A STUDY OF FACTORS AFFECTING THE DEVELOPMENT OF CAMPUS BIKE-SHARING SYSTEM IN THAILAND

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ABSTRACT

University campuses consist of diverse buildings serving various functions, such as classrooms, laboratories, offices, and cafeterias. Students and university employees may commute between these buildings multiple times a day. Organizing transportation within the campus that suits the campus' characteristics and the community's travel behavior is a critical and challenging task. This study focuses on using bicycles as a transportation mode on university campuses. Commuter demographics, behavior, and their attitudes toward cycling were analyzed through a survey covering students, faculty, and staff in several universities. We gathered 1,433 responses from 19 universities across Thailand. The results revealed that most undergraduate students rely on motorcycles and public transport as their primary modes of transportation. In contrast, postgraduate students, faculty, and staff predominantly use private cars. Only 2.9% of all respondents use bicycles regularly.

Using Binary Logistic Regression on the response data, we found that demographic factors, such as residency and mode of transportation, are significant determinants of bicycle use on university campuses. Moreover, the lack of dedicated bicycle lanes and long travel times is the primary obstacle preventing people from cycling within university campuses. Additionally, the availability of parking spaces for bicycles was a problem, and good road surfaces and road signs that support cycling were critical factors influencing bicycle use on campus, respectively. Based on these findings, the study suggests the importance of enhancing the availability and

accessibility of bicycle facilities to promote cycling as a sustainable transportation option on university campuses.

Keywords: University campus, Bicycle, Travel behavior, Sustainable transportation, Binary Logistic Regression

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Chapter 1

Introduction

1.1 Background

A university campus may have buildings and amenities designed to fulfill diverse functions, including classrooms, laboratories, cafeterias, and sports facilities. Students, faculty, and staff commute between locations, creating a continuous flow within the campus area throughout the day. However, many universities face numerous transportation-related challenges, such as limited parking availability, air and sound pollution, and inefficient land utilization (Çolakkadıoğlu et al., 2018; Tiwari & Aljoufie, 2021; Wang et al., 2020; binti Zakaria et al., 2021). The gathering of empirical data on travel demand assumed crucial importance in improving university travel management strategies and fostering sustainable transportation on campus (Toor & Havlick, 2004; Black et al., 1999; Balsas, 2003). Therefore, encouraging students and university staff to adopt public transit, walking, or cycling is positioned to reduce carbon emissions and promote sustainable development objectives. Carefully considering on-campus transportation management and its associated policies is essential (Lord-Farmer et al., 2017; Pooley et al., 2013; Bond & Steiner, 2006; Zhang & Boamah, 2021).

Promoting cycling on campus offers numerous advantages for both individuals and the community. At the individual level, cycling promotes physical activity and improves overall health and well-being. It provides a convenient and cost-effective means of transportation, particularly for those who do not own a car and live within a reasonable biking distance from campus facilities. On a broader scale, promoting cycling supports campus community-wide benefits. Cycling is an environmentally friendly mode of travel, emitting zero pollutants and reducing carbon emissions. As cities contend with environmental pollution and traffic congestion issues, cycling emerges as a sustainable solution to address these challenges. As more students and university members adopt cycling as a mode of transportation, it becomes increasingly recognized as a sustainable solution to campus mobility challenges. Many universities supported this trend by providing shared bicycles for students, staff, and faculty. The bike-sharing program's purpose is to be a non-motorized vehicle for short distances or first/last mile trips. Also, this program was developed for people who have to connect to other public transportation, for example, the subway and buses.

Additionally, integrating Sustainable Development Goals (SDGs) into the transportation management strategies of university campuses has become increasingly important. The SDGs provide a comprehensive framework for addressing global challenges, including those related to transportation and sustainable development. By aligning campus transportation policies with the SDGs, universities can contribute to broader international efforts to promote environmental sustainability, reduce carbon emissions, and enhance access to sustainable transportation options. This alignment underscores the significance of promoting cycling, walking, and other eco-friendly modes of transportation on university campuses, not only to address local challenges but also to contribute to the achievement of global sustainability goals.

Several studies have investigated on-campus transportation, each offering insights into various aspects of cycling usage and infrastructure. For instance, Kelarestaghi et al. (2019) used Structural Equation Modeling (SEM) to explore the relationship between demographics and cycling habits in college campuses within the Baltimore Metropolitan Area. Their findings revealed that males were less concerned about risk factors such as theft and road conditions, while females exhibited a positive attitude towards campus improvements, such as pro-bike programs. Attard et al. (2021) conducted a participatory active travel workshop at the University of Malta Campus, focusing on measuring walking and cycling activity and walkability. Their study highlighted the need for improvements in walkway areas and bicycle lanes, as well as identifying barriers and opportunities for walking and cycling on campus. Additionally, Bonham & Koth (2010) investigated cycling culture at the University of South Australia's Mawson Lakes Campus, discovering that less than 2% of individuals used bicycles as their primary mode of transportation. However, focus group discussions indicated an interest in the environmental promotion of transportation and the associated physical and emotional benefits, suggesting the potential for increased commuting participation. Safety remains a critical concern for all cyclists.

In Thailand, many university campuses are actively promoting sustainable transportation options, particularly walking and cycling. These campuses have undertaken infrastructure enhancements to support pedestrian and cycling activities. Additionally, some institutions provided bike-sharing systems on campus, facilitating short-distance and promoting environmentally friendly transportation. Some universities cooperated with private companies to provide such programs. For example, Kasetsart University (KU) has signed a Memorandum of Understanding (MOU) with Mobike to launch a bike-sharing program on campus. Some of them were coordinated with local government to develop programs. For example, Chulalongkorn University (CU) and Bangkok Metropolitan Administration (BMA) have developed a station-based bike-sharing program together on campus (Pakdeewanich et al., 2020).

However, research in this area in Thailand remains relatively limited in scope. For example, Snodin (2019) interviewed 20 international students across different regions of Thailand to explore their experiences on university campuses. Pribyl et al. (2018) focused on student expectations regarding smart-campus transportation policies, but their study was limited to only two universities: Czech Technical University in Prague (Czech Republic) and Thammasat University (Thailand). Singhirunnusorn and Sahachaisaeree (2013) investigated the feasibility of creating conducive environments for cycling and walking behaviors, focusing on Mahasarakham University as the study site, thus limiting the generalizability of their findings. Furthermore, Charmondusit et al. (2022) proposed best practices for sustainable transportation and management at a primary university campus in Thailand.

Most of these studies have analyzed the demographics, behaviors, and attitudes of university students and employees towards non-motorized vehicles to inform campus planning and transportation policy-making. However, research specifically focused on bike-sharing on Thai university campuses is limited. Moreover, there is a notable absence of nationwide studies on cycling behavior within university campuses. This study seeks to address these gaps by investigating the factors that influence bicycle use on university campuses.

1.2 Statement of the Problem

The increasing adoption of bike-sharing programs on university campuses in Thailand reflects a positive trend toward sustainable and eco-friendly transportation. However, this progress is not consistent across all campuses, with some institutions successfully implementing bike-sharing systems while others have not. The lack of a comprehensive understanding of the factors influencing the development of campus bike-sharing systems poses a significant challenge. Unlike previous research that often focused on individual campuses, our study takes a broader approach by examining several university campuses across Thailand. This broader scope allows us to address the major aspects of cycling on campuses in Thailand, filling existing research gaps.

Our study aims to investigate the factors contributing to the development of campus bike-sharing systems through an extensive online survey involving 19 universities from different parts of the country. The survey covers various aspects of on-campus cycling, including commuters' demographics, attitudes, and obstacles preventing them from using bicycles. We then employed Binary Logistic Regression (BLR) to analyze the factors influencing bicycle utilization on university campuses. Given the substantial number of respondents and the involvement of multiple universities, we anticipate that our findings will have a positive impact on campus design, transportation planning, and decisions related to commuting and sustainability policies at both regional and national levels.

Through this comprehensive investigation, our research seeks to provide valuable insights into sustainable and effective bike-sharing programs on university campuses in Thailand.

1.3 Objectives of the Study

The objectives of the study are as follows:

1) Investigating how demographics affect bicycle use on campus in Thailand.

2) Investigating how attitudes affect bicycle use on campus in Thailand.

3) Examining the impacts of Gross Provincial Product (GPP) on bicycle use on campus in Thailand.

1.4 Significance of the Study

The significance of this study is its potential to contribute valuable insights and recommendations for the development and improvement of campus bike-sharing systems in Thailand. As university campuses play an essential role in fostering sustainability and environmental responsibility, understanding the factors that influence the adoption and success of bike-sharing programs becomes crucial. The findings of this research can inform policymakers, university administrators, and stakeholders in the higher education sector, offering guidance on how to enhance campus transportation, promote eco-friendly mobility, and align with global sustainability goals. Additionally, the study addresses a research gap in the major view of cycling on campus in Thailand, providing a foundation for future investigations and contributing to the academic discourse on sustainable transportation in educational environments.

1.5 Scope of the Study

The primary objective of this research is to examine the factors influencing the development of campus bike-sharing systems in Thailand, with a focus on demographics, attitudes, and obstacles. We aim to gain insights into the key determinants that shape the adoption and success of bike-sharing programs within university campuses across the country.

Data collection for this study is conducted exclusively within 19 university campuses in Thailand, utilizing online surveys as the primary method. We employ binary logistic regression to analyze the collected data, allowing us to identify significant factors and their impact on the utilization of bike-sharing systems. The selection of the 19 university campuses is based on their inclusion in the Times Higher Education (THE) Impact Rankings 2020. In 2020, these campuses were identified as actively incorporating Sustainable Development Goals (SDGs) into their policies and practices. This criterion ensures that our study focuses on institutions that have demonstrated a commitment to sustainability initiatives and are likely to have relevant data available for analysis. By filling this gap, our study aims to provide valuable insights that can inform policymakers and stakeholders in developing effective strategies for implementing and managing bike-sharing programs on campus.

Our research approach adopts a broad perspective, focusing on the overall landscape of university campuses in Thailand rather than delving into specific individual institutions. The data collection process will rely solely on online questionnaires or surveys administered to students, faculty, and staff members across the selected campuses. Likert scale responses will be used to gauge participants' attitudes and perceptions. The data collection period is scheduled from June to October 2020, during which time the COVID-19 pandemic was prevalent. This context will be considered in our analysis, as the pandemic may have influenced commuting behaviors and perceptions of bike-sharing systems.

In conclusion, our research aims to provide a comprehensive understanding of the factors affecting bicycle use on university campuses in Thailand. By leveraging data from a diverse range of universities and employing advanced statistical analysis techniques, we seek to generate insights that can inform policy decisions and promote sustainable transportation initiatives at both regional and national levels

Chapter 2

Literature Review

The literature review serves as a crucial foundation for understanding the complexities and implications surrounding bicycle use on university campuses in Thailand. In this chapter, we comprehensively explore relevant literature, starting with an examination of bike-sharing systems to establish a fundamental understanding of this transportation model. Our goal is to lay the groundwork for analyzing the role of bike-sharing programs in promoting sustainable mobility on university campuses by exploring their mechanics and operational dynamics.

Following our discussion on bike-sharing systems, we transition to an overview of cycling culture and infrastructure in Thailand. This section provides valuable insights into universal attitudes towards cycling and the existing infrastructure supporting non-motorized transportation across the country. Narrowing our focus, we then explore a comprehensive examination of cycling within the unique context of Thai university campuses. Here, the various factors influencing bicycle use among students, faculty, and staff, including demographics, attitudes, and obstacles, were investigated. By synthesizing existing literature on this topic, we aim to gain a holistic understanding of the challenges and opportunities associated with promoting cycling as a sustainable mode of transportation within academic institutions.

This chapter also offers insights into the methodological tools utilized in our thesis and the rationale behind their selection, aiming to showcase the rigor and integrity of our research methodology. Additionally, it discusses alternative tools that were considered and the reasons for their exclusion, thereby providing transparency and clarity regarding our research process. Furthermore, related literature to the tools employed in our research is presented, offering a comprehensive overview of existing scholarship relevant to our study objectives. Through this thorough literature review, we aim to establish a solid theoretical foundation and conceptual framework for our research on bicycle use on Thai university campuses.

2.1 Bike-Sharing Systems

Bike-sharing service allows cyclists to ride bikes without owning a bike. The service consists of a bike fleet that can be shared among riders. Such service could be a rental model or provided for hourly free (Kocianova & Slebodnik, 2021). Some services allow the riders to rent out the bikes and park or return the bikes anywhere, whereas some require riders to rent and return the bikes at service or docking stations (Midgley, 2009a). Currently, bike-sharing services are available in more than 700 cities worldwide (Fishman et al., 2014). This large number confirms the interest in commuting in an environmentally friendly way.

There are four generations of bike-sharing programs (Shaheen et al., 2010; DeMaio, 2009). The first bike-sharing system was introduced in Amsterdam in the 1960s. It allowed commuting within the city without charge. Unfortunately, it was misused and canceled within a few days. Later, bike-sharing services that use docking stations were developed. In such services, the riders must rent out and return the bikes from designated docking stations. The rental fees could be paid by coin (DeMaio, 2009). Such services can be referred to as the second generation of bike-sharing. Although this type of bike rental service multiplied around the world, there are many problems of theft and vandalism (Shaheen et al., 2010). Thus, the third generation of bike-sharing systems was introduced. Such systems employ magnetic or Radio Frequency Identification (RFID) cards or smartphones to verify riders and rent out the bikes (Midgley, 2009b). Such technologies, along with the Global Positioning System (GPS), allow bike-sharing systems to be dockless, the fourth generation. That is, riders can rent and return the bikes anywhere in the service area, which could be a small area such as a university campus or community or an entire city. Dockless bicycles are now available in many countries, e.g., China (Ma et al., 2018b), Hong Kong (Lu et al., 2019), Singapore (Shen et al., 2018), Greece (Bakogiannis et al., 2019), Germany (Reiss & Bogenberger, 2015), France (Shaheen et al., 2010), and Thailand (Mateo-babiano, 2015).

Currently, bike-sharing services are available in various places around the world. For example, Velo (Raux et al., 2017), Veturilo (Otero et al., 2018), and Call a Bike (Shaheen et al., 2010) are bike-sharing services in Europe. Ofo (Chen et al., 2020), Mobike (Yang et al., 2019), and Shanghai Public Bicycle (Shaheen et al., 2010) are available in China. Services in North America include B-Cycle, PBSC (Parkes et al., 2013), BIXI (Shaheen et al., 2010), and many more. At any rate, the business models of these service providers are different. Shaheen et al. (2010) classifies bike-sharing providers with other business models into five categories, as shown in Table 2.1.

Table 2.1 Providers and Business Models of Bike Sharing

Provider	Common Operating Model	Revenue Sources
Advertising Company	Provide bike-sharing services in return for the privilege to advertise on city streets or billboards.	Advertising, Usage fees
Public transport agencies	Provide services under the guidance of a public authority	Subsidies, Usage fees, Advertising
Local government and public authority	Directly design and operate services or purchase services provided by others	Local funding, Usage fees, Advertising
Profit organization	Provide profitable services with minimal government involvement	Usage fees, Advertising
Non-profit organization	Provide services with support from public agencies or councils	Local funding, Usage fees, Bank loans

Reference: (Shaheen et al., 2010)

Bike-sharing service revenues come from diverse sources, such as advertising, usage fees, local funding, government subsidies, and bank loans. Local governments play a significant role in anticipating the shift towards sustainable transportation. In the analysis conducted by Shaheen et al. (2010), different providers and their operating models are presented in Table 2.1. Some bike-sharing services were sponsored for advertising purposes, and advertisers were required to offer comprehensive services for public bicycles. Certain bike-sharing programs were established not just for transportation networks but also as part of environmental initiatives. Typically, these systems received support from local governments in the form of subsidies. However, authorized providers were required to oversee all aspects of the system, including management, maintenance, and the redistribution of bicycles. Both profit and non-profit organizations, with government approval, provide services, with revenues especially generated from usage fees. Finally, all providers contribute to fostering an eco-friendly city, regardless of the specific business models they adopt.

In 2012, Thailand embraced the eco-friendly trend with the establishment of its first bike-sharing program in Bangkok, known as PUN PUN (Raha, 2015). Initially consisting of only 12 docking stations, the program operated within the Central Business District (CBD) of Bangkok, characterized by high-rise and high-density development (Kanchanasut & Preyawanit, 2018). The number of stations gradually increased, accompanied by significant daily trip growth, which stabilized by 2014. Presently, PUN PUN boasts approximately 50 bicycle stations spread across the CBD of Bangkok (Sangveraphunsiri et al., 2022).

