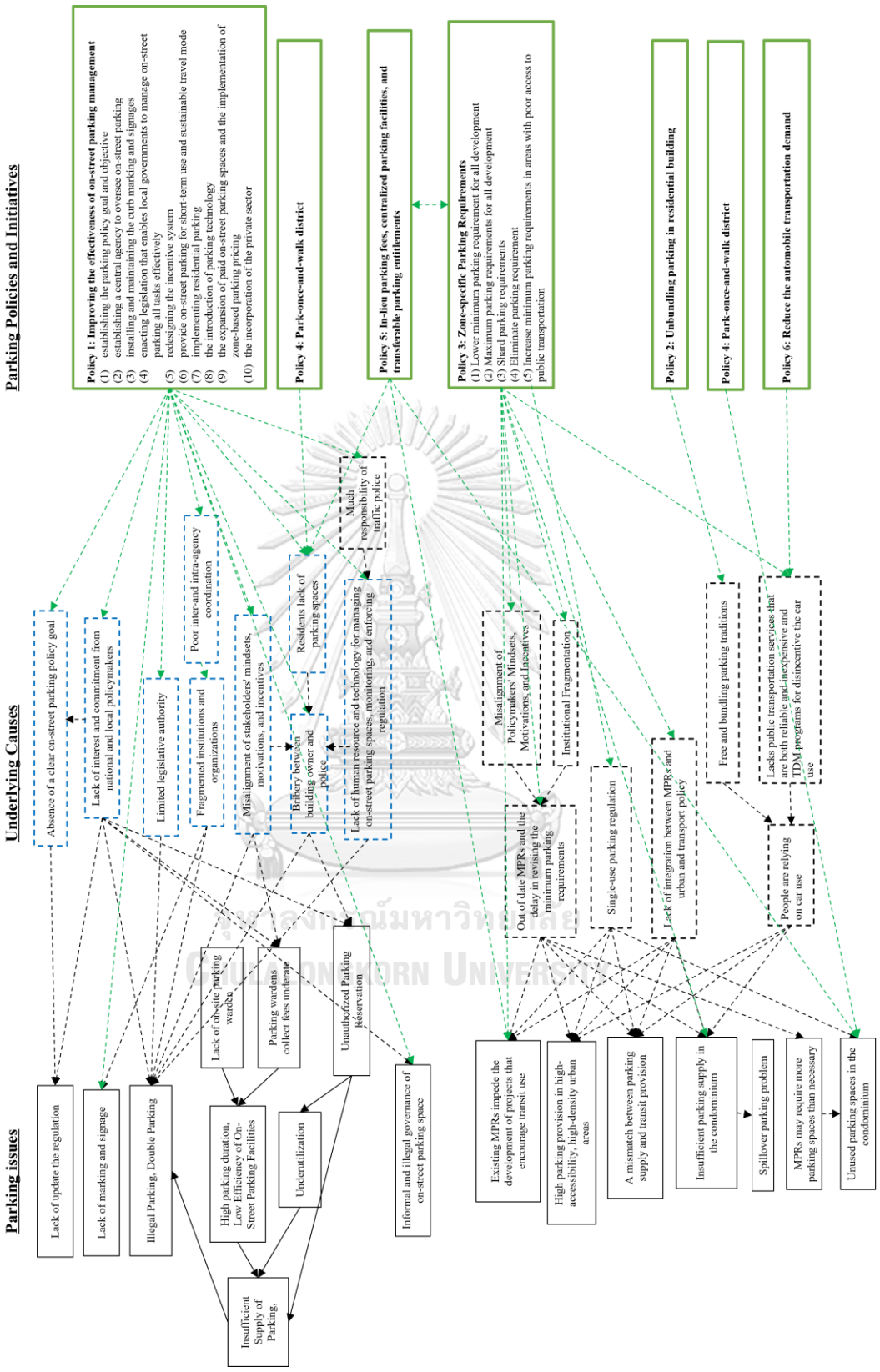


Figure 6-1 The relationship between parking issues, underlying causes, and parking policies

6.2 Parking Policies for Sustainable Mobility

A number of cities have introduced parking reforms to minimize the negative impact of parking problems and tackle the parking issues, with the majority occurring in developed countries and the minority in developing countries. This section outlines six key parking policies to address parking problems and support sustainable mobility in Bangkok as a guideline for cities in developing countries. Each parking recommendation opens with the rational points derived from this study's empirical findings, followed by a discussion of the benefits, implementation strategies, and potential issues.

6.2.1 Policy 1: Improving the effectiveness of on-street parking management

In light of the in-depth empirical evidence discussed in Chapter 4 regarding the problems of the current on-street parking management in several aspects, such as the structure, mindsets, and incentives of stakeholders, and the working process, which produce a number of obvious parking problems with adverse effects on society, the national and local governments should seriously improve the on-street parking management accordingly. Several components of the existing on-street parking management, such as the institutional and legal framework, parking program, and implementation method, should also be enhanced. This policy goals are to maximize use and increase revenue.

In addition, in response to the emergence of new crowd-sourced and mobility services, such as car sharing, ridesharing, ride-hailing, and food delivery in several developing cities, the national and local governments should consider allocating and managing these mobility options, such as providing on-street parking slots for car sharing vehicles and temporary parking spaces for food app delivery drivers. In a number of cities, including Plymouth, Northville, and Vancouver (Clem, 2018; Zura & Renouf, 2021), the lack of appropriate management of on-street parking for these new mobility services has been noted as causing many societal problems.

- **Benefits**

From the literature review, the benefits of an effective on-street parking management can not only resolve on-street parking issues that found in this study but also contribute to the success of the off-street parking policy as on-street parking problems are the primary impetus for adopting minimum parking regulations. In addition, the effective on-street parking management has contributed significantly to the promotion of sustainable mobility by reducing unauthorized parking reservation and illegal parking, thereby encouraging the efficient and equitable use of on-street parking spaces and alleviating the local traffic congestion problem. This improves the community's livability by reducing conflicts over parking and accidents caused by parking issues and promoting the sustainable mobility options. This has the additional benefit of enhancing public safety and reducing corruption by eliminating illegal fee collection.

- **Policy implementation strategies**

To implement this parking recommendation, we proposed comprehensive on-street policy implementation guidelines that contain 10 policy actions to increase the effectiveness of the on-street parking management. The policies are divided into three groups, as indicated in Table 6-1: improve the management of what should be managed, enhance the efficiency of what is managed, and expand on-street parking management programs. The details of each policy action are as follows.

Table 6-1 Policy implementation guidelines for improving the on-street parking management

Action / **Function**	**IMPROVE**	**ENHANCE**	**EXPAND**
Planning/ Strategies	(1.1) Setup the parking policy goal and objective (1.2) Establish a central parking agency	(1.6) On-street parking for short-term use and sustainable travel mode (1.7) Implement residential parking permit program	(1.9) Expand paid on-street parking areas, convert illegal parking to legal parking, and introduce zone-based parking pricing
Infrastructures	(1.3) Improve the curb markings and signages	(1.8) Deploy parking technologies	(1.10) Incorporate the private sector
Regulations	(1.4) Enact legislation enabling the BMA to effectively manage all parking management activities (1.5) Redesign incentive system		

Policy action 1.1: Setup the parking policy goal and revise parking program

Due to the problem of a lack of interest and commitment from national and local policymakers and a misaligned mental model among stakeholders, the policy action advocates require the local governments to take genuine interest in the on-street parking management, develop the parking policies, and establish the goals of the current operations. The agencies' annual development plans may include these goals to align the stakeholders' mindsets and motivations. In addition, the on-street parking policies should consider the current and future urban trends, such as food delivery, the sharing economy, Mobility as a Service (MaaS), and Autonomous Vehicles.

Subsequently, local governments should update their parking programs to ensure that their aims and objectives are aligned. A survey of the existing parking supply and demand is necessary for setting up the parking program. The parking survey should be revised every 2 to 3 years in order to determine any needed adjustments to the implementation program and, if necessary, the parking policies (Auckland Regional Council, 2009).

Policy action 1.2: Establish a central parking agency to oversee on-street parking

Analyzing the institutional context of the parking management in Bangkok reveals that no agency is fully accountable for on-street parking. Therefore, the local governments should establish a central parking agency to oversee on-street parking by appointing an agency with complete responsibilities or creating a new commerce unit under the local governments. The BMA City Market Office is an example of a commercial unit that oversees public and private markets in Bangkok.

The central parking agency's functions may include planning, controlling, monitoring, and evaluating the on-street parking regulations and management. For example, in the Philippines, the Makati Parking Authority, a non-profit public-private partnership, is authorized to manage and implement all policies, rules, and regulations governing on-street parking initiatives (Makati Central Estate Association, 2021; Parking Reform Atlas, 2021). This policy action does, however, require the legal support outlined in policy action 1.4.