2.2 An Overview of Cycling in Thailand

Bicycle use in everyday life has become a focal point in Thailand's policy framework since 2012, championed by the Thailand Walking and Cycling Institute (TWCI) and ThaiHealth. These organizations employed evidence and various influencing strategies to advocate for the development of policies supporting bicycle commuting. The success of this advocacy can be attributed to the participatory policy development platform provided by the National Health Assembly (NHA), which facilitates the utilization of evidence in formulating policy frameworks (National Health Commission Office, 2012).

In Thailand, bicycles are utilized for commuting in Bangkok and other areas for various reasons, including navigating within building complexes, traveling between public transportation systems, shopping for groceries, avoiding traffic jams, and promoting exercise and leisure (Boonpan et al., 2022). According to Pettinga et al. (2009), who established five criteria for cycling-inclusive planning, the current situation can be summarized as follows:

1. Low Directness: Cycling routes often involve significant detours instead of following the shortest path, as cyclists are required to navigate car-centric infrastructure, including U-turns and cul-de-sacs (a route or course leading nowhere). Additionally, cyclists frequently experience long waiting times at traffic lights.

2. Lack of Coherence: Existing bike lanes are scattered, disconnected, and vary in design types. Consequently, only a limited number of destinations can be accessed via these fragmented routes.

3. Safety Concerns: Cyclists face safety challenges due to numerous crossings, interactions with motorized traffic, unexpected scenarios, minimal priority given to bicycles by other road users, and insufficiently protected bike lanes.

4. Limited Comfort: Current infrastructure lacks features such as shading, exposing cyclists to hazards, noise, and pollution, thus reducing overall comfort levels.

5. Attractiveness: While cycling may be appealing in quieter alleys, near local markets, and within parks, it loses its appeal on larger roads, where conditions are less conducive to enjoyable cycling experiences.

Governmental policies and regulations in Thailand traditionally focused on aspects such as user licenses, traffic rules, bicycle logistics, tariffs on imported bicycles, and insurance rather than facilitating cycling and other non-motorized transportation (Rattanapong & Nilavajara, 2003; Rongruangyaem, 2016). However, since 2012, TWCI and ThaiHealth have spearheaded efforts to develop a policy framework supporting bicycle commuting and non-motorized transportation through the NHA. The 2012 NHA resolution on "supportive system and structure for walking and cycling in daily living" laid the foundation for this new policy trajectory, reconceptualizing cycling as a physical activity and non-motorized transportation (Ungsuchaval et al., 2022).

The policy advocacy efforts of TWCI and ThaiHealth have been supported by evidence use, including theoretical, empirical, and experiential evidence. Theoretical evidence highlights cycling as a form of physical activity, aligning with global recommendations on physical activity for health. Empirical evidence demonstrates the benefits of cycling for health, economy, and the environment, while experiential evidence draws on the experiences and views of key policy actors, driving the policy proposal forward (Health Assembly 5/Main 1/Annex 1, 2012).

To support the advocacy of bicycle commuting policy, TWCI and ThaiHealth employed various strategies, including building networks to engage with government officials, strategically utilizing grants to fund policy-related activities, contextualizing bicycle commuting within local lifestyles, and communicating evidence to the wider public through social marketing campaigns (Ungsuchaval et al., 2022).

In terms of policies, Thailand's journey towards promoting bicycle commuting reflects a collaborative effort between advocacy organizations, government agencies, and other stakeholders. By leveraging evidence and employing strategic advocacy strategies, Thailand has made significant strides in developing policies that support cycling as a sustainable mode of transportation in everyday life.

Cycling not only serves as a sustainable mode of transportation but also contributes to tourism. The development of bicycle lanes in the Rattanakosin area of Bangkok occurred in three stages from 2008 to 2019 (Ratanaburi et al., 2021). Stage 1 involved the creation of the Rattanakosin bicycle lane between 2008 and 2013, driven by collective efforts to promote bicycle tourism in the area since 1998. The increasing popularity of bicycle tourism was evident through various events and schemes held between 2003 and 2008, including the bicycle night tour organized by the Tourism Authority of Thailand. Responding to the growing interest, the Bangkok Metropolitan Administration (BMA) initiated the "Bangkok Smile Bike" project in 2008, followed by the implementation of bicycle lanes. However, the bicycle lanes faced challenges due to insufficient legal enforcement, resulting in frequent invasions and obstructions. Stage 2 saw a major upgrade of bicycle lanes in 2014-2015. Following the change in government in mid-2014, the new administration sought to align with the cycling trend by directing efforts to build and upgrade bicycle infrastructure nationwide. In response, the BMA chose to upgrade the Rattanakosin bicycle lane, focusing on enhancing safety and comfort by widening the lanes and improving road surfaces. Stage 3 involved the replacement of bicycle lanes from 2016 to 2019. This phase resulted from a combination of unforeseen circumstances and community attitudes towards bicycle infrastructure. In preparation for the Royal Cremation Ceremony of King Rama 9 in 2016, the central government decided to temporarily clear road space in the Rattanakosin area. Due to the lack of community acceptance, the bicycle lanes were voluntarily removed and replaced with original lanes for motor vehicles. Public involvement decreased during this period, and the physical presence of bicycle lanes gradually diminished, ultimately leaving only remnants of the lanes, including those on footpaths.

Bicycles have been increasingly utilized for tourism and travel purposes in various regions of Thailand. For instance, Chaikaew et al. (2018) conducted an analysis of bicycle network development in Wiang Phayao, emphasizing the importance of connecting bicycle routes to tourist attractions and ensuring safety along the route. However, there are challenges, as individuals traveling by car may oppose the development of bicycle routes due to concerns about parking space availability

(Chaikaew et al., 2018). This highlights the need for careful planning and consideration of stakeholders' perspectives in promoting cycling infrastructure development for tourism and travel purposes in Thailand.

Leopairojna et al. (2017) identified both physical and institutional barriers to the use of bicycles on Samui Island, a popular tourist destination in southern Thailand. The physical barriers, such as inadequate cycling infrastructure and unsafe road design, were evident. The institutional challenges, such as resource constraints and fragmented responsibilities, along with behavioral factors, including reliance on motorized transport and safety concerns, were key impediments to progress. Srinuan (2007) conducted a study on bicycle usage among residents and tourists in the Songkhla Municipal area, identifying suitable routes. The research indicated that most respondents used bicycles for exercise and shopping due to their cost-effectiveness. Tourists primarily visited the Songkhla Municipal area for recreational purposes. The study recommended the implementation of shared roadways, bike lanes, and sidewalks on various routes to accommodate cyclists. In a separate study, Singsaktrakul and Muneenam (2019) investigated cycling tourism within the Songkhla Special Economic Zone in southern Thailand, employing document analysis, observations, and interviews with 29 stakeholders from diverse sectors. The findings revealed that local administrative organizations and government authorities have initiated plans to promote cycling tourism, including the establishment of bike lanes and improvements to tourist attractions and facilities. Despite the presence of natural and cultural attractions, the Zone lacks specific amenities tailored to cycling tourists, such as maintenance tools and information services. Moreover, the absence of signage and route information presents challenges for cyclists navigating the area.

Promjittiphong et al. (2018) investigated the reduction of CO2 emissions and Greenhouse Gas (GHG) emissions through sports tourism, focusing on the Benja Burapha Cycling Rally located in Sa Kaeo, Eastern Thailand, in 2017. Their study highlighted the potential of sports tourism, a relatively underexplored area in Thailand, to provide travelers with unique experiences at natural attractions while promoting health benefits. It also highlighted indirect benefits, including decreased fuel consumption and GHG emissions in the transportation sector. This suggests that sports tourism could be a viable option for mitigating GHG emissions in Thailand, complementing existing efforts in green tourism initiatives. Bridhikitti (2022) examined the impact of constructing bicycle lanes in Mahasarakham, located in northeastern Thailand. The bicycle lane plan, developed by the Faculty of Architecture, Urban Design, and Creative Arts at Mahasarakham University, aimed to reduce GHG emissions. It revealed that utilizing the bicycle lanes for one year resulted in a reduction of approximately 0.2 million tons of carbon dioxide equivalent in 2020. Also, it suggested that promoting the sustainability of the bicycle lane system is crucial to address safety and convenience concerns.

The number of cyclists in Thailand has seen a significant increase in recent years, reflecting a growing trend towards cycling as a mode of transportation. According to data from 2013, there were 2.25 million cyclists in Thailand, with 150,000 cyclists in Bangkok and 2.1 million in other provinces. Furthermore, approximately 260,000 individuals used cycling as their primary mode of travel. This number was expected to rise to 2.7 million by 2014 (Chaichannawatik et al., 2017). Campaigns such as the Bangkok Car Free Day (BKKCFD) have played a crucial role in promoting cycling in the city. Since its inception in 2000, the BKKCFD event has witnessed a substantial increase in participation, with over 20,000 cyclists taking part in 2013, compared to just 150 participants in 2005 (Chaichannawatik et al., 2017). Additionally, government agencies have developed public cycling spaces for recreational and exercise purposes, such as the bike path in Wachirabenjathus Park and green bike routes around Suvarnabhumi airport. These initiatives have seen significant usage, with the Suvarnabhumi airport bike route attracting between 3,000 to 4,000 cyclists per day, reaching a peak of 7,167 cyclists on June 8th, 2014 (Thiwaree, 2013).

Furthermore, numerous cycling groups and clubs, both large and small, routinely organize group rides within and beyond the city limits, particularly on weekends. Within university campuses, an active cycling community thrives, linking transportation and environmental concerns with modern trends. Gatherings at cycling-themed cafes are commonplace, fostering a vibrant cycling culture. Moreover, cycling enjoys widespread coverage in social and traditional media, with over 100 Facebook pages dedicated to cycling in Bangkok alone, amassing approximately 1.2 million followers as of March 2016. These platforms encompass recreational communities, advocacy groups promoting cycling as a mode of transport, sports media, and initiatives championed by academic institutions, which serve as hubs for sustainability experiments (Sengers, 2016). The bicycle market, particularly for premium models, has experienced robust growth, with sales surging by 15-25% and surpassing USD 200 million. The International Bangkok Bike Fair in September 2015 further cemented Thailand's position as the hub of the ASEAN cycle business.

The current approach in Thailand can be described as fragmented, with a focus on individual infrastructure projects. There is a lack of emphasis on crucial elements such as data monitoring, communication, education, electric bikes, and other necessary policies like transport demand management, traffic calming, and car taxation (Narupiti et al., 2014). Moreover, there seems to be limited engagement with international experts or sharing of best practices. However, there are proposals for nationally appropriate mitigation actions, including technical support for cycling as a feeder mode for public transport.

2.3 A Comprehensive View of Cycling on Thai University Campuses

Cycling on Thai university campuses presents both opportunities and challenges in the context of promoting sustainable transportation. Many campuses in Thailand have embraced the idea of cycling as a mode of commuting, aligning with global sustainability goals. For example, at Mahidol University (MU), Salaya campus, there is a strong emphasis on promoting walking and cycling as the primary modes of transportation within the campus. The reduction of motorized vehicle lanes from six to three, coupled with the expansion of sidewalks, actively encourages individuals to choose walking or cycling over motorized transportation (Charmondusit et al., 2022). Similarly, Chulalongkorn University (CU) has taken initiatives to foster cycling by implementing dedicated bicycle lanes and installing parking racks across the campus grounds. Since 2010, the university has distributed over a thousand bicycles to various units, facilitating students and staff commuting. This admirable effort is part of a corporate social responsibility project by the Metropolitan Electricity Authority (MEA), aiming to reduce emissions and promote physical activity (Pinthong et al., 2018). However, several issues obstruct the widespread adoption and success of cycling initiatives on these campuses.

Khongouan and Sakulrattanakulchai (2014) studied transportation modes and student perspectives on bicycle usage across university campuses. The research was conducted at Kasetsart University (Bangkhen Campus), Mahidol University (Salaya Campus), and Thammasat University (Rangsit Campus), gathering data from both bicycle users and non-users. Results revealed that all three campuses provide similar transportation options, including bicycles, cars, walking, and university public buses. While cycling was previously popular at Kasetsart University, its popularity has decreased. Whereas Mahidol University has effectively increased cycling participation and established a conducive cycling environment. A bicycle campaign at Thammasat University is still in its early stages. Key challenges identified in campus cycling include safety concerns and a lack of awareness regarding the benefits of cycling. To promote bicycle usage on campus, recommendations include establishing a network of bicycle lanes, improving existing parking facilities, initiating bicycle usage campaigns, and developing services for public bicycle utilization. Leopairojna and Trakulvech (2008) examined the feasibility of implementing a public bike system at Kasetsart University (KU) and aimed to understand user needs. The study revealed that the project faced challenges in gaining popularity, as half of the bikes remained unused due to inconvenient borrowing processes and safety concerns within the KU environment. To address this issue, various strategies have been proposed to increase bike usage, highlighting the importance of enhancing both the public-use bike system and campus safety measures. In 2017, Kasetsart University took a significant step forward by signing a Memorandum of Understanding (MOU) with Mobike to launch the bike-sharing program on campus (Pakdeewanich et al., 2020a).

Figure 2.1 Bicycle Parking Space in Mahidol University
(Charmondusit et al., 2022)

Figure 2.2 Bicycle Promotion in Chulalongkorn University
(Pinthong et al., 2018)

One common challenge is the lack of adequate cycling infrastructure. Many universities struggle with insufficient or poorly designed cycling lanes, compromising the safety and convenience of cyclists. For example, at King Mongkut's Institute of Technology Ladkrabang (KMITL), Meesit et al. (2023) conducted a SWOT analysis of bicycle use and found inadequate investment in cycling infrastructure and a limited policy framework for bicycle-friendly measures. The majority of respondents at KMITL cited standardized infrastructure as a primary motivation for increasing walking or bicycling. The absence of dedicated parking facilities and secure spaces for bicycles also discourages students from choosing cycling as a viable mode of transportation. Traffic congestion on and around campuses further complicates the cycling experience. The lack of supportive policies and initiatives to promote cycling culture contributes to a general undervaluation of bicycles as a means of commuting. Taekratok and Luansak (2018) explored the transportation dynamics at Naresuan University, which was ranked 4th out of 22 universities in Thailand by the Green Metric World University Rankings in 2016. It was about the satisfaction levels of students, faculty, and staff with incentives to adopt green transportation policies, specifically transitioning from motorbikes to cycling. Almost 90% of students used motorbikes as a primary transportation from accommodations to campus. Notably, respondents expressed a willingness to transition to cycling, particularly if shaded bike paths were provided.

Limanond et al. (2011) investigated the travel behavior of students at Suranaree University of Technology (SUT), located in a rural area of Northeastern Thailand. The campus layout was not originally conducive to non-motorized transportation, with significant distances between zones and no covered walkways or bicycle lanes connecting them, leaving students vulnerable to extreme weather conditions. Additionally, the uphill terrain between residence halls and classroom buildings made walking and biking unpopular commuting options. Limited public transit services and the remoteness of off-campus destinations further encouraged students to rely on private motorized vehicles. Even students without vehicles still averaged 3-4 km of motorized travel per day, often by borrowing or sharing rides with peers. The study suggests that campus design and transportation policies should prioritize making sustainable transport options more accessible, including locating key facilities within walking or biking distance and designing bike routes that accommodate hilly terrain. Policies such as free on-campus transit services and restrictions on motorized vehicle usage could further promote sustainable transport on campus.

2.4 Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a set of 17 interconnected goals adopted by the United Nations in 2015 as part of the 2030 Agenda for Sustainable Development (United Nations, 2020). These goals aim to address various global challenges, including poverty, inequality, climate change, environmental degradation, and access to education and healthcare, as shown in Figure 2.4. Each goal has specific targets to be achieved by 2030, providing a framework for countries and organizations to work towards a more sustainable and equitable future. The SDGs cover a wide range of areas, including ending poverty and hunger, ensuring access to clean water and sanitation, promoting gender equality, reducing inequalities, combating climate change, and fostering sustainable cities and communities, among others. By addressing these interconnected issues, the SDGs seek to promote economic growth, social inclusion, and environmental sustainability on a global scale.

Figure 2.3 Sustainable Development Goals
(United Nations, 2019)

To achieve the SDGs, countries around the world are taking action at the national, regional, and local levels. This includes implementing policies and initiatives to address specific targets, mobilizing resources and partnerships, and monitoring progress towards the goals. Governments, businesses, civil society organizations, and individuals all have a role to play in advancing the SDGs and creating positive change in their communities and beyond.