Policy action 1.3: Improve the curb markings and signages

Due to the lack of parking signage and markings that frequently causes conflicts between public officers and drivers, the local governments should improve the street infrastructure for the on-street parking management to ensure that all road markings, curb markings, and signage are effectively communicated to parking users. In addition to organizing the motorcycle parking, the local governments should also designate more legal motorcycle parking spaces.

Policy action 1.4: Enact legislation enabling the BMA to effectively manage all parking management activities

The agencies' lack of legislative authority to implement the effective on-street parking management is a significant issue. The national government should prioritize enacting legislation that will enable local governments to manage all tasks effectively, such as parking enforcement in unmanaged parking areas where municipal police could collaborate with traffic police to reduce their workloads. In the United Kingdom, the Netherlands, and Spain, local governments have the authority to enforce on-street parking regulations (Sustainable Urban Transport Project, 2017). In addition, legislation should be updated to allow local governments and traffic police to use technologies, such as fee collection and enforcement systems, to support the on-street parking management. The fines could also be adjusted to give drivers a greater incentive to seek legal parking rather than illegal parking and cover the cost of enforcement, such as towing costs.

Policy action 1.5: Redesign incentive system

Since parts of the existing incentive structures for on-street parking management are misaligned or do not incentivize stakeholders to manage on-street parking properly, the national and local governments should reform the incentive system for policymakers, implementers, and enforcers. For example, based on the findings, parking attendants are

motivated to collect the parking money in whatever way possible to meet the fixed-rate KPI as there is no incentive for additional work. An agreement with residents to allow unlimited parking for a monthly fee is one of the solutions that could help them achieve the KPI and boost their profits. Therefore, the local government should consider awarding a bonus if parking revenue exceeds the KPI.

Policy action 1.6: On-street parking for short-term use and sustainable travel mode

Based on the empirical evidence indicating a high proportion of long-term parking as one of the causes of insufficient parking spaces to meet demand and a lack of on-street parking policy and strategy for the emerging digital platform and technology transformation, the local government should allocate or designate some on-street parking spaces for a short stay for customers, and loading and unloading of goods and passengers in activity centers like a commercial, retail, and restaurant areas. In addition, the local governments should work closely with local businesses and relevant companies, such as food delivery and ride-hailing companies, to determine the location, timing, and size requirements for short-term parking zones. The local governments should also establish time restrictions or high parking charges to ensure a high turnover rate.

In addition, to respond to the emerging mobility services that support the sustainable mobility goal, the local governments should diversify on-street parking provisions for sustainable travel options, such as electric vehicles (EV), car sharing, cycling, and micro-mobility parking. For cycle and micro-mobility, such as scooters, parking may be provided on the streets or footpaths in more locations, especially near transit stations. The local governments may consider providing on-street public EV parking with charging stations in areas where off-street parking is unavailable. This is to encourage people to switch to EV, as the lack of home charging is one of the hurdles to adopting electric vehicles (Leingchan, 2022). The United Kingdom's On-Street Residential Charge Point Scheme has provided subsidies for local governments to install EV public charging stations since 2017 (Office for Zero Emission Vehicles, 2022). Additionally, the local governments may allocate on-street parking spaces for car sharing and EV car sharing and allow private companies to lease these parking spaces from local governments. Auckland is an outstanding example (Auckland Transport, 2022).

Policy action 1.7: Implement residential parking permit program

Since parking issues in Bangkok's central area are caused mainly by the lack of formal parking spaces in most shophouse-style buildings, the BMA should implement the residential parking permit program in the selected areas where residential streets experience sustained periods of high parking demand. The BMA should determine which areas are appropriate for the parking permit scheme, such as areas with low traffic volume, especially at night. Residential parking permits do not provide a specific parking place in front of the property but rather the right to park within the permit boundary. Residents can acquire a limited number of parking permits by submitting an official request to the BMA. This may incur an annual fee at the rate of the local market price. Depending on the location's

characteristics, a residential parking permit may be valid for the entire day or a specified period, such as between 8:00 p.m. and 8:00 a.m. during off-peak hours.

Policy action 1.8: Deploy parking technologies

The lack of technologies in supporting and monitoring the on-street parking management has been identified as the root cause of some parking issues. The local governments and police should therefore push for reform in parking management by utilizing technologies to enable more effective and transparent on-street parking fee collection, operations, and enforcement. This will also assist the agencies in collecting data and monitoring the various programs' performance and help diminish the incentive for ineffective management, such as bribery. New parking technologies may begin with low-cost investments, such as pay-by-phone by SMS, QR-code, mobile applications, or digital handhelds for parking attendants. Shenzhen, Dubai, and Manila are examples of cities this method is implemented (Sustainable Urban Transport Project, 2017).

A citizen enforcement system should also be developed, allowing citizens to report parking issues, such as unauthorized parking attendants and public officers' corruption, via a website, application, or social media. For example, the city government of Palembang has launched a smartphone application that enables motorists to determine whether a parking attendant has the legal authority to collect parking payments on the street by scanning a QR code on a parking attendant's identification badge (Reinventing Parking, 2021a).

Policy action 1.9: Expand paid on-street parking areas, convert illegal parking to legal parking, and introduce zone-based parking pricing

Because this study found illegal parking attendants in areas with a high demand for on-street parking, the local governments should update the location of designated on-street parking that operate in accordance with the ordinance and expand on-street parking management programs to more than 65 streets designated since 1995. Priority should be given to areas with parking issues, particularly in locations with low traffic volume. In addition, the local governments should consult with the Traffic Police to "convert illegal parking into legal parking" by revising banned parking locations and implementing the parking management in areas where parking behavior does not comply with the current regulations and does not impede traffic flow. Ban Mo is an example of a location that should be implemented.

Since the on-street parking fee structure is similar across Bangkok, the local governments should also consider implementing zone-specific pricing when expanding parking management initiatives. The price of on-street parking may be determined by parking demand, the market price of off-street parking in the zone, the pricing objective, and the pricing strategy. For example, the Taipei city government performs a six-monthly review of parking charges and changes parking pricing according to parking demand. Prices are adjusted upwards if the utilization exceeds 80% and downwards if the usage falls below 50% (Reinventing Parking, 2021b).

Policy action 1.10: Incorporating the private sector

Incorporating the private sector may be a viable alternative for improving the effectiveness of the on-street parking management and expanding the parking management programs, as proven effective in Japan, Singapore, and China (Barter, 2011). The BMA should solicit competitive tenders from the private sector to manage the fee collection system's overall operation. The competitive bidding will be organized into districts or zones to prevent the possibility of a single fee collector, as competition between operators would help keep costs low and root out corruption (Sustainable Urban Transport Project, 2017). Revenue sharing between the BMA and operators is possible, but the former must require digital payment from contractors to obtain transaction data for monitoring and estimating expected revenue.

- **Policy concerns**

With the on-street parking management, people may be concerned about paying for parking and losing their illegally occupied parking space. In addition to the regulations required to develop a residential parking permit program, there is a possibility of pushback from local residents and business owners who rely on on-street parking to accommodate their vehicles and those of their visitors, customers, and employees. Therefore, local governments should have a clear communication plan with users and the broader public to clarify the program's goals and how users can access the curb. The messages emphasize the various rules and policies, restriction limits, payment options, and program benefits. Nonetheless, local governments must regularly collect data and analyze the performance of the on-street parking programs in order to make improvements.

Pricing curbside parking may also exacerbate problems, such as increasing illegal parking in nearby unpaid or unregulated on-street parking locations. Therefore, the local governments and police should also enforce rules effectively in these areas. In addition, although this policy includes a few policy actions to tackle corruption behavior, such as the use of technology for monitoring, the development of a citizen enforcement system through which people can report issues, and a strategy to convert illegal parking into legal parking in order to reduce corruption behavior. The national and local governments must continue monitoring and enforcing areas not covered by parking management systems to ensure that corruption does not occur in other low-monitoring areas. Human-generated data could be used to develop a map of enforcement priorities.

6.2.2 Policy 2: Zone-specific Parking Requirements

The findings of Chapter 5 suggest that the current minimum parking standards, which still encourage automobile privileges, are out of date. Due to the misalignment between stakeholders and the lack of empirical evidence to justify reform, the revision of the regulations has been highly delayed. In addition, minimum parking requirements are incompatible with land use configurations and transit provisions, ignoring the accessibility to public transportation, despite the draft of the new Bangkok Comprehensive Plan that has considered these issues. The issues are notable features of developing cities (Thanh, 2017). The empirical evidence indicates that they have resulted in Bangkok's minimum parking regulations being an impediment to transit-friendly development, requiring more parking than

is needed and a large number of parking spaces in the central and transit-rich areas of the city center.

Considering the empirical evidence that addresses off-street parking issues, national and local governments should urgently reform parking requirements to push toward making Bangkok a sustainable city. Therefore, this study proposes zone-specific parking requirement policies based on urban density, public transportation accessibility, and traffic volume. As illustrated in Table 6-2, the Bangkok area is divided into four zones, each with specific parking requirements. However, changes in parking requirements may cause on-street parking problems and safety issues within the district and its nearby areas without effective management of on-street parking. Therefore, the parking recommendation is proposed in two phases, with the first phase considering that in the central business district where on-street parking is strictly enforced by the Traffic Police. In other areas, enforcement is weak or irregular. The second phase starts when on-street parking has been effectively managed in each area.

As seen in Table 6-2, a reduced minimum of parking requirements are considered in areas where existing transit facilities and services provide several alternative modes of transportation, at least mass transit. Conversely, the maximum parking requirements are considered in urban core areas where new developments provide more parking and increases traffic congestion. In addition, the areas must have sufficient access to public transportation to attract people without requiring excess parking. In places with mixed-use developments, the implementation of a requirement for shared parking has been proposed. Due to the low number of parking spaces that developers provide in suburban areas and areas without reliable public transportation, it is also proposed in some areas to increase parking requirements. When a high-density land use area with good access to public transportation has an effective on-street parking management, the elimination of minimum parking requirements could be considered. Each policy's implementation guidelines are explained in the next section.

- **Benefits**

Reforming the parking requirements would promote the sustainable mobility initiatives and provide several positive impacts on society. Reducing the number of parking spaces can reduce the demand for automobile use, reducing traffic congestion and air pollution. Limiting the number of parking spaces also encourages the shift to more eco-friendly modes of transport and avoids unused parking spaces. It also allows the development of projects that encourages transit-friendliness and affordable housing, as well as cost savings for developers and reduced housing costs for consumers.

Table 6-2 Recommended Parking Requirements in each city zone

Zone characteristics	**Central business area with very good public transport accessibility**	**Areas in high-density land use with very good public transport accessibility**	**Areas in very good public transport accessibility**	**Other than those areas**
Phase 1 Off-street parking policy action	(2.1) Lower minimum parking requirements (all developments) (2.2) Maximum parking requirements (all developments)	(2.1) Lower minimum parking requirement (all developments) (2.2) Maximum parking requirements (all developments) (2.3) Shared parking requirements (mixed-use developments)	(2.1) Lower minimum parking requirements (non-residential developments) (2.3) Shared parking requirements (mixed-use developments)	(2.4) Increase minimum parking requirements in areas with poor access to public transportation and no parking management program. (residential developments)
Phase 2 Integrated with effective on-street parking management	(2.5) Eliminate parking requirements (all developments)	(2.5) Eliminate parking requirements (all developments)	(2.1) Lower minimum parking requirements (all developments) (2.2) Maximum parking requirements (all developments)	(2.1) Lower minimum parking requirements (all development in areas with effective on-street parking management)

- **Policy implementation strategies**

Policy action 2.1: Reduce minimum parking requirements for development in areas with high access to public transportation

As previously mentioned, the existing Bangkok minimum parking regulations are an obstacle to some projects located near mass transit stations. In some situations, it may be required to provide more parking than is needed. The Department of Public Works and Town and Country Planning (DPWTCP) and the BMA should revise the regulations to reduce minimum parking requirements for the new non-residential development in areas with high access to public transportation, such as within 500 meters of a transit station in an urban area, which is a walkable distance (Pueboobpaphan et al., 2022). Due to several stakeholders' concerns over parking problems caused by poorly controlled on-street parking in non-city center areas, lower minimum parking requirements for new residential development may initially be implemented exclusively in the central business district and high-density areas.

Each building type may have a different level of reduction of minimum parking requirements. For example, the DPWTCP and BMA may consider reducing the current MPRs by more than 25% in residential development because several developers have stated that the

25% proposed in the new Bangkok Comprehensive Plan has no effect on their decisions on parking provision in location near transit areas in the city center. Moreover, in determining the level of reduction for lowering the minimum parking requirements, it may be necessary to conduct a more in-depth examination of the parking generation rate of buildings, particularly those constructed to meet the minimum parking requirements. The parking requirement ratio adjustment may consider factors other than geographic locations and transit accessibility. For instance, Litman (2021) proposed several factors that can be used to adjust parking requirements, including residential and employment density, mobility management programs, and availability of car sharing within or near the buildings.

However, the author believes preliminary reforms are necessary before implementing more significant changes. The DPWTCP and BMA should begin the reduced minimum parking requirements with details, allowing the city to quickly address off-street parking issues in the pilot areas. Then, authorities can use this opportunity to generate the public opinion and increase the public knowledge of parking issues that have been neglected for a long time.

Policy action 2.2: Introduce maximum parking standards to limit the parking supply

The research findings indicate a high number of parking spaces in Bangkok's urban centers, contributing to various social issues. Maximum parking requirements that limit the total number of parking spaces can directly lower the parking supply in the urban districts. Therefore, national and local governments should revise the regulations to establish maximum standards and a cap on the number of parking spaces associated with new development or change of use in areas with great access to public transit. In order to determine the maximum parking restrictions, it is important to conduct surveys of the existing parking supply and demand in urban cores and work with developers to establish the optimal ratio for maximum requirements. In the long term, the national and local governments may consider lowering parking maximums below the previous minimum parking needs to strictly regulate the number of parking spots in urban areas. The locations with less access to public transportation could have different maximum parking fees than those with greater access.

Policy action 2.3: Introduce shared parking requirements

Due to the fact that different land uses attract people at various times of day, an office whose parking demand peaks during the day might share parking spaces with a residential building whose parking demand rises at night. The finding revealed the behavior of parking usage in condominiums, revealing that nearly all parking spaces are unoccupied during the day. Therefore, the DPWTCP and BMA should encourage shared parking by reducing the minimum parking spaces required for mixed-use or single-use developments in mixed-use areas such as the area with high accessibility to the transit station. In addition, the authorities should have a formal agreement with developers willing to use a shared parking ratio and committed to using it as shared parking. If the land use changes to single land use, the number of parking spaces must be changed. Therefore, the authorities are responsible for the post-development monitoring procedure. For instance, Montgomery County, Maryland, allows shared parking to meet minimum parking requirements when a building is used for two or

more purposes and is owned by the same entity (Forinash et al., 2003).

Policy action 2.4: Increase residential minimum parking requirements in areas with poor access to public transportation and no parking management program

In general, residents of Bangkok condominiums outside of Bangkok's transit zone have fewer opportunities to utilize public transportation than those residing near mass transit. In addition, in many areas with an unmanaged on-street parking management program, illegal parking causes several social problems as the project development provides parking spaces equal to the current minimum parking requirements but does not consider the travel patterns of residents that rely on automobile use.

The DPWTCP and BMA should therefore consider modifying the regulations to increase the minimum parking requirements in areas with limited public transportation access and no parking management program. Moreover, collecting the parking generation rate in those places may be necessary for estimating the number of minimum parking requirements to ensure that the area's residents have a parking demand for cars, not motorcycles.

Policy action 2.5: Eliminate minimum parking regulations in areas where on-street parking management is effective

Eliminating parking requirements is not ideal for all locations. In the Central Business and high-density zone, where public transportation accessibility is strong, the national and local governments should consider removing parking requirements by combining good on-street parking management with maximum parking regulations to reduce parking supply in the city. Eliminating parking regulations is a more market-driven strategy, since it allows developers to determine the number of parking spaces they will provide for their customers in a new development. In combination with the maximum parking regulations, developers cannot build more parking spaces than the maximum allows. In addition, the national and local governments should consider soliciting comments from a wide variety of stakeholders in the early revision process to eliminate minimum parking requirements. After effective on-street parking management has occurred, it is necessary to collect empirical data on parking utilization and household characteristics to influence policy formulation and ensure that regulations reflect local conditions.

Even if the parking requirements are abolished, the London and Buffalo evidence indicates that most developments still provide on-site parking because it is a requirement for successful developments. (Guo & Ren, 2013; Hess & Rehler, 2021). No developer wants a project to fail because too many or too few parking places are provided. Furthermore, even though the city has eliminated minimum parking requirements, the national and local governments should require parking spaces for specific purposes, such as loading and unloading zones, disabled parking spaces, and carpooling, if necessary.

- **Policy concerns**

One of the most concerning points is that changing the minimum parking requirements could result in shortages of on-site parking and spillover parking in surrounding locations, leading to broader problems such as illegal parking and traffic congestion. We acknowledge the possibility and believe that it is manageable through effective on-street parking management. Before a client purchases or rents a unit, it is essential that the property owner tells them about the limited number of parking spaces. The unbundling of parking could be advantageous in the case of a residential building when the buyer is required to pay for a parking space.

Changing the minimum parking requirements may also result in an inequitable distribution of parking spaces across existing projects. To address this issue, the national and local governments should permit buildings with an existing parking supply that exceeds their needs to sell the parking entitlement to new development projects in the region that lacks parking spaces or cannot add parking (see "Policy 5"). The government should also allow the conversion of underused parking spaces into other uses, such as pocket gardens.