Many countries have developed national strategies and action plans to align with the SDGs, integrating them into their development agendas and policies. International organizations, such as the United Nations and its specialized agencies, provide guidance and support to countries in implementing the SDGs, facilitating knowledge sharing, capacity building, and financing mechanisms. In addition to government-led efforts, there is growing recognition of the importance of multi-stakeholder partnerships in advancing the SDGs. Businesses, academia, non-governmental organizations, and other stakeholders are collaborating to develop innovative solutions and scale up impact in key areas such as sustainable energy, education, healthcare, and environmental conservation. Addressing these challenges will require sustained commitment, collective action, and a renewed focus on building resilience and inclusivity in the pursuit of sustainable development.

2.5 Factors Influencing Bike-Sharing Systems

Several factors may impact bicycle usage, including location, urban design, and accessibility to public transportation, all of which influence individuals' choice of transportation mode. Additionally, maintaining a bike-sharing program or encouraging bicycle use requires addressing multiple factors. Shi et al. (2018) investigated critical factors contributing to the sustainability of dockless bike-sharing programs from a network perspective. They employed literature analysis, interviews, and social network analysis (SNA) to identify crucial factors and connections within these programs. In the context of dockless bike-sharing programs, SNA views such systems as complex networks involving various stakeholders and relationships. It revealed several critical factors affecting bike-sharing programs, including quantity control, waste disposal and recycling challenges, exploration of profit models, lack of infrastructure and parking management, legislative management, integration with public transportation, and commuting preferences of residents. Consequently, the study proposed management strategies for addressing these challenges, categorized into four main areas: shared transport schemes, legislative improvements, public-private partnerships, and product lifecycle management.

Eren and Uz (2020) conducted a thorough examination of the factors influencing station-based bike-sharing programs. These factors were categorized into six main categories: weather conditions, built environment and land use, public transportation, station level, socio-demographics, and temporal factors. While it remains unclear which factor has the most significant impact on bike sharing, it is evident that weather conditions, particularly rain, have a significant negative effect on bike sharing demand. This effect is observed both on weekends and weekdays for both members and non-members. Bike-sharing behavior studies have highlighted a strong correlation between trip demand and various socio-demographic factors, including gender, age, education, income, and vehicle ownership.

The research conducted by Ricci (2015) and Martin et al. (2013) has indicated that members of bike-sharing programs are primarily male, young, educated, working individuals with high incomes. This trend is further supported by studies in various regions. Such as Melbourne and London further supported these findings, revealing a higher proportion of male users, particularly in the age range of 30-34, with higher income levels and educational attainment (Fishman et al., 2015). Efthymiou et al.

(2013) explored the factors driving the adoption of bike-sharing services in Greece, a country where bike-sharing is just emerging. It highlighted the importance of income level, mode of transportation for commuting, and environmental consciousness in influencing an individual's likelihood of joining these programs. In particular, respondents with moderate incomes between 15,000 and 25,000 Euros show a higher propensity to participate in bike-sharing systems, and bike-sharing is more attractive to pedestrians. Age also plays a role, with younger individuals showing a greater willingness to accept bike-sharing compared to older age groups. Lastly, the study highlights the significance of environmental consciousness in driving participation in sustainable transportation initiatives.

Additionally, age emerges as a significant factor influencing bike-sharing program usage, with young adults, particularly those aged 18-34, being more likely to become bike-sharing program members (Fishman et al., 2015). However, age restrictions imposed by bike-sharing programs may hinder the broader promotion of bicycle use, as highlighted by Woodcock et al. (2014). Barbour et al. (2019) investigated the demographic factors influencing bike-sharing usage, incorporating health-related inquiries and indicators. Significant factors included gender, age, income, household size, commute duration and mode, and vehicle ownership. Their study revealed that Caucasian males living in single-person households and those with longer daily travel times were more likely to use bike-sharing services regularly. Younger respondents under 30 years old tended to use motorized transportation in the absence of bike-sharing options. Furthermore, the respondent's body mass index (BMI), serving as a health-related measure, emerged as a notable predictor of bike-sharing usage. Notably, individuals with an obese BMI (BMI above 30) displayed varying levels of readiness to forgo automobile trips when bike-sharing was available. This observation is significant as it indicates a willingness among some individuals with obesity to adopt active transportation methods, thereby potentially improving their overall health.

Furthermore, gender and socio-economic characteristics, such as income levels, also influence Bike-sharing usage, with studies indicating lower participation rates among women and potential disparities in access based on income (Goodman & Cheshire, 2014; Zhou, 2015). Murphy and Usher (2011) investigated the implementation and impact of the bicycle-sharing service in Dublin through questionnaire surveys. The research primarily focused on the role of the bike-sharing service as an integrated mode within the city's transportation system, particularly concerning public transport. The users of the service predominantly come from middle-class and upper-middle-class backgrounds, suggesting potential equity issues in accessing the scheme and indicating barriers preventing individuals from lower socio-economic backgrounds from utilizing the service. Notably, the scheme has been less effective in facilitating a modal shift from private cars to bicycles, primarily encouraging transitions between sustainable modes of transport rather than away from unsustainable ones. However, the study findings highlight the scheme's significant role in facilitating multi-modal transport between various forms of public transport within the city. Consequently, there is a recommendation to promote this role by increasing the number of stations and bicycle units near public transport stops, particularly rail stations, to enhance connectivity and accessibility.

Vogel et al. (2014) examined the Vélo'v bike-sharing system in Lyon, France. It was one of the pioneering systems in Europe since its establishment in 2005. With around 7 million trips in 2013 and approximately 50,000 annual users, Vélo'v has significantly increased bicycle use in the city by 50%. The study focused on characterizing user mobility patterns and creating a user typology based on cluster analysis by analyzing a database containing both bicycle movement and user data for the year 2011. It revealed distinct user groups with notable features, including gender-related differences. However, spatial usage patterns did not significantly differ among these groups, highlighting the overlap in residential, professional, and leisure areas among users.

Factors such as car ownership and driving license ownership were found to have varying impacts on Bike-sharing usage, with some studies suggesting that car ownership does not necessarily diminish demand for bike-sharing services, while others highlight potential barriers associated with driving license ownership (Shaheen & Guzman, 2011; Hyland et al., 2018).

Travel time and commuting distance also significantly influence transportation mode decisions. Commuters staying within or close to the campus often prefer non-motorized transport options such as walking or cycling, while those living farther away tend to rely on public transport or private motorized vehicles (Hamad et al., 2021; Akar et al., 2012). Bachand-Marleau et al. (2012) identified factors influencing the use of bike-sharing systems and the frequency of usage. A survey was conducted in Montreal, Quebec, Canada. It found that proximity to docking stations had the most significant impact on the likelihood of using a shared bicycle system. Additionally, individuals who owned a yearly shared bicycle membership were found to use shared bicycles approximately 15 times more per year. The recommendations of strategies to optimize bike-sharing systems were increasing the number of docking stations in residents' areas and theft prevention in advertising campaigns. In Thailand, commuters in Bangkok and its metropolitan region typically favor public transport or personal vehicles, while those in other cities often opt for private vehicles due to limited public transportation options (Singhirunnusorn and Sahachaisaeree, 2013; Charmondusit et al., 2022; Jomnonkwao et al., 2016; Fraszczyk et al., 2019; Chalermpong and Ampansirirat, 2011; Lowe and Piantanakulchai, 2023).

Kaplan et al. (2015) examined the factors influencing tourists' intentions to use urban bike-sharing services while on holiday, using the Theory of Planned Behavior. Surveying 655 potential tourists in Copenhagen's new bike-sharing system, the study revealed significant interest in frequent and diverse bike-sharing usage during vacations, with holiday cycling linked to factors such as residing in cycling-friendly countries and past cycling experience. Electric bicycles appealed to tourists interested in bicycle technology, while strong correlations emerged between frequent cycling intentions and positive attitudes and norms toward cycling. The study suggests that integrating bike-sharing schemes and bicycle infrastructure into tourism experiences could enhance the appeal of bike-sharing for tourists and residents alike, informing marketing strategies and infrastructure development efforts to promote sustainable transportation options in urban areas.

Kim et al. (2012) investigated the factors influencing travel behavior in bike-sharing, recognizing the scarcity of research in this area despite the widespread adoption of bike-sharing systems in over 100 cities worldwide. This study focused on five variables—floor area of nearby residential and commercial buildings, parks, schools, and subway stations—and conducted regression analyses to assess their impact on bike-sharing usage frequency. The analysis examined various scenarios, including weekdays versus weekends, precipitation, and departure point and destination, revealing that the total area surrounding residential and commercial buildings, parks, schools, and subway stations positively influenced bike-sharing usage. However, the degree of influence varied depending on the specific variable, with commercial buildings promoting public bicycle usage more effectively than residential buildings and parks encouraging bike-sharing usage significantly more than schools or subway stations. Furthermore, the study identified differences in travel behavior between weekdays and weekends, with weekends experiencing twice the volume of bike-sharing traffic compared to weekdays. Additionally, rainfall was found to generally decrease bike-sharing usage, as expected.

Fishman et al. (2015) aimed to identify and quantify the factors influencing bike share membership in Australia's two bike share programs located in Melbourne and Brisbane. The study collected data through online surveys of both members and non-members, revealing several significant predictors of membership, including reactions to mandatory helmet legislation, riding activity, the convenience of private bike riding, age, proximity of docking stations to workplaces, and income level. In contrast, de Chardon and Caruso (2015) introduced various methodologies for estimating the daily number of trips, a crucial measure of Bike-Sharing System (BSS) usage, using readily available data such as the number of bicycles at a station over time. The study presented model coefficients and trip count estimates for specific cities, demonstrating the effectiveness of day-level aggregation for estimation purposes. Additionally, the research offers a rigorous formalization of station-level data, allowing for the distinction of spatio-temporal rebalancing quantities and identification of new characteristics of BSS station usage.

Audikana et al. (2017) provided valuable insights into the challenges faced by small cities (<100,000 inhabitants) when implementing bike-sharing systems. The study identified significant obstacles related to usage rates and economic sustainability in such contexts, emphasizing the importance of factors such as network density, existing modal share, and target groups in shaping system performance. Despite efforts to increase bike-sharing availability, usage rates in small cities like those in Switzerland remain lower compared to larger urban areas. The study underscored the crucial role of partnerships, effective communication, and accountability mechanisms in addressing these challenges. Additionally, it emphasized the influence of modal share on bike-sharing network effectiveness, with territories having high levels of individual motorized modal share facing greater implementation difficulties. Understanding the dynamics of target groups and the role of various public transport modes is crucial for enhancing the performance of bike-sharing networks in small cities. Fishman et al.

(2014) investigated the impact of bike share programs on car travel, focusing on cities such as Melbourne, Brisbane, Washington, D.C., London, and Minneapolis/St. Paul. The study examined survey and trip data to determine the extent to which bike-share journeys replace car trips. Additionally, it explored the motor vehicle support services needed for bike share fleet management. It showed significant reductions in motor vehicle use attributed to bike share, with Melbourne and Minneapolis/St. Paul experiencing estimated decreases of approximately 90,000 km per year, and Washington, D.C. seeing a reduction of 243,291 km. However, bike-sharing programs in London recorded an increase of 766,341 km in motor vehicle use due to low car mode substitution rates and extensive truck usage for bike rebalancing.

Jiménez et al. (2016) contributed to the Bike Sharing Systems research field by introducing a novel method for classifying bike stations based on users' mobility patterns. The study identified three key ratios—load factor, cumulative trips, and turnover station ratio—to assess station effectiveness, using the Dublin Bikes Scheme as a case study. The new turnover station ratio proved crucial in evaluating station performance and system structure, helping identify distribution imbalances and underutilized stations. The study presented a robust algorithm for station classification, demonstrating its effectiveness and practical relevance in real-world Bike Sharing System scenarios. Godavarthy et al. (2017) investigated the feasibility of winter bike-sharing in the United States, focusing on user willingness and operator strategies in cold climates. The study found a strong willingness among respondents to use bike-share during winter, particularly when bike paths and sidewalks are cleared of snow and ice, by gathering bike-sharing users in Fargo, North Dakota. It suggested that the bike-sharing program has promoted cycling, with a majority of respondents indicating increased bike usage since its implementation. Additionally, an operator survey conducted among 10 bike-sharing programs operating through the 2015–2016 winter revealed that winter ridership typically ranges from 10% to 30% of peak summer ridership. The study identified operational strategies, challenges, and best practices for winter bike-sharing, including reducing the number of stations or bikes, extensive marketing efforts, and implementing measures to maintain bike stations and clear snow at stations. The study concluded that there is a demand for winter bike-sharing in cold climates, which can be met through reduced operational capacities and careful maintenance practices to ensure uninterrupted service.

Wang and Zhou (2017) conducted a comprehensive study to examine the impact of bike-sharing systems on citywide congestion in the United States. Their research employed a difference-in-differences model with two-way fixed-effects panel regression using a panel dataset covering 96 urban areas from 2005 to 2014. It found that the introduction of bike-sharing systems had a significant impact on congestion. Specifically, larger cities experienced congestion reduction benefits from bike-sharing system implementation, while richer cities tended to experience increased congestion. Additionally, the analysis revealed that bike-sharing systems had a notable positive effect on reducing rush-hour congestion. Moreover, it highlighted the potential for bike-sharing systems to moderate traffic congestion during peak hours and facilitate modal substitution away from private car usage.

The literature primarily focuses on variables related to bicycle usage on university campuses, including demographics, attitudes, and obstacles. Factors such as campus location (urban or rural), layout, and connectivity to external public transportation systems significantly influence bicycle use within campuses. For instance, campuses with convenient access to commercial areas, green spaces, and centralized working areas tend to have higher rates of non-motorized vehicle usage, while those with hilly terrain and limited public transport access experience lower bicycle usage (Bai et al., 2022; Zhao et al., 2020; Mohd-Nor Mfi et al., 2010; Faghih-Imani et al., 2014; Ding et al., 2020; Li et al., 2018). Additionally, various studies have explored factors influencing cycling behavior on and around university campuses. Campus topography and weather conditions, such as hilly terrain and inclement weather, act as barriers to cycling. Moreover, demographic factors such as gender, income level, and age also influence cycling patterns, with males, lower-income individuals, and younger commuters exhibiting a higher inclination towards cycling. Attitudes and perceptions toward cycling further play a crucial role, with positive attitudes associated with greater willingness to cycle, while negative perceptions discourage cycling (Abasahl et al., 2018; Barbour et al., 2019; Sisiopikou, 2018; Fernandez-Heredia et al., 2014; Kellstedt et al., 2019).

Chevalier et al. (2019) conducted an evaluation of bicycle acceptance, focusing particularly on dockless bike-sharing systems. The research was carried out across five university campuses in Shanghai, a city known for its high bicycle modal share and extensive presence of dockless bike-sharing systems. It examined perceptions and usage patterns related to cycling, revealing widespread appreciation for cycling, especially in areas with moderate and reasonable bicycle density. Interestingly, the study found that dockless bike-sharing systems enhance the cycling experience but also present emerging challenges such as increased perceived danger and parking issues. Ashley (2012) explored the feasibility of implementing a bike share program as an alternative transportation option at Bridgewater State University (BSU). The study involved developing bike share models through brainstorming sessions with key stakeholders from the BSU campus and surrounding community. Additionally, three New England colleges with existing bike-sharing programs were examined to understand their program structures and challenges. A survey of the BSU community was then conducted to gauge interest and potential usage of a bike-sharing program. Results revealed that 84% of participants were interested in a bike-sharing program, with 50% indicating they would use it eleven or more times per year. Intended usage included on-campus classes, commuting, fitness, and errands. Feasible bike-sharing program options for BSU include commuter-focused programs with high turnover rates and slower check-out options for longer usage periods.

Kellstedt et al. (2019) examined the rollout of dockless bike-sharing programs, which premiered in the Spring of 2018. Their study focused on a program initiated at a large public university, uncovering significant adoption rates: 19,504 registered users and 165,854 rides recorded within just three months. It identified key user demographics, safety concerns, limited awareness of the program among faculty and staff, cost barriers, and adherence to program rules. To ensure sustained success, the study emphasized the importance of implementing safety measures, clarifying program guidelines, and raising awareness among faculty and staff. Furthermore, exploring potential habit formation, mode shift, and integration with other transportation modes can enhance the effectiveness of bike-share interventions. Marketing efforts targeting later adopters and older populations, educational campaigns to promote understanding and acceptance of the program, and infrastructure enhancements to improve safety and accessibility are essential elements for advancing bike-share initiatives and fostering a culture of active transportation on college campuses.