In addition, with restrictive maximum limitations on the number of parking spaces, developers may be concerned about the long-term marketability of a luxury residential building for people with extremely high incomes, as all constructions must conform to the maximum limits. One strategy is a project that wants to supply more parking than the legal limit may purchase the right of underused parking from a different development project in the same district (see "Policy 5").

6.2.3 Policy 3: Unbundling residential parking

Regarding the tradition of free bundle parking in Thailand, which encourages developers to provide many parking spaces in condominiums to meet customer expectations, those who purchase a condominium unit in Thailand can expect bundle parking. Conventionally, the cost of parking for residential units is "bundled" into the purchase price rather than charged separately to the owners. This means tenants and owners who do not own a vehicle and do not need parking spots must pay for parking spaces. Moreover, everyone in residential buildings believes they have a right to parking, even though it is not their parking exclusively. When there are insufficient parking spaces, the results of this study indicate that residents will be forced to compete for parking spots, causing mental health and social violence.

Therefore, the national and local governments should revise the regulations to require that new condominium projects "unbundle" payments for parking spaces from condominium purchases and allow buyers to choose whether or not to pay for parking spaces. In order to restrict the free selling of parking spaces, governments may also establish a minimum price for parking spaces. For instance, the floor could be set at a minimum cost of no more than 450,000 THB (#32, 33). In addition, the regulations should require building management to sell parking spots only to building residents until all residential units are sold while allowing parking owners to lease parking spaces to other users. Currently, residential unit owners who do not own a car lease unofficially the shared parking spaces in condominiums to other

residents or non-residents. However, this practice is restricted in some condominiums by the property management. In some condominiums, such as the Lumpini condominiums, residents who want parking spaces are charged an additional monthly fee of roughly 300 THB, but the cost of parking is still included in the purchase price.

Unbundling parking should be considered for implementation in locations where public transportation is easily accessible. It should also be considered in areas with relatively low parking demand. Several developed cities, such as Dorchester, Bellevue, and San Francisco, have implemented an unbundling policy in residential development projects and found many positive benefits for the city. (MTC'S VPP PARKING PROJECT, 2022)

- **Benefits**

Unbundling parking is the most equitable way of distributing parking resources and can significantly reduce the price or rent of houses for individuals who do not own a vehicle, enabling developers to construct and sell houses at a lower price to those who prefer not to own a vehicle. This also contributes to sustainable mobility by reducing traffic congestion and pollution as a result of a decline in car ownership and by encouraging the use of public transportation, as recent research indicates that bundled free parking encourages car use among vehicle owners by encouraging them to take driving trips and discouraging transit use (Manville & Pinski, 2021; ter Schure et al., 2012).

- **Policy concerns**

Requiring new developments to unbundle parking may not be well received by the development community, especially if parking minimums remain high. Consequently, the government may change the minimum parking requirements before implementing unbundling parking. Unbundling parking may also cause residents who do not have access to parking spaces in the building to park in the neighborhoods, hence increasing the demand for on-street parking, which may increase the on-street parking issue. Therefore, the local governments and police must manage on-street parking to prevent problems caused by people who park illegally.

Additionally, unbundling parking may impact developers if they supply more parking spaces than residents require. When all residential units are sold, the government should allow the developers to transfer the excess parking spaces to another development within the district (see "Policy 5"). Alternately, the developer may lease parking spaces in a park-once-and-walk district managed by the local governments. (see "Policy 4")

6.2.4 Policy 4: Park-once-and-walk district

This study demonstrates that most of central Bangkok lacks parking as shophouse buildings in central Bangkok was not previously required to provide parking. There are only three off-street public parking places available for the public. Because they have no other option, shophouse residents and business owners must bribe government officials to acquire parking spaces for their buildings. Moreover, we discovered that more than 90% of condominium parking spaces are unused during the day.

As an alternative approach to the problem of insufficient parking in central Bangkok and unused parking, the local governments should consider establishing neighborhood-based parking management or park-once-and-walk districts programs. The logic behind a park-once-and-walk area is that each parking facility may serve the entire neighborhood, not just a single site, where the majority of space is accessible to the general public, even if privately owned (Reinventing Parking, 2018). People are encouraged to park in one location and then walk between destinations within the district rather than driving.

- **Benefits**

The park-once-and-walk district management could increase parking supply in the community, relieving the problem of scarce parking for shophouse buildings in the urban area and maximizing the use of unused parking in the buildings. A more supply of off-street parking would decrease demand for on-street parking. Consequently, illegal parking and cruising for parking would decline, reducing traffic congestion and air pollution in the area. In addition, increased parking availability in a commercial area would boost business in the area.

- **Policy implementation strategies**

Policy action 4.1: Opening government office parking spaces to the public during non-business hours

Several district offices are observed to be located in a dense neighborhood with limited off- and on-street parking. The BMA should therefore consider making the district office parking spaces available for the public outside business hours. The driver may park and then walk to the destination. Moreover, based on observations, many government offices and places in Bangkok have many unused parking spaces outside business hours that might be used as public parking or park-and-ride facilities if placed near a transit station. Therefore, the BMA should consult with other government agencies to allow public access to their parking lots. Also, the BMA should oversee the management of these parking places in the government buildings or hire the private sector to manage them.

Policy action 4.2: Develop and implement the shared parking program

The local governments should develop a shared parking program in the city that takes into account the area of implementation, the agreement and benefits for non-government institutions (e.g., temple) and private parking open to the public, and how to ensure security when non-residents are controlling neighborhood access (Liu et al., 2018). There are incentives in Taipei, Seoul, and Beijing for buildings to make their parking available to the public (Reinventing Parking, 2018). One example is a property tax rebate for each off-street parking space made available to the public.

The parking-sharing platform or application may be viable instruments for the parking program's implementation. To implement this scheme, the local governments may collaborate with a private parking company that provides parking information and reservations, such as Park2go.co.th, Jordsabuy.com, and Thailand-parking.com. The local governments may explore multiple approaches to the operation of the shared parking

program. For example, only enforcing compliance with regulations and all operations by a private firm depends on the agreement with private owners (Los Angeles Department of Transportation, 2019).

- **Policy concerns**

The number of available shared parking spaces poses the greatest obstacle to implementing this strategy. Both public and private building owners may not wish to share parking. Therefore, the policymakers must provide an attractive incentive to make parking available to the general public. In addition, change may take time. District-based parking contributes to enhanced urban sustainability in the long term.

6.2.5 Policy 5: In-lieu parking fees, centralized parking facilities, and transferable parking entitlements

According to the findings of this study, minimum parking requirements are a critical constraint for project developments. The in-lieu parking fees are the alternative if developers do not want to provide the required on-site parking spaces by paying the city a fee (Shoup, 1999a). The city may utilize the funds to construct new public shared parking for the district in the area with insufficient parking or to provide centralized off-site parking for the development's tenants and visitors (Forinash et al., 2003; Kimley-Horn, 2012). The local governments should therefore consider developing and implementing in-lieu parking fee programs.

Furthermore, empirical evidence revealed that unused parking spaces exist in condominiums, indicating excess parking spaces. To utilize these unused parking spaces, the local governments should consider establishing the transferable parking entitlements program. This program allows the transfer of unused parking spaces from one development to another in the surrounding area (Forinash et al., 2003).

- **Benefits**

Parking in-lieu fees can be advantageous for developers, cities, and the public. Developers gain flexibility in fulfilling parking minimums at locations that cannot comply with regulations mandating on-site parking, such as those near transportation stations. The space saved on a location that would have been allocated to parking could be used for activities that are more focused on people. There could be fewer on-street parking spaces as a result of the in-lieu parking fees, leading to a decline in vehicle traffic. While in-lieu fees can be an essential source of funding for cities to develop new public parking supply, they can also be allocated toward infrastructure improvements or operational programs that improve access for drivers, bikers, and transit riders to support sustainable mobility (Schleck, 2021).

The transferable parking entitlements program could facilitate the use of unused parking spaces and promote the flexibility of maximum parking requirements. This approach permits communities to regulate the parking supply without impeding developments that would not be feasible without more parking (Forinash et al., 2003).

- **Policy implementation strategies**

Policy action 5.1: Develop and introduce transferable parking entitlements programs

National and local governments should implement transferable parking entitlements programs that allow unused parking spaces in buildings to be sold to a neighboring developer. If the new development is willing to supply fewer on-site parking spaces than the minimum requirements, the parking entitlements may also be counted as required parking. To ensure compliance with parking rules and regulations, the local governments should be the center for selling parking entitlements.

Policy action 5.2: Develop in-lieu parking fees and use the in-lieu parking fees to fund public parking or centralized parking facilities.

The local government should consider incorporating in-lieu parking fees into its minimum parking requirements. The costs may vary according to the cost of parking in the building developments (Shoup, 1999a). For instance, condominium parking developments cost approximately 100,000 THB per parking place. The local governments may then use the in-lieu parking fee, provide public parking or centralize parking facilities in each district where the developers pay the in-lieu fee. However, the in-lieu costs should be returned if the local governments fail to provide parking within a specific time.

In addition, in implementing an in-lieu parking fee, the government must consider the impacts of a lack of on-site parking that may be insufficient or inappropriate for the developments' contexts. Therefore, before approving the in-lieu fee for the developments, the government must examine the parking demand for each property and ensure sufficient parking.

- **Policy concerns**

Insufficient on-site parking could be an issue with in-lieu parking fees, leading to illegal parking and congestion due to overspill parking pressure. Moreover, the local governments may not create parking facilities as quickly as the private sector, causing a delay that could impact the neighborhood's parking situation. Some cities construct the public parking structures to improve this issue before receiving the in-lieu fees. The in-lieu fees are then used to pay off the debt incurred to fund the constructions (Kimley-Horn, 2012).

6.2.6 Policy 6: Reduce the automobile transportation demand and encourage use of sustainable mobility options

Poorly planned roadway expansions in Bangkok and Thailand have caused problems for cities, including traffic congestion, air pollution, and accidents, since they encourage the use of automobiles and discourage public transportation. Moreover, Bangkok's poor and expensive public transportation is one of the reasons why people rely on their cars. To satisfy the automobile demand, parking has become a valuable asset for any development, from both the customer's and the developers' viewpoints. Therefore, to tackle the issues of excessive traffic demand, the national and local governments should implement a policy aimed at

reducing the demand for automobile transportation and, subsequently, the need for parking spaces. One of the policy implications is the promotion of sustainable mobility options, such as public transportation, walking, and cycling.

- **Benefits**

A decrease in the use of private cars can reduce traffic congestion in central areas, improve air and noise pollution, reduce space for parking, and increase modal shift towards sustainable mobility. In addition, changing the daily commute from automobiles to sustainable modes of transportation could also improve health and happiness (Fischer, 2014).

- **Policy implementation strategies**

Policy action 6.1: Consider allowing the replacement of car parking spaces with sustainable mobility options

Even if sustainable mobility trends, such as shared mobility and electric vehicle, have emerged in Bangkok during the past five years, the city's regulations have not changed. The national and local governments should consider revising the parking requirements to allow developers to reduce the required parking spaces if a development offers sustainable modes of transportation, such as bicycles, car sharing, and electric vehicles. For example, in Villa Park, Chicago, each car sharing parking space can replace up to four regular parking spaces, resulting in a potential reduction of 40% in overall parking (The Center for Neighborhood Technology, 2016). Meanwhile, the city of Zurich has reduced the minimum parking requirements for residential projects, including car sharing and bicycle parking (Gies et al., 2021).

Policy action 6.2: Consider required parking for sustainable mobility options

To encourage sustainable mobility options, the national and local governments should consider the modification of the parking requirements to demand parking spaces for sustainable mobility options, such as bicycles, electric vehicles, and car sharing to promote non-private car use. For instance, the village of Schaumburg in Illinois has included provisions for bicycle use directly into their zoning regulations, stipulating that all retail centers must have at least 10 bicycle parking spaces at each main building entry (Forinash et al., 2003).

Policy action 6.3: Improve the public transportation service and pricing

Given the poor performance and service of the bus system, people continue to rely on using private vehicles. The MoT should therefore invest in improving the bus system to make it more appealing to users, including purchasing new buses, rerouting and expanding routes to satisfy demand, and providing bus lanes.

The mass rail transit also requires a fare structure revision. Multiple station entry fees and a high maximum fare ceiling contribute to the high travel fares (TDRI, 2021). The MoT should consider waiving station entry fees for passengers who transfer between different mass

rail transit lines. The maximum fare ceiling should also be reasonable and standardized for the mass rail transit network. In addition, the national and local governments should consider employing windfall tax funds or profit from the parking operation to support subsidies and provide reasonably priced transportation options to feed people into the mass transit system.

Policy action 6.4: Provide more park and ride facilities

Park and Ride (P&R) facilities reduce reliance on private vehicles and encourage transit use by offering easy parking for transit riders. P&R contributes to reducing traffic congestion and improving sustainable mobility, particularly in areas with inadequate feeder transport systems. The Mass Rapid Transit Authority of Thailand (MRTA), under the MoT, now provides at least thirteen P&R facilities. The MoT should consider providing more park-and-ride facilities at suburban or peripheral locations where car travel does not exacerbate traffic congestion. This would encourage motorists to leave their cars at a car park outside the central area and complete their journey via public transportation.

- **Policy concerns**

Revising the parking requirements to promote sustainable mobility options could give numerous short- and long-term benefits to cities; nevertheless, this practice is primarily used in developed countries with a friendly environment and infrastructure for walking and cycling. Therefore, to implement this strategy in developing countries where the walking and biking facilities need improvement, national and local governments must determine which sustainable mobility mode is promoted to help the city accomplish its goals.

Furthermore, some implementation strategies require many actions from government agencies and stakeholders, particularly regarding the public bus, mass transit system, and park-and-ride facilities, which could be challenging. However, this effort could eventually contribute to better urban sustainability in the long term.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary of the Research Results

Parking is one of the most challenging aspects of urban planning and implementation, although it is so unattractive that very few researchers, especially those in developing countries, focus on its importance. Therefore, this study aims to examine the problems of current on-street and off-street parking policies, investigate the causes of parking issues, and establish a parking policy that supports the city's development of sustainable mobility. To achieve these study objectives, an integration of the Iceberg Model of Analysis and the Political Economics Analysis conceptual frameworks was applied. It consists of the three steps outlined below: 1) Identifying parking issues; 2) Investigating the root causes of parking issues; and 3) Developing a parking policy based on the empirical findings of the study, with the goal of promoting sustainable mobility. The objectives of the study have been accomplished, and their findings are summarized here.

7.1.1 Parking issues in Bangkok

The parking issues have been analyzed by examining the manifest problems, the characteristics of on-street parking demand and supply, the parking provision of project developments, and the utilization of parking in condominium buildings using the field survey data. The empirical findings indicate that the ineffectiveness of on-street parking management, the chaos of on-street parking, and the troubles with the city's decades-old minimum parking requirement are major challenges in Bangkok. These parking issues have negative effects on individuals and society as a whole, including increased traffic congestion, physical violence, accidents, and air pollution. They may also reduce housing affordability and public safety.

The ineffectiveness of on-street parking management identified by this study's virtual survey and field survey includes the following: (i) the actual management of on-street parking does not correspond with the regulations; (ii) the lack of sufficient signs and markings in designated paid parking zones; (iii) the designated paid parking zone lacks a parking warden; (iv) parking wardens did not collect fees following BMA regulations; (v) informal and illegal parking attendants; (vi) weak and irregular enforcement of the parking regulations.

The chaos of on-street parking consisted of (i) widespread double parking and illegal parking, (ii) widespread unauthorized parking reservations, and (iii) insufficient on-street parking spaces. The parking statistics also reveal that Bangkok's on-street parking is extremely inefficient compared to that in other developing cities. The average parking duration is long, and the turnover rate low.

The empirical analysis indicates that Bangkok's decades-old Minimum Parking Requirements (MPRs) are an obstacle to developing condominiums, hotels, offices, and

mixed-use buildings, specifically those that want to encourage transit use. The empirical case also presents the consequences of the existing MPRs, which include: (i) relatively high parking provision in central and transit-rich areas; (ii) a mismatch between parking supply and transit provision; (iii) insufficient parking supply in condominiums; (iv) excessive parking spaces in condominiums.

7.1.2 Underlying causes of parking issues

Documentary research and in-depth interviews were utilized to examine the context, underlying structures, and stakeholders' mental models that may contribute to parking issues. The study's findings reveal the multiple causes that contribute to current parking issues. The causes were the political-economic, institutional, and legal frameworks, policy strategy and planning, operational management, tradition, and mindsets and incentives of the stakeholders.

The primary root causes of on-street parking issues are political and local leaders' lack of interest and commitment. They show neither an awareness of on-street parking issues as a serious problem nor a commitment to manage them effectively. When both leaders lack significant actions, the existing on-street parking lacks a clear on-street parking policy to serve as the management's direction and objective. Several components of the existing on-street parking management were identified as having significant root causes that must be addressed for effective on-street parking management. Other root causes include: (i) the limited legislative authority of the local governments; (ii) the lack of human resources and technology for managing on-street parking spaces, monitoring, and enforcing regulations; (iii) the misalignment of stakeholders' mindsets, motivations, and incentives; (iv) the lack of parking spaces in the neighborhood and the bribery between residents and public officials; (v) fragmented institutions and organizations with poor inter-and intra-agency coordination.

Moreover, the response to the new urban trends driven by the emergence of digital platforms, such as food delivery, ride-hailing, and express delivery services, does not take into account the current on-street parking management. That has become a part of Bangkok's lifestyle and has increased the need for on-street parking. This is another cause of current parking issues. In addition, the rise of electric and driverless vehicles, which will transform the infrastructure of the existing on-street parking, should also be considered.