To summarize, existing studies have mostly focused on specific campuses or regions, lacking a comprehensive understanding of on-campus, as shown in Table 2.2 cycling on a national scale. Therefore, our research aims to investigate the factors influencing on-campus cycling nationwide, encompassing multiple universities with diverse characteristics. This broader scope not only facilitates a holistic understanding of on-campus cycling but also provides valuable insights for policy-making and sustainable campus development at the national level.

Table 2.2 Factors Influencing Bike-Sharing System Usage

Factors	Impacts	References
Gender (Male)	Positive Correlation	Wang & Akar (2019); Goodman & Cheshire (2014); Zhou (2015)
Age (16-37 years old)	Positive Correlation	Fishman et al. (2015); Efthymiou et al. (2013) Woodcock et al. (2014)
Income (High Income)	Positive Correlation	Ricci (2015); Martin et al. (2013); Fishman et al. (2015)
Ownership (Private Bicycle)	Positive Correlation	Barbour et al. (2019)
Driving license	Negative Correlation	Shaheen & Guzman (2011); Hyland et al. (2018)
Weather type (Rain)	Negative Correlation	Kim (2018)
Bicycle lane (separated)	Positive Correlation	Vogel et al. (2014)
Food/Restaurant Density	Positive Correlation	Audikana et al. (2017)
Commercial/Shopping Density	Positive Correlation	Kim et al. (2012); Bai et al. (2022); Zhao et al. (2020)
Residence	Positive Correlation	Kim et al. (2012); Akar et al. (2012); Hamad et al. (2021)
Street light	Positive Correlation	Wong & Akar (2019)
Number of Docks (Bike-sharing services)	Positive Correlation	Bachand-Marleau et al. (2012); Hamad et al. (2021)
Number of dockless bike-sharing services	Positive Correlation	Fishman et al. (2014); Wang & Zhou (2017); Murphy & Usher (2011)
Park area	Positive Correlation	Singhirunnusorn & Sahachaisaeree (2013); Bezerra & Cunha (2018)
Tourism area	Positive Correlation	Chaikaew et al. (2018)
Recreation area	Positive Correlation	Kaplan et al. (2015)
Travel time	Negative Correlation	Barbour et al. (2019)
Travel Distance	Negative Correlation	Hamad et al. (2021)

The selection and utilization of appropriate research tools are critical factors that significantly influence the outcome of scholarly investigations. In our pursuit of understanding the factors influencing the possibility of bicycle use, we have explored a multitude of research tools.

Manaugh et al. (2017) conducted a study to explore the factors influencing cycling frequency in a campus setting within a large metropolitan area. The research identified several barriers to cycling and evaluated their relative significance across different demographic groups. Notably, the study utilized multinomial logistic regression (MNL) to predict individuals' likelihood of falling into different cycling categories (never, rarely, usual, always) based on socio-demographic and trip characteristics. These findings provide valuable insights for transportation engineers and planners aiming to encourage cycling among diverse commuter groups. By employing MNL as a statistical tool, the study achieved a deeper understanding of the complex interplay between various factors influencing cycling behavior, including socio-demographic factors, route characteristics, and residential choice factors, and how they impact individuals' propensity to cycle at different frequencies.

Nolan et al. (2016) conducted a study to explore the determinants of bike-sharing station usage using a fine-grained approach, focusing on Bayesian regression models. The research examined the effects of various factors such as bicycle infrastructure, population and employment, land use mix, and transit access on trip generation at stations. Utilizing Bayesian regression models, the study analyzed these effects separately by season of the year, weekday/weekend, and user type (subscriber versus casual). The findings revealed that bike-sharing stations located near busy subway stations and bicycle infrastructure experienced greater utilization, while areas with higher population and employment generally predicted greater usage. However, the analysis uncovered nuanced relationships, such as the stronger association between residential population and trips on non-working days. Additionally, the study used the models to forecast trips generated at new stations opened in 2015, indicating large variations in predictive power influenced partly by weather conditions and other unpredictable factors. These nuanced insights from the inferential analysis offer valuable information for transportation planners seeking to optimize bike-sharing systems.

Sun et al. (2018) investigated factors influencing bike-sharing trip generation and attraction at the station level, using a generalized additive mixed model (GAMM). Focusing on Seattle's failed bike-sharing system, Pronto, the study examined various factors such as land use, roadway design, and weather on bike pickups and returns. GAMM was employed to address temporal autocorrelations and nonlinear seasonality in the data. Results highlighted the impact of terrain and weather on bike-sharing usage, providing valuable insights. Additionally, the study revealed preferences of users in the University District for shared bikes in areas with higher household density and residential land use, regardless of workdays or non-workdays. In conclusion, GAMM proved crucial in addressing the temporal trends and seasonality inherent in bike-sharing trip count data, offering nuanced insights often overlooked by traditional models.

Zhang et al. (2017) investigated how built environment factors influence the use of public bike systems (PBS) at the station level, using trip data from Zhongshan's public bike system. Despite the rapid development of PBS, few studies have explored this aspect, particularly considering the spatial correlation between nearby stations. The research employed multiple regression analysis to examine the influence of various built environment variables on trip demand and the demand-to-supply (D/S) ratio at bike stations, incorporating spatial correlations using a weighted matrix. Built environment factors such as station attributes, accessibility, cycling infrastructure, public transport facilities, and land use characteristics were considered. The findings revealed that trip demand and the D/S ratio at bike stations were positively influenced by population density, length of bike lanes and branch roads, and diverse land-use types near the station, while being negatively influenced by the distance to the city center and the number of other nearby stations. Interestingly, public transport facilities did not significantly impact both demand and D/S at stations, possibly due to local modal split dynamics. The study also found a positive association between PBS usage at stations and usage at nearby stations, suggesting spatial clustering effects. Moreover, the research highlighted that adding a new station within a 300 m catchment area of an existing station could improve the demand-supply ratio. Regression fits were particularly strong for weekdays and peak hours.

Nikitas (2018) conducted a quantitative survey of 640 responses to examine road users' attitudes towards bike-sharing and its potential introduction to Drama, a small Greek city. The study aimed to understand the acceptability and factors influencing the adoption of bike-sharing initiatives in a city similar to many others in terms of size, transport culture, and socio-economic characteristics. Most respondents recognized bike-sharing as a mode with pro-environmental, cost-effective, and health-improving qualities, with the potential to promote a greener identity for the city. Despite low current bicycle use frequency, evidence suggested people would support a bike-sharing investment. Factors such as age, gender, modal choice determinants, perceived effectiveness in reducing traffic congestion, and usage expectations influenced acceptability. While the lack of cycling infrastructure and road safety concerns were identified as usage barriers, the study indicated that bike-sharing could be a publicly acceptable investment for smaller cities with the implementation of pro-cycling policies. The study utilized ordinal logistic regression to analyze factors influencing respondents' acceptability of bike-sharing, providing valuable insights for promoting sustainable travel behavior patterns in urban areas.

Corcoran et al. (2014) analyzed trip-level data from Brisbane's 'CityCycle', Australia's largest Public Bike-Sharing Program (PBSP), to investigate the spatio-temporal dynamics of the system. The study focused on the effects of weather and calendar events on public bicycle use. Using novel spatial analytical techniques, the researchers examined how site-specific weather conditions and calendar events influenced the spatio-temporal dynamics of the PBSP. Additionally, they incorporated Poisson regression estimation to understand the factors affecting the frequency of bicycle use across different locations and times. The results of the analysis highlighted that rain and wind were both significantly related to the number of trips taken at the system-wide level, with stronger winds and rainfall significantly reducing the total number of trips. Regarding the effect of calendar events, both public and school holidays were not found to exert a significant influence at the system-wide level when considered as independent factors. However, public holidays were found to have a significant positive effect when modeled alongside other factors.

Tang et al. (2017) investigated the primary factors affecting bike-share users' ride frequency by analyzing data from an online survey conducted with users of the Shanghai Minhang bike-sharing system. The paper first compared ride frequencies of Chinese bike-sharing systems with those of their international counterparts. Then, based on the online survey responses from users of the Shanghai Minhang bike-sharing system, the paper analyzed users' ride characteristics. Furthermore, employing the Binary Logistic Model, the study examined the major factors influencing usage frequency. It found that the availability of alternative modes of transportation and the purpose of non-commuting trips by bike-sharing had the greatest impact on ride frequency. Interestingly, non-commuting trips had a stronger influence on ride frequency compared to commuting trips.

Campbell et al. (2016) utilized a stated preference survey and multinomial logit analysis to model the factors influencing the decision to switch from existing transportation modes to bikeshare or e-bikeshare in Beijing. The study identified distinct sets of factors influencing demand: bikeshare choice was primarily influenced by measures of effort and comfort, while e-bikeshare choice was more sensitive to user heterogeneities. Bikeshare demand was strongly affected by trip distance, temperature, precipitation, and poor air quality. However, user demographics did not significantly influence the bikeshare choice, indicating that it attracts users from various social backgrounds. In contrast, e-bikeshare choice was more tolerant of trip distance, high temperatures, and poor air quality, though precipitation had a highly negative impact. User demographics played a significant role in e-bikeshare demand. Analysis of the impact on the existing transportation system revealed that both bikeshare and e-bikeshare tended to draw users away from "unsheltered modes" such as walking, biking, and using e-bikes. While it remained uncertain whether shared bikes are an attractive "first-and-last-mile solution," e-bikeshare is seen as an appealing bus replacement.

El-Assi et al. (2017) conducted an analysis to identify the factors influencing bike share ridership in Toronto. Their study employed a comprehensive spatial analysis to explore the impact of various factors, including socio-demographic attributes, land use, built environment, and weather conditions, on bike share ridership. The empirical models showed significant effects of road network configuration, such as intersection density and spatial dispersion of stations, on bike-sharing demand. Additionally, the presence of bike infrastructure, such as bike lanes and paths, was found to be crucial in increasing bike-sharing demand. The study also investigated temporal changes in bike share trip behavior using a multilevel framework, revealing a significant correlation between temperature, land use, and bike share trip activity.

Mattson and Godavarthy (2017) explored the rise of bike share programs in smaller cities, like Fargo, North Dakota, where Great Rides Bike Share was launched in 2015 with 11 stations and 101 bikes. Despite being one of the smaller systems in the United States, it achieved remarkable success. This study analyzed the ridership data from Great Rides Bike Share during its first two years of operation, investigated the factors contributing to its success, and estimated the impacts of weather, temporal, and spatial variables on bike share use. Fargo's bike share usage exceeded that of many larger programs in the country in terms of trips per bike per day. The analysis revealed significant impacts of temperatures, wind, precipitation, and station locations on a college campus on bike share usage. Cold and hot weather, precipitation, and wind negatively affected bike share use, while the presence of stations on the university campus had a positive impact on ridership.

Ma et al. (2018a) examined the integration of metro and bike-share systems as a sustainable travel model. Their study aimed to understand the factors influencing bike-share activity around metro stations, considering bike-share as a feeder mode to the metro. Initially, they identified metro and bike-share transfer trips by matching bike-share smartcard data with metro smartcard data. Then, they used standard deviation ellipses (SDE) to calculate the activity spaces of bike-share around metro stations. The researchers established both ordinary least squares (OLS) regression and a spatial error model (SEM) to investigate the effects of social-demographic, travel-related, and built environment factors on these activity spaces. The SEM outperformed OLS significantly in terms of model fit. Results revealed that on weekdays, the average activity space of the metro bike-share is larger than on weekends. An increase in the proportion of local residents promotes larger activity spaces on weekends, while higher road and metro densities restrict activity spaces on weekdays. Moreover, increased job density significantly reduces activity spaces throughout the week. Additionally, both on weekdays and weekends, closer proximity to the central business district (CBD) results in smaller activity spaces. This study provides valuable insights for policymakers and city planners seeking to optimize bike-share distribution and encourage sustainable commuting.

Tran et al. (2015) aimed to present a model of bike-sharing demand at the station level in the city of Lyon. Robust linear regression models were used to predict the flows of each station. The data used in this project consisted of over 6 million bike-sharing trips recorded in 2011. The built environment variables used in the model were determined in a buffer zone of 300 meters around each bike-sharing station. In order to estimate the bike-sharing flow, the method of linear regression was used during the peak periods of a weekday. The results showed that bike sharing was principally used for commuting purposes by long-term subscribers, while short-term subscribers' trip purposes were more varied. The combination of bike sharing and train seemed to be an important intermodality. An interesting finding was that students were important users of bike sharing. It was found that there were different types of bike-sharing usage influenced by socio-economic factors depending on the period within the day and type of subscribers.

Santos et al. (2013) attempted to identify factors that influenced the modal split for journeys to work in 112 medium-sized cities in Europe. Using a discrete choice modeling approach, they found that: (a) car share increased with car ownership and GDP per capita; (b) motorcycle share decreased with petrol price and increased with motorcycle ownership; (c) bicycle share increased with the length of the bicycle network in the city; (d) public transport share increased with resident population, GDP per capita, and the number of buses operating per 1000 population, and decreased with public transport fares, number of rainy days per year, proportion of people aged 65 and over living in the city, and the proportion of households with children; (e) the number of students in universities and further education establishments per 1000 resident population was positively associated with the shares of public transport, motorcycle, bicycle, and walking. Policies aimed at increasing the bicycle network were likely to increase cycling share, while policies aimed at increasing the number of buses and reducing public transport fares were likely to increase public transport share. Policies aimed at discouraging car ownership were likely to reduce car share.

Raux et al. (2017) analyzed the socio-demographic profile and travel behavior of annual members of the "Velo'v" bike-sharing system in Lyon, France. The system began in 2005 and currently operates around 350 stations and 4500 bikes, serving over 50,000 annual members. An internet-based survey described the detailed socio-demographic profiles, travel means, and habits of more than 3000 respondents. Additionally, around 700 volunteers filled out one-day and seven-day activity-travel diaries, covering all travel modes and day-to-day variations in travel behavior beyond just bike-sharing. A discrete choice model was used to analyze the socio-demographic and spatial factors affecting the probability of being an annual member of the Velo'v system. This was compared with descriptive statistics of their daily travel behavior, including bike-sharing and traditional modes, to the travel behavior of the general population based on the latest Household Travel Survey available in the Lyon area (2015). The majority of Velo'v annual members were male, younger, and held higher social positions compared to Lyon's general population. Higher social position and residential proximity to stations both had separate and positive effects on the probability of being an annual member of the service. Velo'v members were not solely reliant on public transport; the majority had access to a car and exhibited fully multimodal travel behavior in their day-to-day activities. Velo'v bikes were used for various activities, not necessarily every day, similar to other travel modes. The multimodal behavior of Velo'v members indicated that the Velo'v supply meets demand, particularly when public transport stations are too distant from home.

Wang & Akar (2019) investigated the factors influencing gender differences in bike-share ridership. Using data from New York City's Citi Bike Share system, they examined the environmental factors affecting bike-share usage for males and females. The study also modeled the impacts of bicycle facilities, land use factors, and public transit services on the share of trip arrivals made by females. The results indicated that the environmental factors influencing bike-share usage for males and females were generally similar. However, the estimated magnitudes suggested that these variables might affect males and females differently. For instance, the installation of more bicycle racks was positively associated with bike-share ridership for both genders. Additionally, the study found that this factor had a greater impact on women than on men. Specifically, a 1% increase in the number of bicycle racks was correlated with a 1.18% increase in the share of trip arrivals made by women.

Campbell & Brakewood (2017) aimed to quantify the impact of bike-sharing systems on bus ridership. They utilized a natural experiment involving the phased implementation of a bike-sharing system across various areas of New York City, enabling the use of a difference-in-differences identification strategy. Bus routes were divided into control and treatment groups based on whether they were located in areas that received bike-sharing infrastructure. The study found a significant decrease in bus ridership on treated routes compared to control routes coinciding with the implementation of the bike-sharing system. The results from the preferred model indicated that every thousand bike-sharing docks along a bus route was associated with a 2.42% decrease in daily unlinked bus trips on routes in Manhattan and Brooklyn. A second model, which also controlled for the expansion of bike lanes during this time, suggested that the decrease in bus ridership attributable to bike-sharing infrastructure alone might be smaller (a 1.69% decrease in daily unlinked bus trips).