Off-street parking issues are primarily the result of outmoded minimum parking regulations and barriers to changing parking standards. The current parking regulations are still based on a city environment dependent on automobiles. The obstacle to revising the regulations is the misalignment of government bodies among policymakers and the absence of relevant data and empirical study. Another significant root cause is the incompatibility between off-street parking policies and urban and transport policies. Traditional residential parking bundles and the lack of reliable and affordable public transportation are the primary drivers of the need for parking in buildings in Bangkok, as they encourage individuals to drive and own cars. In addition, some technologies and digital platforms relevant to off-street parking, such as an online parking reservation and automated parking system, have been developed in response to the growing demand for parking. Furthermore, many condominiums and other residential developments have recently added charging stations for electric automobiles.

7.1.3 Parking policies implications in Bangkok

The overarching policy goal of these policies' implications is to address parking issues, critical causes in the mechanism of parking problems, and promote new urban and mobility trends both now and in the future. Ultimately, it could help promote sustainable mobility. National and local governments have an essential role in these proposed policy implications by establishing the regulations and mechanisms for the policy implications that would have both positive and negative effects on the conduct of the private sector. For instance, some policies may restrict private sector's action, while others may generate new opportunities for the private sector to collaborate with the government in developing the city. Based on the empirical findings of this study, we propose the following policy recommendations for the national and local governments of Thailand and other developing countries.

(1) Considering empirical evidence indicates that the existing on-street parking management is poor in several essential components for adequate on-street parking management, national and local governments should seriously improve the effectiveness of on-street parking management. These changes include the institutional and statutory framework, parking policy, physical infrastructure, and implementation procedure. Proposed parking strategies include the residential parking permit program, on-street parking spaces for short-term usage and sustainable travel modes, and the application of parking technologies to facilitate parking fee collection, monitoring, and enforcement. Partnering with the private sector to manage on-street parking spaces is an alternative approach for enhancing the effectiveness of on-street parking management. In response to the advent of new mobility options, such as electric vehicles and car sharing, national and local governments should also consider allocating on-street parking spaces to sustainable mobility alternatives, such as offering on-street parking slots for car-sharing vehicles. The benefits of this policy have significantly contributed to the promotion of sustainable mobility by encouraging the efficient and equitable use of on-street parking spaces and easing the problem of local traffic congestion.

(2) It was discovered that the current minimum parking requirements must be revised, since they hinder the development of transit-friendly projects and are incompatible with land use and transit planning. Therefore, the national and local governments should urgently consider revising the parking requirements in Bangkok. To reform minimum parking requirements, we proposed zone-specific parking requirement policies to align parking policy with urban and transport policies that specify parking policy for various urban zones based on urban density, proximity to public transportation, and traffic volume. In a high-traffic demand area with high transit accessibility, where the goal is to reduce traffic congestion and encourage transit use by limiting parking supply, the proposed parking action is a dual strategy that reduces the minimum parking requirements and sets the maximum requirements for residential and non-residential parking. In addition, this policy proposes that when a zone has an effective on-street parking management, it may consider providing fewer parking spaces in the city, such as in the central business district with good access to

public transportation, and eventually eliminating minimum parking requirements. The policy also includes introducing a requirement for shared parking and increasing the minimum parking requirements in locations with limited public transport accessibility. Reforming the parking requirements would promote sustainable mobility and benefit society. Reducing parking spaces can reduce car use, congestion, and air pollution. It also allows transit-friendly and affordable housing projects.

(3) Regarding the tradition of free parking bundles in Thailand, the cost of parking for residential units is bundled into the purchase price, and all residents must share the cost, placing an unfair financial burden on households without cars. Therefore, the national and local governments should revise the regulations to require that new condominium developments unbundle payments for parking spaces from condominium purchases and allow buyers to choose whether or not to pay for parking spaces. Unbundling parking would significantly reduce the price or rent of dwellings for non-car owners and contribute to sustainable mobility by reducing traffic congestion due to a decline in car ownership and promoting public transit use.

(4) According to the findings of this study, the majority of central Bangkok lacks parking spaces for shophouse buildings and uncovered a high proportion of unused parking spaces in condominiums during the day and in some buildings during non-business hours. Thus, the local government should consider establishing neighborhood-based parking management or park-once-and-walk districts programs to increase the parking supply by utilizing underused parking spaces in several off-street parking lots instead of creating new ones. This policy aims to ensure that each parking facility serves the entire neighborhood and not just a specific location, where most of the space is open to the public, even if privately held. Therefore, it is proposed that government offices with unused parking during non-business hours should make it available to the public. Also, a program that encourages private parking lots to be open to the public should be developed and executed.

(5) In light of empirical evidence indicating that minimum parking requirements may impede some projects' development and cause excessive parking spaces in buildings, the national and local governments should consider implementing in-lieu parking fees and transferable parking entitlement programs. The In-lieu parking fees and transferable parking entitlements create a strategy that makes parking requirements more flexible and improves the utilization of parking spaces. For example, if a developer does not intend to supply the required on-site parking spaces, he or she can pay the in-lieu parking fee instead. In addition, transferable parking entitlements programs allow the transfer of unused parking spaces from one development to another in the neighborhood. This program is an essential parking reform strategy for reducing minimum parking requirements and promoting maximum parking requirements.

(6) Poorly planned road developments and poor and expensive public transportation in Bangkok encourage the usage of automobiles and increase the city's demand for parking spaces. Therefore, the national and local governments should establish a

policy targeted at reducing the demand for automobile transportation and, consequently, the demand for parking spaces. These guidelines require that the national and local governments improve public transportation service and pricing, replace car parking spaces with sustainable mobility options, require parking for sustainable mobility options, and provide additional park-and-ride facilities.

7.1.4 Extended application of findings to other developing countries

Traditionally, parking problems in developing countries have followed a similar pattern. These parking problems include: (i) widespread illegal parking on main roads and minor roads (Eedan Al-Jameel & Muzhar, 2020; Yan-ling et al., 2016); (ii) insufficient on-street parking supply (Chen et al., 2016; Parmar, Das, Azad, et al., 2020); (iii) inadequate on-street parking design and management (Bulactial et al., 2013; Fillone & Paringit, 2010; Putra & Hidayah, 2019); (iv) institutional fragmentation and lack of coordination among agencies (Wang & Yuan, 2013); (v) the disconnect between parking policy and urban transport planning (Institute for Transportation and Development Policy, 2014; Phuc et al., 2019; Thanh, 2017); (vi) lack of political support (Barter, 2011; Shoup et al., 2016); (vii) unused parking spaces in building (Liu et al., 2018); and (vii) corruption in the formal planning system (Fisman & Miguel, 2007).

These parking issues are similar to those recently found in Bangkok. For instance, the on-street parking problems found in this study, such as insufficient on-street parking design and management, are also present in other developing cities, such as Ho Chi Minh City (Phuc et al., 2019) and Manila (Bulactial et al., 2013). In many Chinese cities, problems with the institutional structure, such as institutional fragmentation, limit the enforcement of parking regulations (Wang & Yuan, 2013). Similar to Bangkok, many developing countries, such as Asian cities (Thanh, 2017), struggle with a misalignment between parking policies and urban transit planning.

Similar patterns in parking problems in developing countries require practical policy implication, planning, and management. Consequently, the extended application of findings and policy implications to these countries are promising. The policy implication that would support, for instance, developing cities with chaotic and problematic on-street parking should first consider improving on-street parking management. Zone-specific parking requirements are also suggested for other developing countries to align parking policies and urban mobility planning.

7.2 Significance and limitations of the study

7.2.1 Significance of the study

This study's findings provide several theoretical insights and policy implications applicable to other developing countries. From the theoretical perspective, this study provides empirical evidence regarding the characteristics of paid on-street parking facilities, the effects of minimum parking requirements on residential and non-residential project developments, and the parking utilization of residential parking buildings. Additionally, the evolution of parking policies and the previous problems are explored. This empirical evidence could serve

as a lesson for developing countries, as on-street parking management and minimum parking requirements are mostly implemented in developing cities. In addition, this study has identified several root causes of on-street parking management and off-street policies, which might be used as a guideline for developing countries to address these issues to improve the parking situation, as we found similar root causes in other developing cities.

From a practical perspective, based on the empirical evidence and detailed root causes identified in this study, we propose the parking policies and strategies to address parking problems and their actual root causes, as well as the implementation strategies and potential issues that take into account the unique characteristics of developing cities in terms of parking issues and traffic conditions. Therefore, other developing countries that may or may not have similar parking issues can use this as a guide on policy implementation. We expect that this study's findings and policy recommendations will support policymakers and transport planners in progressing parking reform in developing countries, thereby enabling them to create sustainable cities.

7.2.2 Limitations of the study

The first limitation of this study is that the sample size of high-level political and municipal leaders is small due to their limited availability. This could lead to the result being missing at some high-level issues. However, we believe this study reveals important lessons for policymakers in developing countries.

Second, this study's scope is focused only on paid on-street parking. As a result, it does not account for the impacts of free parking on parking demand in paid parking locations, such as the impact of nearby free parking availability on paid-parking use. We believe it would have little effect on this study because the streets in the study areas are typically divided into sections, and the unpaid streets near each street are typically prohibited for parking or near the small roads that are highly saturated by building owners who always occupy the places.

Third, the in-depth field study area on-street parking is limited to four study areas in central Bangkok. However, we believe these findings could represent Bangkok's on-street parking. In the city’s suburb, on-street parking spaces are unmanaged and less strictly enforced than in the city center. Therefore, the findings of this study may represent the best-case situation for places with on-street parking management in which we discovered many parking problems. This could imply that similar or worse problems could be seen in unmanaged suburban areas. Consequently, this study makes policy recommendations regarding the management of on-street parking that are applicable to the entire city of Bangkok, not just the city center.

Fourth, in this study, only preliminary qualitative research was used to describe the impact of parking issues. We consider, however, that these findings could be useful for policymakers in developing nations.

Due to the Covid-19 epidemic and the low participation rate of non-residential building owners and managers, the data on parking use is restricted to condominium buildings only. In addition, the data on condominium parking has a small sample size in locations far

from transit stations and the suburbs. This could be difficult to interpret the result in a suburban area. Nonetheless, we believe this study has uncovered significant findings for designing parking policies and informing policymakers and transport planners.

7.3 Future Research

A few issues need further examination in future research. The parking use of condominiums, as well as other building types, located in the suburbs and far away from rail transit stations should be investigated further to establish a more comprehensive parking policy. It is unclear how the pricing policy affects travel behavior if people have to pay the actual price according to the regulations. We also need to examine the characteristics of on-street parking by comparing unpaid and paid on-street parking areas to examine whether parking management with fee collection affects parking demand or not.

It is still unknown how the "New Normal" at work (i.e., work from home) affects the residential and non-residential building parking situation after the COVID-19 outbreak. Additionally, with the emergence of Mobility-as-a-Service (MaaS) and autonomous vehicles, it is uncertain how on-street parking regulations and management will need to be changed to accommodate these new modes of transportation.

Some cities, such as Shenzhen, have implemented an integrated parking policy that considers on-street and off-street parking policies together as a comprehensive plan (Lin & Guo, 2019), which may be beneficial for growing cities that often consider them separately (Barter, 2011). For instance, the on-street parking plan considers the availability and utilization of off-street parking, whereas the off-street parking policy considers the demand for on-street parking in each area. Therefore, future research should study the relationship between the availability of on-street and off-street parking to develop an integrated parking policy for developing cities.

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APPENDIX A
THE LIST OF THAI-TO-ENGLISH LEGISLATION NAMES

Thai	English
พระราชบัญญัติจราจรทางบก พุทธศักราช 2477	Road Traffic Act B.E. 2477
พระราชบัญญัติจราจรทางบก พุทธศักราช 2522	Land Traffic Act B.E. 2522
พระราชบัญญัติจัดระเบียบการจอดยานยนตร์ในเขตเทศบาลและสุขาภิบาล พุทธศักราช 2503	Parking Management within Municipalities Act B.E. 2503
เทศบัญญัติของเทศบาลนครกรุงเทพ เรื่อง จัดระเบียบการจอดยานยนต์ พุทธศักราช 2503	BMA Ordinance (No. 1) B.E. 2503
ประกาศกรุงเทพมหานคร เรื่อง กำหนดที่จอดยานยนตร์และอัตราค่าธรรมเนียมจอดยานยนตร์	BMA Announcement (No. 1) B.E. 2537
พระราชบัญญัติควบคุมการก่อสร้างอาคาร พุทธศักราช 2479	Building Construction Control Act, B.E. 2479
พระราชบัญญัติควบคุมอาคาร พุทธศักราช 2522	Building Control Act B.E. 1979
พระราชบัญญัติควบคุมอาคาร (ฉบับที่ 2) พุทธศักราช 2535	Building Control Act B.E. 1992
กฎกระทรวง ฉบับที่ 7 (พุทธศักราช 2517)	Ministerial Regulation No.7 B.E.2517
ข้อบัญญัติกรุงเทพมหานคร เรื่อง ควบคุมอาคาร พุทธศักราช 2544	BMA Ordinance on Building Control B.E. 2544
พระราชบัญญัติจัดระเบียบการจอดรถในเขตองค์กรปกครองส่วนท้องถิ่น พุทธศักราช 2562	Parking Management within Municipalities Act B.E. 2562
ข้อบัญญัติกรุงเทพมหานคร เรื่อง การจัดระเบียบการจอดรถ พุทธศักราช 2564	BMA Ordinance on Parking Management B.E. 2564

APPENDIX B
QUESTIONNAIRE AND SURVEY FORM OF PARKING USAGE

Faculty of Engineering
Chulalongkorn University

แบบฟอร์มข้อมูลรายละเอียดและการใช้งานที่จอดรถในคอนโดมิเนียม

วัตถุประสงค์ เพื่อศึกษา "ความต้องการใช้พื้นที่จอดรถยนต์ภายในเขตกรุงเทพมหานครและปริมณฑล" และนำเสนอแนวทางการปรับปรุงกฎหมายและกฎระเบียบที่เกี่ยวข้องกับการกำหนดจำนวนที่จอดรถยนต์ในอาคารขนาดใหญ่ ให้มีความเหมาะสมสอดคล้องกับการพัฒนาเมืองในปัจจุบันและอนาคต ซึ่งรับผิดชอบโดย คณะวิศวกรรมศาสตร์ และคณะสถาปัตยกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย และมหาวิทยาลัยเทคโนโลยีราชมงคลพระนคร วิทยาเขตพณิชยการพระนคร

คำชี้แจง คณะผู้วิจัยจะใช้ข้อมูลเพื่อการศึกษาวิจัยเท่านั้น และจะเก็บข้อมูลไว้เป็นความลับ

ส่วนที่ 1 รายละเอียดของโครงการ

1. ชื่อโครงการ.....
2. ปีที่สร้างเสร็จ ปี พ.ศ.....
3. จำนวนห้องชุด.....ยูนิต
4. สัดส่วนการเข้าอยู่อาศัยของลูกบ้าน อยู่เอง.....% ให้เช่า.....% ห้องว่าง.....%
5. ชื่อบริษัท นิติบุคคล.....

ส่วนที่ 2 ข้อมูลการใช้งานที่จอดรถยนต์ในช่วงเวลากลางวันและกลางคืน

1. จำนวนช่องจอดรถยนต์ปกติ (ไม่รวมซ้อนคัน) .....
2. ในคอนโดมิเนียมมีการจอดซ้อนคันหรือไม่ [ ] มี จำนวนประมาณกี่คัน..... [ ] ไม่มี
3. การบริหารที่จอดรถยนต์ มีการเก็บค่าบริการที่จอดรถหรือไม่ [ ] ไม่มี [ ] มี
   มีการบริหารอย่างไรและคิดราคาเท่าไหร่ โปรดอธิบาย.....
   .....

วันจันทร์-วันพฤหัสบดี

4. จำนวนรถยนต์ที่จอดใน<u>ช่วงเวลากลางวัน</u> มีจำนวนประมาณ.....คัน
5. ในตอนกลางคืนที่จอดรถเต็มหรือไม่ [ ] เต็ม [ ] ไม่เต็ม (กรุณาตอบข้อต่อไป)
6. จำนวนรถยนต์ที่จอดใน<u>ช่วงเวลากลางคืน</u> มีจำนวน.....คัน

วันเสาร์

7. จำนวนรถยนต์ที่จอดใน<u>ช่วงเวลากลางวัน</u> มีจำนวนประมาณ.....คัน
8. ในตอนกลางคืนที่จอดรถเต็มหรือไม่ [ ] เต็ม [ ] ไม่เต็ม (กรุณาตอบข้อต่อไป)
9. จำนวนรถยนต์ที่จอดใน<u>ช่วงเวลากลางคืน</u> มีจำนวน.....คัน

ขอขอบพระคุณท่านเป็นอย่างสูงที่
ท่านได้สละเวลาในครั้งนี้

Timetable

Project:			
Date:			
Time	In	Out	Number of parked vehicles
0.00 - 1.00	3	1	28
1.00 - 2.00	2	0	26
2.00 - 3.00	2	0	24
3.00 - 4.00	1	0	23
4.00 - 5.00	0	0	23
5.00 - 6.00	1	5	27
6.00 - 7.00	1	28	54
7.00 - 8.00	2	20	72
8.00 - 9.00	1	4	75
9.00 - 10.00	3	8	80
10.00 - 11.00	8	6	78
11.00 - 12.00	4	5	79
12.00 - 13.00	3	11	87
13.00 - 14.00	3	3	87
14.00 - 15.00	4	3	86
15.00 - 16.00	6	7	87
16.00 - 17.00	13	5	79
17.00 - 18.00	11	5	73
18.00 - 19.00	19	5	59
19.00 - 20.00	18	3	44
20.00 - 21.00	19	6	31
21.00 - 22.00	23	7	15
22.00 - 23.00	9	1	7
23.00 - 24.00	5	1	3
รวม	161	134	