Faghih-Imani & Eluru (2016) aimed to incorporate spatial and temporal effects, both observed and unobserved, into modeling bicycle demand using data from New York City's bicycle-sharing system (CitiBike). They estimated spatial error and spatial lag models that accounted for the influence of spatial and temporal interactions, drawing exogenous variables from BSS infrastructure, transportation network infrastructure, land use, points of interest, and meteorological and temporal attributes. The best spatial lag model estimation results were used to predict usage for a hold-out sample. Overall, the proposed framework provided satisfactory predictions of usage. The daily customers' models yielded better results with an MAE of about 0.68 bicycles per hour compared to an MAE of about 1.8 for members' models. Additionally, it was observed that the output for the arrival model was marginally better than the output for the departure model. The results also showed that for arrivals, about 90% of the records had errors in prediction within 10% of station capacity, while for departures, more than 75% of the records had errors in prediction within 10%. These findings indicate that incorporating observed and unobserved spatial-temporal interactions improved the accuracy of estimated parameters and the predictive capability of the modeling framework.

Zhao et al. (2014) aimed to model how urban features and system characteristics affect daily bike-sharing use and turnover rate using data from 69 bike-sharing systems in China. The results of data regression and comparison indicated that bike-sharing ridership and turnover rate tended to increase with urban population, government expenditure, and the number of bike-sharing members and docking stations. However, the number of public bikes had a significant negative impact on bike-sharing ridership and turnover rate. The study suggested that to achieve an ideal bike-sharing turnover rate in most Chinese cities, the bike-member (supply-demand) ratio should have been better controlled within 0.2. Additionally, it was proposed that personal credit cards (allowing bike-sharing members to pay with "personal credit" if they did not return public bikes within the free use hours) and universal cards (integrating bike-sharing systems into other urban transit systems using a rechargeable smart card for a range of payments and trips) could significantly increase bike-sharing daily use and turnover rate.

Younes et al. (2019) examined changes in bike-share ridership resulting from rail transit closures in the Washington, D.C. area and explored the potential benefits of promoting bike-share systems in large metropolitan areas during transit disruptions, regardless of their type, cause, or duration. Disaggregated trip history data were used to analyze the impact of three different transit closures in 2016, each lasting from 7 to 25 days. The objective of the study was to gain insight into how transit disruptions affect bike-share use. An autoregressive Poisson time series model was employed to estimate the effects of transit closures on bike-share activity. Kernel density estimation was used to understand spatial changes in ridership one week before, one year before, and after each closure. Results were compared temporally and spatially, confirming that transit disruptions were associated with increased bike-share ridership at the local level. Once the affected Metro stations reopened, bike-share ridership returned to its original levels. The study concluded that within 0.25 miles of a rail station and with rail stations spaced fewer than 3 miles apart, a bike-share system could serve as a mechanism for low-carbon mobility to complement transit.

Kim (2018) studied the effects of weather conditions and non-working days on bike-share ridership at both the system and station levels. The introduction of the temperature-humidity index (THI) and a variable for scorching heat highlighted the negative correlation between high temperatures and bike usage, particularly during the daytime. The study also found differences in bike rentals between weekdays, weekends, and public holidays, with a notable decrease observed during public holidays. Clustering analysis revealed three distinct station clusters with different temporal patterns of bike rentals, reflecting geographical characteristics and usage purposes. Stations with high morning usage were associated with commuting, while those with evening peaks had varying purposes. The study indicated that weather and non-working days differently influenced bike-share ridership depending on the station clusters, emphasizing the importance of considering station characteristics in understanding bike usage patterns.

Nosal & Miranda-Moreno (2014) explored the influence of weather on urban bicycle facility usage in Montreal, Ottawa, Vancouver, Portland, and along the Green

Route in Quebec. This study utilized long-term hourly and daily counts obtained automatically through inductive loop detectors. The counting data locations were categorized into utilitarian and recreational groups. Regression models incorporating autoregressive and moving average (ARMA) errors were employed to examine the direct impact and delayed effects of weather variables on hourly and daily bicycle counts. The findings revealed that temperature was positively correlated with cycling, while humidity was negatively correlated with it. Precipitation had a significant negative effect on cycling flows, which increased with rain intensity. Lagged effects of rain were also identified, including its impact in the previous three hours, morning rain, and afternoon rain. Additionally, urban bicycle flows showed greater sensitivity to weather conditions on weekends compared to weekdays, and recreational facilities were more affected than utilitarian ones.

Faghih-Imani & Eluru (2015) conducted a comprehensive analysis of bike-sharing system (BSS) user behavior at the trip level, focusing on destination preferences. Utilizing trip data from Chicago's Divvy bicycle-sharing system, they employed a multinomial logit model (MNL) to understand the decision-making process of users when selecting destination stations. The study differentiated between BSS members and daily customers and found distinct patterns in their preferences. Members showed a preference for stations with shorter distances, while daily customers preferred stations with larger capacities. The analysis revealed that during morning and evening commuting periods, users tended to choose stations with higher job densities and lower population densities. The study also explored the impact of various factors, such as network distance, land use, and station capacity, on destination choices. The model's validation confirmed its accuracy and applicability, providing insights for BSS operators to optimize station locations, plan bicycle availability, and understand the impact of system changes on user preferences.

Caulfield et al. (2017) analyzed the trends in a bike-sharing scheme implemented in Cork since 2014, revealing that in a small, compact city like Cork, average trip times were short, and regular users exhibited habitual trip patterns, often using the same bike stations and following similar routes on a daily or weekly basis. The findings also indicated that weather conditions influenced bike-share usage, with longer trips being more common during better weather. The study also compared these findings with similar systems in larger cities, finding several parallels. For instance, the presence of morning and evening peaks in usage was consistent with cities like Chicago, while the trend of more evening and weekend usage mirrored systems such as Montreal's BIXI. Similarly, the habitual use of the system for commuting aligned with trends observed in cities like Toronto, and the presence of shorter morning trips resembled patterns seen in Lyon. Moreover, the study found similarities with weekend usage observed in larger systems like Chicago and New York. These parallels suggest that despite Cork's smaller scale, its bike-sharing system shares many behaviors with larger schemes, indicating the potential benefits of bike-sharing systems in smaller cities.

Table 2.3 Research Methods Utilized in Bike-Sharing Studies

Author	Literature Analysis	Survey	Focus group/ Interview	Descriptive	Regression Analysis/ Logit Model	etc.
(Manaugh et al., 2017)	✓				✓ Multinomial Logistic regression	✓ Mixed-method
(Noland et al., 2016)	✓				✓ Bayesian regression model	
(Sun et al., 2018)	✓			✓		✓ Generalized additive mixed model (GAMM)
(Zhang et al., 2017)	✓				✓ Multiple linear regression model	
(Nikitas, 2018)	✓	✓		✓	✓ Ordinal regression model	
(Corcoran et al., 2014)	✓				✓ Poisson regression estimation	

Author	Literature Analysis	Survey	Focus group/ Interview	Descriptive	Regression Analysis/ Logit Model	etc.
(Tang et al., 2017)	✓	✓			✓ Binary Logistic Model	
(Campbell et al., 2016)	✓	✓			✓ Multinomial Logit (MNL)	
(El-Assi et al., 2017)	✓			✓	✓ Multivariable regression model	
(Mattson & Godavarthy, 2017)	✓				✓ Regression	
(Ma et al., 2018a)	✓				✓ Ordinary least squares regression	✓ Spatial Error model (SEM)
(Tran et al., 2015)	✓				✓ Robust linear regression model	
(Santos et al., 2013)	✓			✓	✓	✓ Discrete modeling
(Raux et al., 2017)	✓			✓	✓ Binary logit model	✓ Discrete choice model
(Wang & Akar, 2019)	✓			✓	✓ Fractional logit model	✓ Negative binomial model
(Campbell & Brakewood, 2017)	✓			✓	✓ Difference-in-differences regression	✓ Placebo model
(Faghih-Imani & Eluru, 2016)	✓				✓ Linear regression model	✓ Spatial lag model
(Zhao et al., 2014)	✓				✓ Partial least squares (PLS) regression model	

Author	Literature Analysis	Survey	Focus group/ Interview	Descriptive	Regression Analysis/ Logit Model	etc.
(Younes et al., 2019)	✓				✓ Autoregressive Poisson time series model	✓ Kernel density estimation (KDE)
(Kim, 2018)	✓					✓ Negative binomial model
(Nosal & Miranda-Moreno, 2014)	✓				✓ with ARMA	
(Faghih-Imani & Eluru, 2015)	✓				✓ Multinomial logit model (MNL)	
(Caulfield et al., 2017)	✓				✓ Logistics regression model	

Regarding the literature review, it is evident that Multinomial Logistic Regression is used for predicting outcomes with more than two categories that do not have a natural order (Manaugh et al., 2017; Campbell et al., 2016; Faghih-Imani & Eluru, 2015), while Ordinal Logistic Regression is suited for outcomes with more than two categories that have a natural order (Nikitas, 2018; Ma et al., 2018a). Binary Logistic Regression deals with binary outcomes, modeling the probability of one of the two categories (Tang et al., 2017; Raux et al., 2017; Caulfield et al., 2017). Bayesian Logistic Regression, applicable to both binary and multinomial outcomes, incorporates Bayesian inference, allowing the integration of prior beliefs with data to estimate posterior distributions of the parameters (Noland et al., 2016). Each method is tailored to specific types of categorical data and has unique modeling approaches and assumptions.

To understand the factors influencing bicycle use, we employed various research methods, including Binary Logistic Regression (BLR) and interviews with university administrators. Our decision to use Binary Logistic Regression was influenced by studies such as Manaugh et al. (2017), who utilized Multinomial Logistic Regression to predict individuals' likelihood of cycling based on socio-demographic factors. Similarly, the interviews with university administrators were inspired by research such as Nikitas (2018), which used quantitative surveys to explore attitudes towards bike-sharing in smaller cities. Our objective is to investigate the factors influencing bicycle use on campuses in Thailand. Our surveys asked students, faculty, and staff whether they use bicycles on campus (yes/no), making this a binary dependent variable. Consequently, we used BLR to determine which factors could increase the probability of individuals transitioning from not using a bicycle on campus to using a bicycle on campus. Through these methods, our aim was to gain insights into the demographics and attitudes influencing bicycle use on campuses in Thailand. We will explain the details in the next chapter.

Chapter 3
Research Methodology

This chapter outlined the systematic approach and methods used to investigate the factors influencing the development of campus bike-sharing systems within the unique landscape of Thai higher education. The chapter provided a comprehensive overview of the methodologies used in this study by describing the research design, data collection techniques, and analytical tools employed.

3.1 Research Design

This study employed a mixed-methods approach, incorporating both quantitative and qualitative methodologies to investigate factors influencing bicycle use on university campuses. Quantitative data were collected through structured questionnaires administered online to students and faculty members across 19 university campuses. The questionnaires, validated by five content experts, assessed demographics, behaviors, attitudes, and perceived obstacles related to bicycle use. Concurrently, qualitative data were gathered through interviews with management staff responsible for sustainability or infrastructure at each university campus. Open-ended questions were utilized to explore participants' perspectives on bicycle use and commuting challenges.

Subsequently, collected data were subjected to thorough analysis to determine meaningful insights. Quantitative data analysis involved descriptive statistics, correlation analysis, and regression analysis to identify relationships and patterns within the data. Qualitative data were analyzed conceptually to identify recurring themes and patterns. Integration of quantitative and qualitative findings provided a comprehensive understanding of factors influencing bicycle use on university campuses, facilitating the formulation of recommendations and guidelines for promoting sustainable transportation solutions and enhancing bicycle infrastructure.

3.2 Research Tools

Binary logistic regression is a statistical method used to model the relationship between a binary dependent variable and one or more independent variables

(Hosmer et al., 2013). It is commonly employed when the dependent variable is dichotomous, meaning it has only two possible outcomes. Binary logistic regression estimates the probability of a particular outcome occurring based on the values of the independent variables. The logistic regression model is expressed using the logistic function, also known as the sigmoid function, which transforms the linear combination of the independent variables into a probability between 0 and 1. The logistic function is defined as:

$$P(y=1)=\frac{1}{1+e^{-(b_0+b_1x_1+b_2x_2+\cdots+b_nx_n)}}$$

In this model, $P(y=1)$ represents the probability of the dependent variable, denoted as *y*, indicating the event of using a bicycle as a mode of transportation within the campus. Conversely, $y=0$ signifies the opposite scenario. The independent variables associated with *y* are denoted by $x_1, x_2, \dots, x_n$ where b_0 represents a constant, and $b_1, b_2, \dots, b_n$ denote the coefficients of $x_1, x_2, \dots, x_n$ respectively. One of the key outputs of Binary Logistic Regression is the odds ratio, which measures the association between each independent variable and the dependent variable. The odds ratio represents the change in odds of the dependent variable occurring (e.g., using a bicycle) for a one-unit increase in the independent variable, holding all other variables constant.

Binary logistic regression has numerous applications in various fields, including healthcare, finance, marketing, and social sciences. It is often used for predicting binary outcomes such as disease diagnosis, customer churn, loan default, and voter preference.

3.3 Research Questions

RQ1: Do the demographics affect bicycle use on campus in Thailand?

RQ2: Do the attitudes affect bicycle use on campus in Thailand?

RQ3: Does the Gross Provincial Product affect bicycle use on university campuses in Thailand?

3.4 Population and Samples

The research aimed to investigate the factors influencing bicycle use on university campuses in Thailand, focusing on a case study approach. Thai university campuses were selected as the focus of the study due to their inclusion in the Times Higher Education Impact Rankings 2020, which considers indicators related to the Sustainable Development Goals (SDGs). Specifically, 19 Thai campuses from this rankings were chosen for inclusion in the study, as detailed in Table 3.1. Nine of these campuses are situated in the central region of Thailand, while three are located in the northern region. Additionally, six campuses are situated in the northeast, with only one in the southern region. The campus areas vary significantly, ranging from 132,800 sq.m. to 13,600,000 sq.m. Notably, only three campuses offer more than one mode of public transportation for commuting to campus, namely Chulalongkorn University (CU), King Mongkut's Institute of Technology Ladkrabang (KMITL), and Srinakharinwirot University (SWU).

Sample sizes could be chosen in three different ways: cost-based, variance-based, and statistical power-based (Singh & Masuku, 2014). Cost-based sampling involved selecting items that were readily available or convenient to collect. While choosing small sample sizes could sometimes be necessary, it could lead to wide confidence intervals or errors in statistical hypothesis testing. Variance-based sampling set a target variance for the estimate to be derived from the eventual sample. Statistical power-based sampling set a target for the power of a statistical test to be applied once the sample was collected. Sample sizes were evaluated based on the quality of resulting estimates, and sample size could be assessed based on the power of a hypothesis test. There were various strategies for determining sample size, including using a census for small populations, imitating the sample size of similar studies, using published tables, and applying formulas. Glenn (1992) offered a useful guide for determining sample size, allowing calculation for different combinations of precision, confidence, and variability levels. Mead's resource equation was often used for estimating sample sizes of laboratory animals and in many other laboratory experiments (Kish, 1965). Cochran (1975) developed an equation to yield a representative sample for large sample proportions, using the value of Z in statistical tables that contained the area under the normal curve. Yamane (1967) provided a simplified formula for calculating sample sizes, assuming a 95% confidence level and p value = 0.05. Rao (1985) presented another calculation for sample size under different circumstances in a simple manner, which was particularly useful for medical or clinical research investigations.

To gather data for the study, the Taro Yamane formula was employed (Yamane, 1967). This formula is commonly used for determining sample sizes in survey research and is calculated based on a population size (N) of approximately 500,000 individuals, including university students, faculty, and staff. The acceptable sampling error was set at 5% (0.05), ensuring statistical reliability. By applying this formula, the calculated sample size (n) for the study was determined to be 400 individuals. Thus, the study must collect at least 400 questionnaires from the population to ensure robust findings.

$$n = \frac{N}{1 + N * e^2}$$

In addition to questionnaire surveys, interviews were conducted with top management responsible for sustainability policies on each of the 19 campuses included in the study. Engaging with key stakeholders at each university allowed the research team to gain insights into the implementation of sustainability policies and their impact on bicycle usage. By interviewing top management, the research aimed to understand the strategies, challenges, and initiatives related to promoting sustainable transportation practices within the campus environment.

This comprehensive approach, incorporating both questionnaire surveys and interviews with top management, ensured a holistic understanding of the factors influencing bicycle use on Thai university campuses. By adhering to established methodologies for sample size determination and data collection, the research aimed to provide valuable insights into the determinants of bicycle usage in the university setting, contributing to the promotion of sustainable transportation practices within the academic community.

Table 3.1 The list of sample universities in Thailand

No.	University	Located in Thailand	Area (sqm.)	Mode of public transport to campus
1	Asian Institute of Technology (AIT)	Central	1,600,000	Buses
2	Chiang Mai University (CMU)	North	13,600,000	Buses
3	Chulalongkorn University (CU)	Central	1,844,800	Buses, Subway, Sky train
4	Khon Kaen University (KKU)	Northeast	8,800,000	Buses
5	King Mongkut’s Institute of Technology Ladkrabang (KMITL)	Central	1,360,000	Buses, Rails
6	King Mongkut's University of Technology North Bangkok (KMUTNB)	Central	132,800	Buses
7	King Mongkut's University of Technology Thonburi (KMUTT)	Central	214,400	Buses
8	Loei Rajabhat University (LRU)	Northeast	516,800	Buses
9	Mae Fah Luang University (MFU)	North	8,000,000	Buses
10	Mahasarakham University (MSU)	Northeast	588,800	Buses
11	Mahidol University (MU)	Central	1,984,000	Buses
12	Nakhon Ratchasima Rajabhat University (NRRU)	Northeast	438,400	Buses
13	Prince of Songkla University (PSU)	South	1,280,000	Buses
14	Silpakorn University (SU)	Central	684,800	Buses
15	Srinakharinwirot University (SWU)	Central	163,200	Buses, Subway, Sky train, Passenger ship
16	Suranaree University of Technology (SUT)	Northeast	11,200,000	Buses
17	Thammasat University (TU)	Central	2,811,200	Buses
18	Ubon Ratchathani University (UBU)	Northeast	8,364,800	Buses
19	University of Phayao (UP)	North	9,120,000	Buses

3.5 Questionnaire Design

The design of a questionnaire was a crucial aspect of the research study, as it laid the foundation for collecting relevant data to address the research objectives effectively. In this section, we provided an overview of the questionnaire structure developed for the present study, focusing on three key components: demographics, modes of transportation on campus, and attitudes toward cycling.

3.5.1 Questionnaire Structure

The questionnaire design for this research was structured to effectively capture key information regarding commuters' demographics, commuting behaviors, and attitudes toward cycling on university campuses. Divided into three distinct parts, the questionnaire aimed to provide comprehensive insights into the factors influencing bicycle use on campus and offer guidance for promoting cycling among university communities. The questionnaire structure overview is shown in Figure 3.1.

Part One: Demographics	Part Two: Modes of Transportation on campus	Part Three: Attitudes toward cycling on campus
• Gender • Age • University affilication • Role • Monthly income • Accommodation • Car ownership • Motorcycle ownership • Modes of Transportation from residence to campus	• Car • Motorcycle • Bicycle • Public transport • Walk • Car/Motorcycle sharing • Use/Never use Bike-sharing program on campus	• Lack of bicycle lane • Losing bicycles • Taking too long • Bicycle use was a problem for other road users • Bicycle parking space was a problem • Good road surfaces and road signs would support cycling • Epidemics affected cycling

Figure 3.1 Questionnaire Structure Overview

3.5.1.1 Part One: Demographics

This section focused on gathering demographic information about the respondents, including their gender, age, university affiliation, role within the university (undergraduate student, graduate student, faculty, or staff), monthly income, accommodation location (inside or outside campus), and ownership of cars or motorcycles. Additionally, respondents were asked about their preferred commuting method between accommodation and campus. These details were crucial for understanding the diverse profiles of commuters and their commuting behaviors.

3.5.1.2 Part Two: Modes of Transportation on Campus

The second part of the questionnaire explored the various modes of transportation utilized by commuters on university campuses. Respondents were asked to indicate their usage of bicycles, motorized vehicles, public transport, walking, and car or motorcycle sharing while navigating the campus environment. By collecting data on the prevalence of different transportation modes, this section aimed to provide insights into the current transportation landscape on university campuses.

Moreover, respondents were asked about the use or never use of bike-sharing programs on campus.

3.5.1.3 Part Three: Attitudes Toward Cycling

In this section, respondents' attitudes toward cycling as a mode of transport on campus were assessed. Questions were structured on a Likert scale, allowing respondents to express their level of agreement or disagreement with statements related to cycling. The scale ranged from "strongly disagree" to "strongly agree," enabling an understanding of individuals' perceptions of cycling on campus. By examining attitudes toward cycling, this section aimed to uncover potential barriers and facilitators to bicycle use among university communities.

3.5.2 Content Validity

To assess the content validity of the questionnaire, we utilized the index of Item Objective Congruence (IOC). Five experts, whose areas of expertise are detailed in Table A.1, were selected to validate the questionnaire using the IOC method. The IOC method, developed by Rovinelli and Hambleton (1976), is widely recognized in test development for assessing content validity during the questionnaire design phase. During the IOC assessment, a value exceeding 0.6 indicates strong content validity. Ideally, the IOC score should range from 0.60 to 1.00, reflecting a high level of questionnaire validity and reliability (Turner & Carlson, 2003).

Once the experts received the invitation, they evaluated each question against three criteria. A score of +1 is assigned if the question is deemed appropriate and unbiased. Conversely, a score of -1 is given if the question is considered problematic or likely to confuse respondents. For questions deemed somewhat flawed or uncertain, a score of 0 is assigned, accompanied by feedback. After scoring all questions, we calculated the average score provided by the five domain experts for each question. A score exceeding 0.6 indicated satisfactory content validity. Questions scoring below 0.6 undergo revision, followed by a repeat of the validation process. The IOC results are shown in Table A.2.

3.6 Data Collection

We divided the data collection process into three parts as follows.

3.6.1 Data Collection from University Campuses

In this study, we aimed to comprehensively investigate the factors influencing bicycle use on university campuses in Thailand. To achieve this goal, we established collaboration with 19 Thai university campuses. Our primary method of data collection involved distributing an online survey questionnaire to students, faculty, and staff across these campuses. The survey was designed to gather information on demographics, commuting behaviors, and attitudes toward cycling. We aimed to collect responses from at least 400 participants based on Taro Yamane’s formula.

3.6.2 Incorporation of Secondary Data

In a comprehensive view of data, we incorporated secondary data on Gross Provincial Product (GPP) into our analysis. GPP served as a proxy for economic activity and development within the provinces where each university campus was located. By examining the relationship between GPP and bicycle use on campus with BLR analysis, we explored how economic factors may have influenced transportation choices among students, faculty, and staff. This contextual information enriched our understanding of the broader socio-economic dynamics.

3.6.3 Interviews with Management-Level Individuals

To gain institutional perspectives on sustainability initiatives, we planned to conduct interviews with management-level individuals responsible for sustainability efforts at each university campus. These interviews would provide insights into the campus-specific policies, programs, and infrastructure supporting bicycle use and sustainable transportation. By engaging with key stakeholders, we ensured that our findings were grounded in the realities of campus operations and decision-making processes.

3.7 Data Analysis

Following data collection, the subsequent phase involved data analysis, which was divided into three main parts, as outlined below.

3.7.1 Descriptive Statistics

Upon completion of data collection, this analysis provided insights into the demographics, modes of transportation from residence to campus, and attitudes toward bicycle use on campus. By presenting the findings in frequency and percentage, we gained a better understanding of the current landscape of transportation behaviors among students, faculty, and staff.

3.7.2 Inferential Statistics

To examine the independent factors influencing bicycle use on campus, binary logistic regression analysis was employed. This statistical technique allowed us to explore the relationship between predictor variables (such as demographics and attitudes) and the binary outcome variable of bicycle use. By analyzing the regression coefficients, we determined which factors had a significant impact on the likelihood of using bicycles on university campuses. This analysis provided valuable insights for developing targeted interventions to promote cycling among campus communities.

In addition to survey data, secondary data on Gross Provincial Product (GPP) was incorporated into our analysis. GPP served as a proxy for economic activity and development within the provinces where each university campus was located. By examining the relationship between GPP and bicycle use on campus, we explored how economic factors may influence transportation choices among students, faculty, and staff. This contextual information enriched our understanding of the broader socio-economic dynamics.

3.7.3 Interviews with Management-Level Individuals

To gain institutional perspectives on sustainability initiatives, we conducted interviews with management-level individuals responsible for sustainability efforts at each university campus. These interviews provided insights into the campus-specific policies, programs, and infrastructure supporting bicycle use and sustainable transportation. By engaging with key stakeholders, we ensured that our findings were grounded in the realities of campus operations and decision-making processes.

Chapter 4

Results and Discussion

This chapter presents the findings obtained from the survey conducted across 19 Thai university campuses, supplemented by secondary data analysis and interviews with management-level personnel involved in campus sustainability initiatives. Through a combination of quantitative and qualitative analysis, this chapter aims to investigate the demographic characteristics, commuting behaviors, attitudes toward cycling, and other factors influencing bicycle use on university campuses. The results and discussion presented contribute to a deeper understanding of sustainable transportation practices within the academic community and provide valuable insights for future policy development and implementation.

4.1 Descriptive Statistics

As mentioned earlier, the combined population of students and university staff across all campuses involved in our study amounts to approximately 500,000 individuals. Utilizing the Taro Yamane formula, we determined that a minimum sample size of 400 would be adequate statistically. However, upon distributing the questionnaire online, we encountered limited control over the response count. Surpassing our expectations, we accumulated a total of 1,433 responses, surpassing our initial target. This expanded sample size gathers us with a more extensive and inclusive dataset.

4.1.1 The demographics of respondents

Table 4.1 illustrates the demographic characteristics of the respondents. The majority of respondents are female (67.1%), with males comprising 32.9% of the sample. Additionally, a significant portion of respondents (93.3%) fall within the age range of 17 to 23 years old, with only a small percentage being older. The survey primarily captured responses from undergraduate students (93.7%), followed by faculty and staff (4.0%) and graduate students (2.3%). Notably, undergraduate students mainly reported monthly incomes between 6,000 to 10,000 baht (53.5%), while the distribution of monthly income among graduate students, faculty, and staff varied across response options.

Table 4.1 The Demographics of Respondents

Attributes (Total N = 1,433)	Sample Percentage
Gender	
- male	32.9%
- female	67.1%
Age	
- 17 – 23 years old	93.3%
- over 23 years old	6.7%
Role	
- undergraduates	93.7%
- graduates	2.3%
- faculty and staff	4.0%
Undergraduates' income (per month)	
- less than 6,000 baht	23.8%
- 6,000 - 10,000 baht	53.5%
- over 10,000 baht	22.7%
Non-undergraduates' income (per month)	
- less than 20,000 baht	26.7%
- 20,001 - 30,000 baht	22.2%
- 30,001 - 40,000 baht	28.9%
- over 40,000 baht	22.2%
Resident	
- Outside the university	68.2%
- On campus	31.8%
Car ownership	
- yes	22.6%
- no	77.4%
Motorcycle ownership	
- yes	39.8%
- no	60.2%
Do not owe car and motorcycle	48.6%

Respondents were also surveyed about their accommodation arrangements and vehicle ownership. A significant portion of respondents live off-campus (68.2%), with a significant percentage not owning either a car (77.4%) or a motorcycle (60.2%). Nearly half of the respondents do not owe both cars and motorcycles (48.6%).

Table 4.2 Modes of Transportation from Residence to Campus, Categorized by Roles and Monthly Incomes

Mode of Transport	Undergraduate Students			Non-Undergraduate Students (N = 90)
	Income < 6,000 baht (N = 319)	Income 6,000 - 10,000 baht (N = 719)	Over 10,000 baht (N = 305)	
Car	10.7%	8.3%	23.9%	60.0%
Motorcycle	29.2%	32.8%	25.2%	5.6%
Bicycle	7.2%	2.4%	4.3%	4.4%
Public transport	34.5%	32.3%	16.7%	26.7%
Walk	16.3%	23.8%	28.9%	2.2%
Car/Motorcycle sharing	2.2%	0.4%	1.0%	1.1%

The subsequent section of the survey explored respondents' transportation modes from their residences to campus. Table 4.2 presents the transportation preferences of respondents, categorized by roles and income levels. Among undergraduate students with incomes below 6,000 baht per month, public transport (34.5%) and motorcycles (29.2%) are the favored modes of transportation. Those earning between 6,000 to 10,000 baht per month display a preference for motorcycles (32.8%) and public transport (32.3%) in approximately equal proportions. Conversely, individuals earning more than 10,000 baht per month mainly choose to walk (28.9%), followed by motorcycles (25.2%) and cars (23.9%). Cycling remains unpopular across all income categories, with minimal representation ranging from 2.4% to 7.2%. Graduate students, faculty, and staff display a higher car ownership rate (60%) compared to undergraduate students, with 26.7% preferring public transport. Notably, cycling remains an unpopular mode of transportation within these groups, accounting for only 4.4% of respondents.

Our findings highlight the transportation preferences among undergraduate students based on income levels. While motorcycles and public transport are favored by over 60% of undergraduate students earning less than 10,000 baht per month, those earning more than 10,000 baht show different transportation patterns, with a notable preference for walking and car usage. Furthermore, non-undergraduate students, typically with higher incomes, mainly favor car usage, indicating the influence of income levels on transportation choices and accommodation selection. This can be attributed to the convenience and flexibility provided by these transportation modes, as corroborated by prior studies (Singhirunnusorn & Sahachaisaeree, 2013; Sisiopikou, 2018)

4.1.2 Modes of transportation on campus

Table 4.3 displays the commuting behavior of university students and staff, presenting the frequency of various modes of transportation. The data reveals that most respondents (89.9%) never used bicycles on campus, with only a small percentage (2.9%) indicating frequent use. Similarly, motorcycle use on campus was relatively low, with 64.3% of respondents identifying as never using motorcycles, while 19.0% indicated frequent use. Additionally, park and ride was infrequent among respondents, with 81.2% reporting never engaging in this mode of transportation. Regarding public transportation, over half of the respondents (51.6%) reported never using it on campus, while approximately one-quarter stated rare use. Interestingly, walking is a popular commuting mode, with 25.7% of respondents reporting frequent walking on campus and a similar proportion (25.4%) indicating rare use.

Table 4.3 Commuting Behavior of University Students and Staff

Total N = 1,433	Never	Rarely	Sometimes	Frequently
Bicycle	89.9%	4.8%	2.4%	2.9%
Motorcycle	64.3%	7.3%	9.4%	19.0%
Park and ride	81.2%	11.0%	4.4%	3.5%
Public transportation	51.6%	23.1%	14.0%	11.3%
Walk	25.7%	25.4%	23.4%	25.5%

Table 4.4 presents data on the utilization of shared bicycles on campus by respondents who participated in the survey. It provides the frequency of shared bicycle use, the purposes of use, and the timing of bike rides throughout the day. Only 134 out of 1,433 respondents, or 9.35% have used bike-sharing system on campus.

Table 4.4 Campus Bike-Share Statistics

Total N = 134	Total samples
Frequency of use	
- less than one day/week	55.2%
- 1 – 2 days/week	34.3%
- 3 – 4 days/week	5.2%
- more than four days/week	5.2%
Purpose of use	
- commuting between buildings	33.6%
- connecting public transportation	38.0%
- leisure	9.0%
- exercise	19.4%
Timing	
- 05.00 – 09.00 am.	20.9%
- 09.01 am. – 01.00 pm.	8.2%
- 01.01 – 05.00 pm.	25.4%
- after 05.00 pm.	45.5%

In the first section, we observe the frequency of bike use, with 55.2% of respondents using shared bicycles less than once a week, 34.3% using them 1 to 2 days weekly, and 5.2% using them 3 to 4 days or more than four days weekly.

Moving on to the second section, we explored the purposes behind bike use. Among these respondents, 33.6% used bicycles for commuting between buildings, while 38.0% used them as a means to connect to public transportation. Moreover, 9.0% used bicycles for leisure activities, and 19.4% used them for exercise. Lastly, the table offers insights into the timing of bike use throughout the day. Notably, 20.9% of respondents used shared bicycles between 5:00 am and 9:00 am, while 8.2%

used them from 9:01 am to 1:00 pm. Additionally, 25.4% used bicycles between 1:01 pm and 5:00 pm, and most of them used shared bicycles after 5:00 pm. (45.5%).

4.1.3 Attitudes toward bicycle use on campus

In the final segment of the survey, respondents considered seven statements on attitudes toward bicycle usage on campus, outlined in Figure 3.1. Utilizing a Likert scale, respondents rated their agreement level with each statement, ranging from strongly disagree to strongly agree.