APPENDIX C
CHARACTERISTICS OF THE STUDY AREA

Figure C.1 the characteristics of the study area at Wat Mangkorn

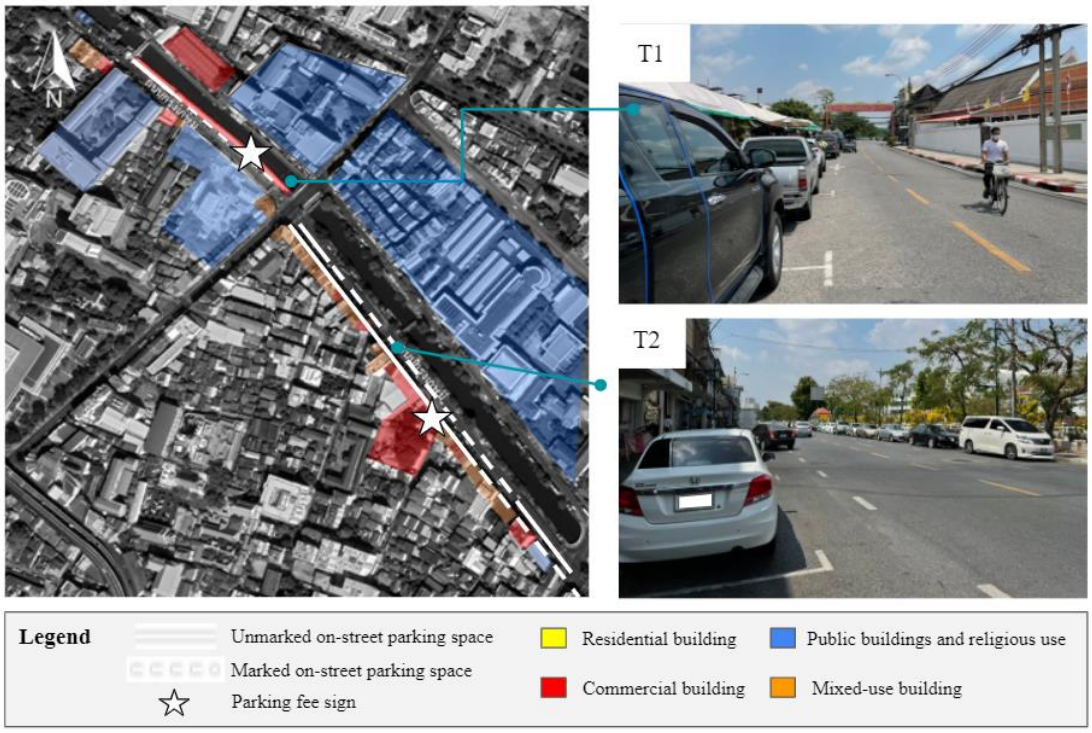

Figure C.2 the characteristics of the study area at Thewet

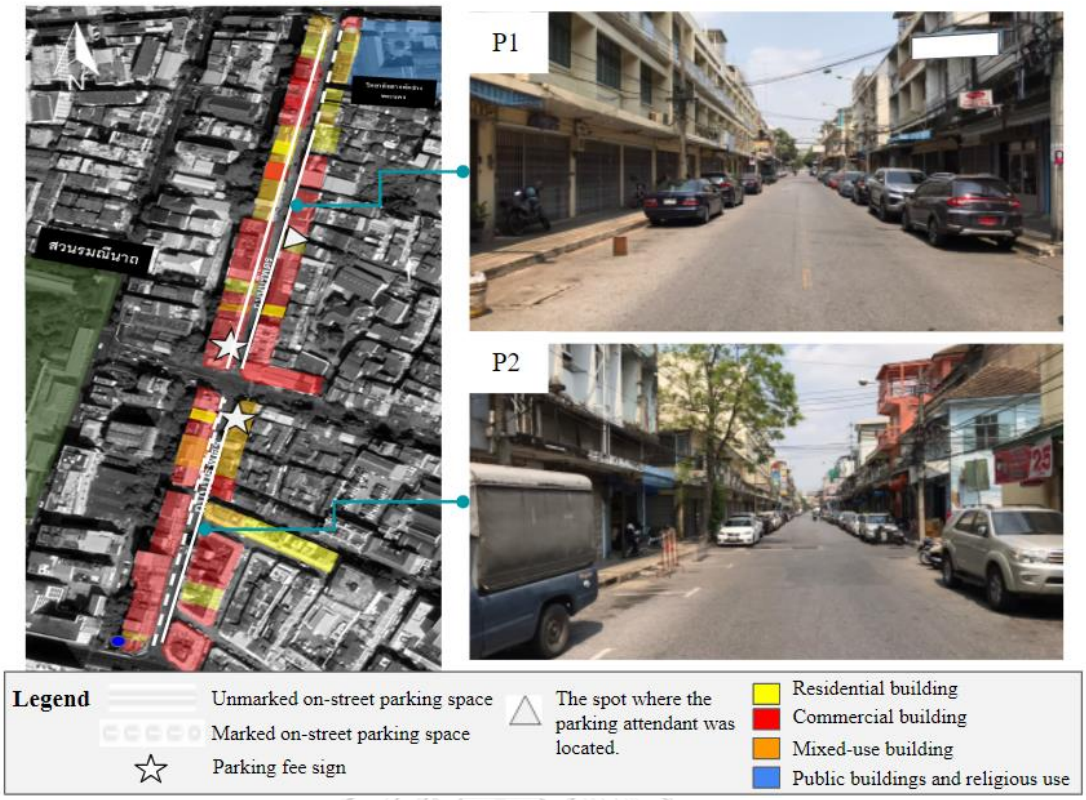

Figure C.3 the characteristics of the study area at Paribatra

Figure C.4 the characteristics of the study area at Ban Mo

APPENDIX D

LIST OF INTERVIEWEES

Interview Number	Identity
#1	Bangkok Metropolitan Council Member
#2	Senior BMA officer #1
#3	Parking attendant
#4	Senior BMA officer
#5	BMA district officer #1
#6	BMA district officer #2
#7	BMA Strategy and Evaluation Department officer
#8	OTP Senior officer
#9	Sub - Inspector (Traffic)
#10	BMA Lawyer
#11	Traffic Police Deputy Superintendent
#12	Traffic Police Inspector
#13	Inspector (Traffic)
#14	Police official (Traffic) #1
#15	Police official (Traffic) #2
#16	Local business owner/resident#1
#17	Local business owner/resident#2
#18	Local business owner/resident#3
#19	Local business owner/resident#4
#20	Local business owner/resident#5
#21	Local business owner/resident#6
#22	Local business owner/resident#7
#23	Local business owner/resident#8
#25	BMA Department of City Planning Senior officer
#26	BMA Department of City Planning officer
#27	BMA Department of Public Work Senior officer
#28	Building Control Bureau, Department of Public Works and Town & Country Planning Senior officer
#29	Town and Country Planning Engineering Bureau, Department of Public Works and Town & Country Planning Senior officer
#30	MRTA Division Director
#31	MRTA Head of department officer
#32	Real Estate Public Limited Company - Senior Vice President
#33	Real Estate Public Limited Company - Vice President#1
#34	Real Estate Public Limited Company - Vice President#2

Interview Number	Identity
#35	Real Estate Public Limited Company - Director
#36	Real Estate Public Limited Company - Customer Researcher
#37	JLL Senior Researcher
#38	EIA Consultant
#39	Parking Management Company - President
#40	Public Work Department, BMA district officer

VITA

NAME	CHAKAPHAN CHULLABODHI
DATE OF BIRTH	24 December 1989
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTIONS ATTENDED	Department of Civil Engineering, Faculty of Engineering, Chulalongkorn University.
PUBLICATION	Chullabodhi, C., Chalermpong, S., and Ratanawaraha, A., (2018). “Minimum Parking Requirements and Residential Property Value: Evidence from Bangkok." Poster Session presented at Transportation Research Board Annual Meeting 2018, January 8–12, 2018, the Walter E. Washington Convention Center, in Washington, D.C. Chullabodhi, C., Chalermpong, S., Ratanawaraha, A., Kato, H., (2020). “Assessing Minimum Parking Requirements and Parking Capacities of Residential Development in the Bangkok Metropolitan Region.” Transportation Research Record. September 2020. doi:10.1177/0361198120947716 Chullabodhi, C., Chalermpong, S., & Ratanawaraha, A. (2022). “Examining the Root Causes of On-Street Parking Mismanagement in Central Bangkok”. Nakhara: Journal of Environmental Design and Planning, 21(1), Article 207. https://doi.org/10.54028/NJ202221207