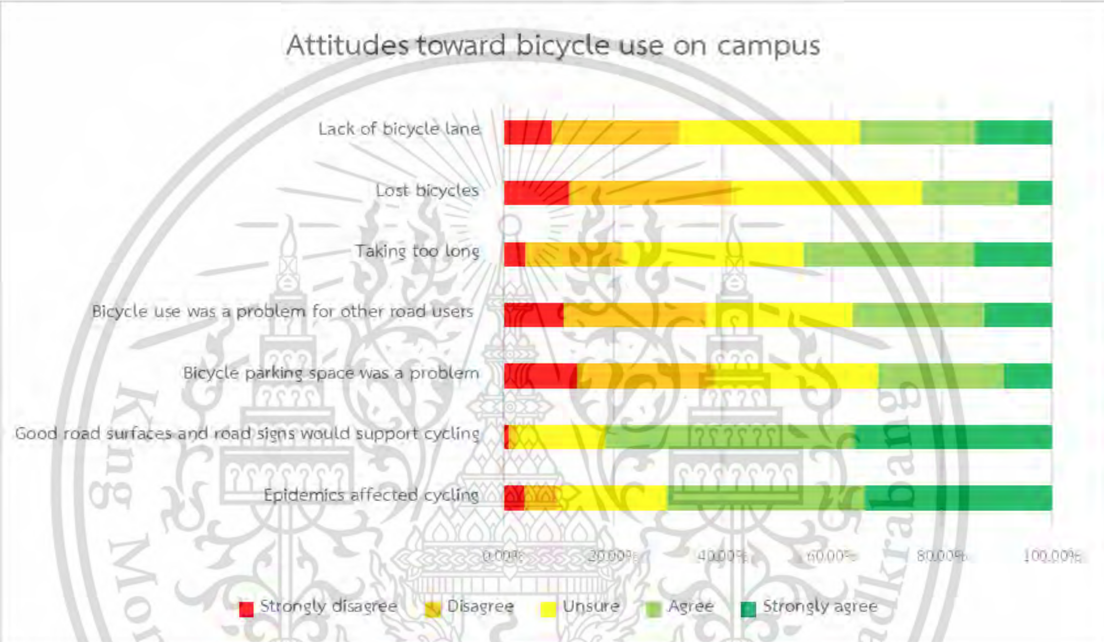

Figure 4.1 Attitudes toward Bicycle Use on Campus

The findings, shown in Figure 4.1, illustrate that most respondents agreed that good road surfaces and road signs would support cycling (45.4%), and the epidemics affected cycling (36.1%). However, respondents are unsure about the remaining five items, including the lack of bicycle lanes, lost bicycles, taking too long on cycling, concerns about bicycle use affecting other road users, and bicycle parking space being a problem.

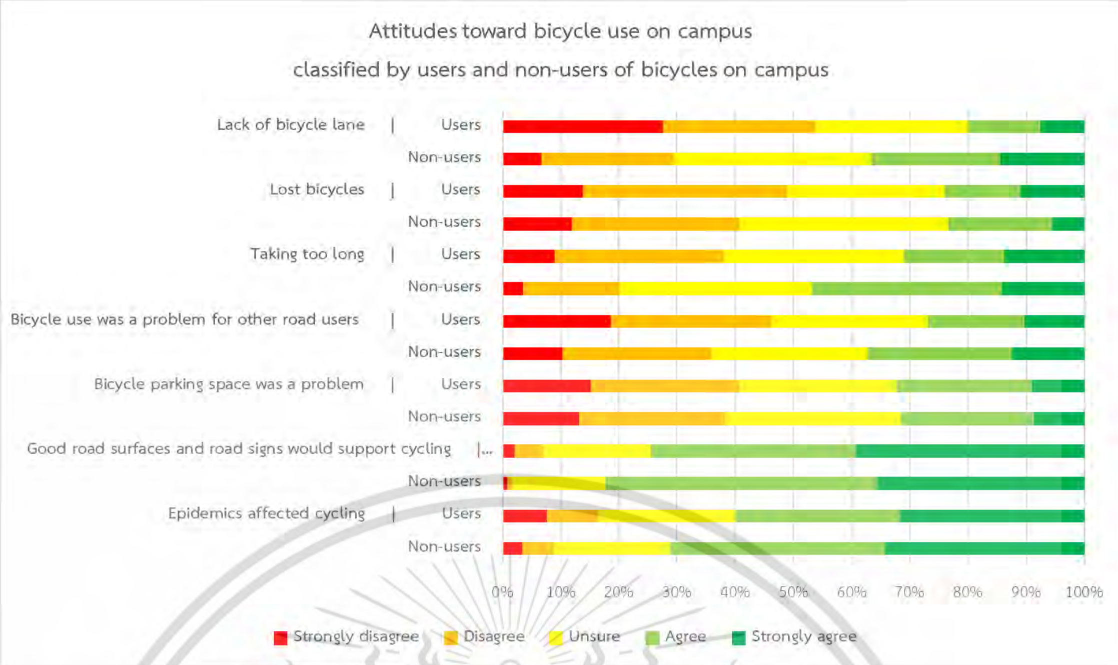

Figure 4.2 Attitudes toward Bicycle Use on Campus are Classified by Users and Non-users of Bicycles on Campus.

Further examination was conducted by categorizing respondents into two distinct groups: frequent bicycle users and non-users. Each group's attitudes were analyzed independently, as shown in Figure 4.2. Respondents who regularly use bicycles strongly agreed with the good road surfaces and road signs supporting cycling (39.3%) and the impact of epidemics on cycling (31.7%). Conversely, they expressed unsure about taking too long (31.0%) and bicycle parking space being a problem (26.9%). With regard to other attitudes, such as the lack of bicycle lanes and lost bicycles, most respondents who regularly use bicycles disagreed with these notions.

In contrast, most respondents who do not use bicycles on campus agreed that good road surfaces and road signs would support cycling (46.6%), along with the impact of epidemics on cycling (37.0%). However, uncertainty persists regarding the remaining five items, which include the lack of bicycle lanes, lost bicycles, taking too long, bicycle use affecting other road users, and bicycle parking spaces being problems. Most respondents are unsure about these aspects.

4.2 Binary Logistic Regression Analysis

To determine the factors that significantly affect bicycle use on campus, Binary Logistic Regression (BLR) was employed to analyze demographic, attitudinal, and Gross

Provincial Product (GPP) level variables. The results of this analysis are presented as follow.

4.2.1 Demographic Factor Analysis

Understanding the factors is essential before exploring the details of the Binary Logistic Regression model parameters for demographics. Table 4.5 provides an overview of the reference groups used for each independent variable in the binary logistic regression analysis. In the case of gender, males are the reference group. For residency, living on campus is the reference group. Owning a car is the reference group for car ownership. Bicycle is the reference group for mode of transportation from residence to campus. Age is treated as a continuous variable and does not have a reference group.

Table 4.6 provides a comprehensive overview of the coefficients, odds ratios, and significance levels associated with various variables, including gender, age, residency status, car ownership, and mode of transportation from residence to campus.

Table 4.5 Reference Group for Independent Variables

Independent Variable	Categories	Reference Group
Gender	0 = Male, 1 = Female	Male (0)
Resident	0 = Live on campus 1 = Live off campus	Live on campus (0)
Car ownership	0 = Owning a car 1 = Not owning a car	Owning a car (0)
Mode of transport from residence to campus	0 = Bicycle 1 = Motorcycle 2 = Car 3 = Public transport 4 = Walking 5 = Car or motorcycle sharing	Bicycle (0)

Table 4.6 Binary Logistic Regression Model Parameters for Demographics

Variable	Coefficient	Odds Ratio	Sig.
Constant	1.192	3.293	-
Gender	-0.235	0.791	-
Age	0.020	1.020	-
Resident	-0.695	0.499	**
Car ownership	0.693	2.000	-
Mode of transport from residence to campus:			
- Bicycle[a]	0	-	-
- Motorcycle	-3.935	0.020	***
- Car	-3.442	0.032	***
- Public transport	-4.059	0.017	***
- Walking	-5.729	0.003	***
- Car or motorcycle sharing	-2.337	0.097	***

* Significant at 0.05, ** Significant at 0.01, *** Significant at 0.001. [a] reference group

-2LogLikelihood = 714.019, Chi square = 225.117, Sig. = 0.000, Nagelkerke R square = 0.302

The demographic variables were found to significantly influence bicycle use on campus, with a significance level of 0.001. The chi-square value is 225.117, and the -2LogLikelihood is 714.019. Furthermore, the Nagelkerke R square value of 0.302 indicates that approximately 30.2% of the variation in bicycle use on campus can be explained by demographic factors. Additionally, residency has a significant impact on bicycle use, with a p-value of 0.01. The coefficient value of -0.695 and the corresponding odds ratio of 0.499 suggest that respondents who live off-campus are less likely to use bicycles compared to those who live on-campus, at a rate of 0.499 times.

In exploring the relationship between the mode of transportation from residence to campus and bicycle use on campus, we categorized transportation modes into six groups, including bicycle, motorcycle, car, public transport, walking, and car or motorcycle sharing, with bicycle as the reference group. This categorization aimed to streamline analysis, grouping all forms of public transport together due to their shared characteristic of terminating at specific locations or stops, necessitating further travel within the campus.

The mode of transportation from residence to campus revealed a significant impact on bicycle use, with a significance level of 0.001. When comparing to using a bicycle as the reference, respondents commuting via motorcycle displayed a coefficient of 3.935 and an odds ratio of 0.020. This implies that respondents who use a motorcycle are 0.020 times less likely to use bicycles on campus compared to those who ride a bicycle to campus. Similarly, respondents who drive a car to campus displayed a coefficient of -3.442 and an odds ratio of 0.032, indicating that those who use a car have a significantly lower chance (0.032 times) of using a bicycle compared to those who ride a bicycle to campus. In the case of respondents who use public transport, with a coefficient of 4.059 and an odds ratio of 0.017, this implies that public transport users have a significantly lower chance (0.017 times) of using a bicycle on campus compared to those who ride a bicycle from their residence. Respondents who walk to campus displayed a coefficient of -5.729 and an odds ratio of 0.003, indicating that those who walk to campus have a significantly lower chance (0.003 times) of using a bicycle compared to those who ride a bicycle to campus. Similarly, respondents who use vehicle sharing to campus displayed a coefficient of -2.337 and an odds ratio of 0.097, this implies that those who use vehicle sharing to campus have a significantly lower chance (0.097 times) of using a bicycle compared to those who ride a bicycle to campus.

There is no significant difference in bicycle use based on gender, with males serving as the reference group. Cycling is generally not seen as an acceptable or popular mode of transport among students, with only 2.9% of respondents using bicycles on campus. Both genders might feel equally discouraged from using bicycles due to factors such as safety concerns. In such environments, both male and female students are likely to prefer other modes of transport.

Age also showed no statistical significance in its relationship with bicycle use on campus. Most of the respondents are between 17-23 years old, which may result in insufficient variability to detect a significant effect. Students within this narrow age range likely have similar physical capabilities that influence their transportation choices, leading to the lack of a significant age effect.

Based on our examination of demographic variables using Binary Logistic Regression, we found several factors influencing bicycle usage on university campuses. Notably, residents on campus display a higher chance to use bicycles compared to those residing off-campus, suggesting that proximity to educational facilities plays a role in transportation mode choice. Moreover, the mode of transportation from residence to the campus was a significant factor in bicycle use on campus. Respondents who regularly commute by bicycle from their residence to campus are more inclined to use bicycles on campus. Conversely, those relying on motorcycles, cars, or public transportation for their commute are less likely to use bicycles on campus. Interestingly, our analysis did not find a significant correlation between car ownership and bicycle use on campus, whereas the mode of transportation from residence to campus proved to be significant. One possible explanation for this finding is that car owners may not exclusively rely on their vehicles for commuting to campus. This finding contrasts with previous studies, such as Hamad et al. (2021), which examined travel behavior on a university campus in the UAE, where cars are the primary mode of transportation due to higher income levels compared to Thailand.

To encourage bicycle use on campus, we advocate for measures such as restricting parking spaces for cars and motorcycles while designating areas for walking and cycling. This could entail enhancing infrastructure and amenities to facilitate safer and more convenient cycling commutes to and from campus, aligning with findings from prior research (Abasahl et al., 2018; Fernández-Heredia et al., 2014). Additionally, targeted awareness campaigns tailored to specific demographics, such as off-campus students and current public transportation users, may effectively promote bicycle usage.

4.2.2 Attitude Factors Analysis

In Table 4.7, we provide a brief overview of the Binary Logistic Regression model parameters for attitudes. This analysis aims to uncover the significant factors influencing bicycle use on campus based on respondents' attitudes.

Regarding attitudes, seven factors have been identified that could potentially influence bicycle use on campus. These factors include the lack of bicycle lanes, losing bicycles, perceptions of taking too long to ride, bicycle use impacting other road users, bicycle parking space being a problem, good road surfaces and road signs supporting cycling, and the impact of epidemics on cycling. Out of these, six were found to have a statistically significant effect on bicycle use on campus, which we explain further. These attitudes were measured across three levels: Disagree (including totally disagree), Not sure, and Agree (including totally agree).

Table 4.7 Binary Logistic Regression Model Parameters for Attitudes

Variable	Level	Coefficient	Odds Ratio	Sig.
Constant	-	0.526	1.692	-
Lack of bicycle lane	Disagree[a]	0	-	***
	Not sure	-0.774	0.461	***
	Agree	-1.297	0.273	***
Losing bicycles	Disagree[a]	0	-	-
	Not sure	-0.208	0.813	-
	Agree	-0.388	1.475	-
Taking too long	Disagree[a]	0	-	***
	Not sure	-0.521	0.594	*
	Agree	-1.042	0.353	***
Bicycle use was a problem for other road users	Disagree[a]	0	-	*
	Not sure	-0.249	0.779	-
	Agree	-0.821	0.440	**
Bicycle parking space was a problem	Disagree[a]	0	-	**
	Not sure	0.347	1.415	-
	Agree	0.960	2.612	**
Good road surfaces and road signs would support cycling	Disagree[a]	0	-	**
	Not sure	-0.909	0.403	*
	Agree	-1.190	0.304	**
Epidemics affected cycling	Disagree[a]	0	-	*
	Not sure	-0.358	0.699	-
	Agree	-0.686	0.504	*

* Significant at 0.05, ** Significant at 0.01, *** Significant at 0.001. [a] reference group

-2LogLikelihood = 849.568, Chi square = 35.570, Sig. = 0.000, Nagelkerke R square = 0.126

The lack of bicycle lanes significantly affects bicycle use on campus at a significance level of 0.001. Respondents who were unsure about this factor had a coefficient of -0.774, while those who agreed with it displayed a coefficient of -1.297. The odds ratio for those unsure was 0.461, and for those in agreement, it was 0.273. This suggests that respondents who were unsure or agreed with the lack of bicycle lanes are less likely to use bicycles on campus compared to those who disagreed. with odds ratios of 0.461 and 0.273, respectively.

Conversely, the "Losing bicycles" factor showed no significant effect on bicycle use on campus, indicating its lack of importance in determining willingness to use bicycles on campus.

The perception that "Taking too long" affects bicycle use significantly at a level of 0.001. Respondents who were unsure about this factor displayed a coefficient of -0.521, while those who agreed had a coefficient of -1.042. The odds ratio was 0.594 for respondents who were unsure, and for those who agreed, it was 0.353. This implies that respondents who were unsure or agreed that using a bicycle takes too long are less likely to use bicycles on campus compared to those who disagreed, with odds ratios of 0.594 and 0.353, respectively.

Similarly, the belief that "Bicycle use was a problem for other road users" had a significant impact on bicycle use on campus at a level of 0.01. Respondents who agreed with this perception displayed a coefficient of -0.821, with an odds ratio of 0.440, indicating a lower chance (0.440 times) of using a bicycle on campus compared to those who disagreed.

Furthermore, the attitude that "Bicycle parking space was a problem" affected bicycle use on campus significantly at a level of 0.01. Respondents who agreed with this perception had a coefficient of 0.960 and an odds ratio of 2.612, indicating a higher likelihood (2.612 times) of using a bicycle on campus compared to those who disagreed.

Moreover, the perception that "Good road surfaces and road signs would support cycling" had a significant impact on bicycle use on campus at a level of 0.01. Respondents who agreed with this statement displayed a coefficient of -1.190 and an odds ratio of 0.304, indicating a lower chance (0.304 times) of using a bicycle on campus compared to those who disagreed.

Lastly, the belief that "Epidemics affected bicycle use" was found to have a significant impact on bicycle use on campus at a significance level of 0.05. Respondents who agreed with this statement had a coefficient of -0.686 and an odds ratio of 0.504, implying a lower chance (0.504 times) of using a bicycle on campus compared to those who disagreed. The findings align with prior studies (Buehler & Pucher, 2021; Nahal & Mitra, 2018; P. Zhao et al., 2018).

Our analysis of attitudes revealed that the lack of bicycle lanes and long travel times significantly impact bicycle use on university campuses, which is consistent with previous research by (Jomnonkwao et al., 2016; Fraszczyk et al., 2019; Fern ́andez-Heredia et al., 2014). Respondents who agreed that absence of bicycle lanes and long travel times as barriers had fewer opportunities to use bicycles than those who disagreed. Moreover, the majority of non-bicycle users indicated that insufficient infrastructure and poor public relations served as significant barriers to cycling on campus. To foster greater bicycle use, we recommend universities invest in infrastructure improvements, such as expanding bicycle lanes and upgrading parking facilities. Universities can also discourage motor vehicle use through measures like parking fees or restricted parking spaces (Fernández-Heredia et al., 2014).

The "Losing bicycles" factor showed no significant effect on bicycle use on campus. Since most respondents are not frequently experienced cyclists, this concern would naturally have less impact on their decision to cycle. This contrasts with previous studies where losing bicycles was a concern in making decisions about cycling (Kelarestaghi et al., 2019).

Furthermore, to promote cycling and walking as more viable transportation options, it's essential to establish dedicated bicycle lanes or pedestrian-friendly pathways connecting key destinations like academic buildings, cafeterias, commercial areas, and public bus stops. It is worth noting that while the impact of the COVID-19 pandemic on campus bicycle use may have evolved since the survey period during the pandemic, improving bicycle infrastructure on campus remains beneficial in the current circumstances.

4.2.3 Gross Provincial Product (GPP) Level Analysis

To analyze the relationship between economic development around the campus area and bicycle usage, we also include Gross Provincial Product (GPP) per capita as a secondary data in our study. The GPP per capita of the province where each campus is located has been sourced from the Office of the National Economic and Social Development Council (NESDC, 2021). We then segmented the GPP per capita into quartiles to better understand the varying levels of economic development among provinces. Quartiles divide the data into four equal parts, allowing for a comparative analysis of economic differences (National Statistical Office of Thailand, 2022). This segmentation enables us to categorize provinces based on their economic status as follows: 1) less than 80,747 baht, 2) between 80,747 and 111,682 baht, 3) between 111,683 and 166,451 baht, and 4) between 166,452 and 831,734 baht. The province with the highest GPP per capita is Rayong, while the province with the lowest GPP per capita is Narathiwat. This categorization allows us to compare different levels of economic development among the provinces where campuses are located, helping to identify economic inequalities and potential areas for targeted actions.

Table 4.8 Gross Provincial Product Level of Each University Campus

GPP level (baht per Capita)	Bicycle Use on Campus	
	Yes	No
Less than 80,747 baht	4.3%	95.7%
80,747 – 111,682 baht	9.5%	90.5%
111,683 – 166,451 baht	12.6%	87.4%
166,452 – 831,734 baht	10%	90.0%

This section aims to explore the connection between economic development in the vicinity of university campuses and bicycle usage. We utilize the Gross Provincial Product (GPP) per capita as a stand-in for the local economic status. Table 4.8 presents the universities, their respective provinces, GPP levels, and bicycle use. Among the universities listed, two are situated in provinces with a GPP level below 80,747 baht per capita, while three campuses are in provinces with a GPP ranging from 80,747 to 111,682 baht per capita. Additionally, six campuses are located in provinces with a GPP between 111,683 and 166,451 baht per capita, and nine campuses are in provinces with a GPP ranging from 166,452 to 831,734 baht per capita.

The Binary Logistic Regression (BLR) analysis reveals no significant relationship between the GPP level and bicycle use on campus (Sig. = 1.000). The -2LogLikelihood is 930.139, and the Chi-square value is 0.000. The Nagelkerke R square of 0.013 suggests that approximately 1.3% of the variability in bicycle use on campus can be explained by the GPP level. This value is notably lower compared to both the demographic and attitude factors. However, when analyzing individual GPP levels, a significant relationship emerges. Campuses located in provinces with a GPP between 111,683 and 166,451 baht per capita display a 3.185 times higher likelihood of bicycle use on campus compared to those in provinces with a GPP below 80,747 baht per capita. Similarly, campuses situated in provinces with a GPP between 166,452 and 831,734 baht per capita demonstrate a 2.467 times higher likelihood of bicycle usage on campus compared to those in provinces with a GPP below 80,747 baht per capita.

In conclusion, while the overall GPP level does not influence bicycle use on campus significantly, analyzing individual GPP levels reveals a noteworthy relationship.

Table 4.9 Binary Logistic Regression Model Parameters for Gross Provincial Product

Variable	Coefficient	Odds Ratio	Sig.
Constant	-3.099	0.045	***
Gross Provincial Product Level (per Capita)			
- Less than 80,747 baht[a]	-	-	-
- 80,747 – 111,682 baht	0.844	2.326	-
- 111,683 – 166,451 baht	1.158	3.185	**
- 166,452 – 831,734 baht	0.903	2.467	*

* Significant at 0.05, ** Significant at 0.01, *** Significant at 0.001. [a] reference group

-2LogLikelihood = 930.139, Chi square = 0.000, Sig. = 1.000, Nagelkerke R square = 0.013

4.3 The Interview Results

This section presents the results of interviews conducted with university administrators across various campuses. The objective of these interviews was to inquire about university development policies related to transportation and commuting on campus. The process began with the initiation of contact with each university campus, where we formally requested permission to conduct interviews with the administrators. A Letter requesting permission to interview university administrators, along with the Interview Form for University Administrators (refer to Figure A.8 and Figure A.9), was sent to each institution. Subsequently, appointments were arranged individually with the administrators at each campus. Interviews were conducted either on-site or online, depending on the convenience of the respective campuses. The comprehensive details of these interviews, including key findings and insights collected from discussions with university administrators, are outlined in Table 4.9. The university administrator's name is included in Table A.3 in Appendix IV.

Asian Institute of Technology (AIT), Chiang Mai University (CMU), and University of Phayao (UP): These campuses prioritize sustainable transportation by promoting bicycles as a primary mode of commuting and restricting parking for cars and motorcycles to designated areas. Additionally, they encourage the use of electric shuttle buses and park-and-ride facilities to reduce carbon emissions and enhance campus mobility.

Chulalongkorn University (CU) and Thammasat University (TU): CU and TU are committed to promoting sustainable transport as part of their broader commitment to the Sustainable Development Goals (SDGs). They offer various commuting options, including electric shuttle buses, shared bikes, and e-bikes, and collaborate with bike-sharing providers to create bike stations on campus.

King Mongkut's Institute of Technology Ladkrabang (KMITL) and King Mongkut's University of Technology North Bangkok (KMUTNB): These campuses prioritize pedestrian-friendly environments and promote walking as a primary mode of commuting. They also provide covered walkways for convenience and safety, although they face challenges sharing roads between bicycles and motorized vehicles.

King Mongkut's University of Technology Thonburi (KMUTT) and Mahasarakham University (MSU): These campuses focus on creating walkable environments and supporting various modes of transportation, including bicycles and motorcycles. They emphasize the importance of a diverse transportation ecosystem to meet the needs of students and staff.

Loei Rajabhat University (LRU), Nakhon Ratchasima Rajabhat University (NRRU), and Prince of Songkla University (PSU): These campuses prioritize park-and-ride schemes and invest in covered walkways to enhance campus accessibility. They also collaborate with bike-sharing providers to promote sustainable commuting options and reduce reliance on single-occupancy vehicles.

Mae Fah Luang University (MFU) and Suranaree University of Technology (SUT): These campuses address the challenge of hilly terrain by promoting running and cycling activities for health. They collaborate with bike-sharing providers to support commuting on campus and prioritize using e-bikes and EV buses to reduce carbon emissions.

Mahidol University (MU) and Silpakorn University (SU): These campuses prioritize safety measures like bicycle lanes and trams to encourage sustainable commuting. They also promote the use of shuttle buses as the primary mode of transportation to reduce car usage on campus.

Srinakharinwirot University (SWU) and Ubon Ratchathani University (UBU): These campuses offer a variety of sustainable transportation modes, including electric buses and EV shuttles. They invest in covered walkways to enhance campus accessibility and prioritize Song Thaew as a primary mode of transportation.

Table 4.10 The Interview Results

No.	University	Overview of commuting on campus	Sustainable transport Policy	etc.
1	Asian Institute of Technology (AIT)	Bicycles, walking, park-and-ride	- Cars and motorcycles can only park in permission areas. - Promoting bicycles as a primary mode of transportation	-
2	Chiang Mai University (CMU)	Electric shuttle buses, covered walkways, motorcycle taxis, bicycles, motorcycles, park-and-ride	- Setting a route for the shuttle to cover the main area and connect to the public transport - Promoting running and cycling activities for health	- Hilly area, difficult to use bicycles on campus
3	Chulalongkorn University (CU)	Electric shuttle buses, walking, motorcycle taxis, bicycles, motorcycles, park-and-ride, shared bikes, e-bike	- Pushing all aspects of the SDGs together, including sustainable transport - Connect to the public transport.	-Most students commute to campus by public transport such as subway or sky train.
4	Khon Kaen University (KKU)	Motorcycles, cars, shuttle buses, walking, bicycles	- Promoting park-and-ride - Building a walkway connecting buildings	- Most students live off campus and use motorcycles as a primary mode of transport.

No.	University	Overview of commuting on campus	Sustainable transport Policy	etc.
5	King Mongkut's Institute of Technology Ladkrabang (KMITL)	Motorcycles, cars, walking, EV bus	- Connecting all areas with skywalks. - Connect to the public transport	- Bangkok campus - The campus is divided into 4 sections by road and rail.
6	King Mongkut's University of Technology North Bangkok (KMUTNB)	Walking, motorcycles, cars	- Connecting all buildings with cover walkways.	- Bangkok campus - Cycling on the same road with motorized vehicles
7	King Mongkut's University of Technology Thonburi (KMUTT)	Walking, Motorcycles, cars, bicycles	- Walkable campus	The campus is limited by area
8	Loei Rajabhat University (LRU)	Motorcycles, cars, walking, EV buses	- Promoting park-and-ride with enough parking space	- The campus is far from the city, and most students and staff live off campus.
9	Mae Fah Luang University (MFU)	Motorcycles, electric shuttle buses, walking, park-and-ride	- Shuttle bus service from off-campus dormitories to the campus - Cooperating with bike-sharing provider to support commuting on campus - Promoting running and cycling activities for health	- Hilly area, difficult to use bicycles on campus
10	Mahasarakham University (MSU)	Motorcycles, shuttle buses, walking, cars	- Promoting shuttle buses as a main transportation mode	- The campus is divided into 2 parts by road.
11	Mahidol University (MU)	Trams, walking, bicycles, cars, motorcycles,	- There are only two lanes on campus road for motorized vehicles. - Adding a course on bicycle safety to the curriculum.	- Salaya campus

No.	University	Overview of commuting on campus	Sustainable transport Policy	etc.
12	Nakhon Ratchasima Rajabhat University (NRRU)	Motorcycles, walking, cars, public buses	- Promoting park-and-ride with enough parking space - Building covered walkways around campus	-
13	Prince of Songkla University (PSU)	Motorcycles, cars, EV shuttle buses, walking	- Promoting park-and-ride with enough parking space - Building covered walkways around campus	
14	Silpakorn University (SU)	Shuttle buses, walking, bicycles, motorcycles, cars	Promoting shuttle bus as a primary mode of transportation	-
15	Srinakharinwirot University (SWU)	Walking, motorcycles, EV buses, shared bikes, cars	- Variety of sustainable transportation modes	- Onkharak campus (Nakhon Nayok)
16	Suranaree University of Technology (SUT)	Shuttle buses, motorcycles, walking, e-bikes, public buses, cars	- Promoting e-bikes and EV buses supported by campus.	- The campus is far from the city. Most commuters use cars and motorcycles.
17	Thammasat University (TU)	Shuttle bus, walking, motorcycle taxi, bicycle, motorcycle, and car	- Creating bike and e-bike stations by cooperating with bike-sharing providers - Promoting shuttle bus as a primary mode of transportation	- Rangsit campus
18	Ubon Ratchathani University (UBU)	Motorcycles, cars, shuttle buses (Song Thaew), walking, bicycles	- Promoting Song Thaew as a primary mode of transportation - Building covered walkways around campus	
19	University of Phayao (UP)	Shuttle buses, cars, motorcycles, walking	- Motorcycles are prohibited in the main area on campus	- Hilly area, difficult to use bicycles on campus

The policies and initiatives implemented by various universities in Thailand support sustainable commuting on campus by promoting environmentally friendly transportation options and reducing reliance on single-occupancy vehicles. Strategies such as prioritizing bicycles as a primary mode of commuting, restricting parking for cars and motorcycles, and investing in electric shuttle buses and park-and-ride facilities help reduce carbon emissions and enhance campus mobility. Additionally, measures like creating pedestrian-friendly environments, providing covered walkways, and collaborating with bike-sharing providers contribute to promoting walking, cycling, and other sustainable transportation modes. These policies align with broader objectives such as promoting health-conscious transportation choices, reducing traffic congestion, and supporting the Sustainable Development Goals (SDGs), ultimately fostering a more sustainable and eco-friendly campus environment.

Chapter 5

Conclusion and Recommendations

This chapter provides a comprehensive analysis of the factors influencing bicycle use on university campuses in Thailand. Through a nationwide study encompassing 19 campuses across different regions, we aimed to explore the demographics, attitudes, and bicycle use on campus. By employing Binary Logistic Regression (BLR) and examining survey data collected from students, faculty, and staff, we gained valuable insights into the complex dynamics shaping transportation choices on campus. This chapter synthesizes the key findings from our research and offers conclusions and recommendations to promote cycling as a sustainable mode of transportation within university communities.

5.1 Conclusions

As discussed in Chapter 3, we conclude by addressing three research questions.

5.1.1 Do demographics affect bicycle use on campus in Thailand?

Yes, demographics indeed affect bicycle use on campus in Thailand. Our research findings indicated that factors such as residency status, income level, and mode of transportation from residence to campus played significant roles in determining whether individuals chose to use bicycles as a mode of transportation on campus. For example, students with lower monthly incomes tended to rely more on motorcycles and public transport for commuting. In comparison, those with higher incomes may have preferred walking or using a car. Additionally, the distance between residence and campus and the convenience of travel were identified as critical demographic factors influencing bicycle use. Therefore, demographics did have a notable impact on bicycle usage patterns on Thai university campuses.

5.1.2 Do attitudes affect bicycle use on campus in Thailand?

Yes, attitudes significantly affect bicycle use on campus in Thailand. Our research findings suggested that attitudes towards cycling, such as perceptions of infrastructure adequacy and concerns about travel time, played a crucial role in determining whether respondents chose to ride bicycles on campus. For example, respondents who perceived good road surfaces and road signs as supportive of cycling were more likely to use bicycles on campus. Conversely, those who viewed cycling as taking too long or faced obstacles such as the lack of bicycle lanes had less chance of using bicycles.

Furthermore, obstacles such as the availability of bicycle lanes, parking facilities, and the campus layout could also influence bicycle usage patterns. Campuses with well-developed infrastructure for cycling, including designated bicycle lanes and secure parking facilities, were more likely to encourage bicycle use among students, faculty, and staff. On the other hand, campuses with inadequate cycling infrastructure or challenging terrain may deter individuals from choosing bicycles as a mode of transportation.

Therefore, addressing attitudes towards cycling and overcoming obstacles related to infrastructure and campus layout are essential steps in promoting bicycle use on Thai university campuses. By improving cycling infrastructure, raising awareness about the benefits of cycling, and addressing perceived obstacles, universities could encourage more sustainable transportation choices and create a campus environment conducive to cycling.

5.1.3 Does the Gross Provincial Product affect bicycle use on university campuses in Thailand?

Yes, the Gross Provincial Product (GPP) potentially affects bicycle use on university campuses in Thailand. Our research findings suggested that while GPP as a whole may not have shown statistical significance in influencing bicycle use on campuses, significant relationships could be displayed when considering individual GPP levels. Campuses located in provinces with higher GPP levels may have had better infrastructure, including cycling facilities and urban planning initiatives, which could have encouraged bicycle use among students, faculty, and staff.

Additionally, higher GPP levels may have indicated greater economic development and urbanization, which could have led to increased traffic congestion and pollution, making cycling a more attractive alternative for commuting on university campuses. Moreover, campuses located in provinces with higher GPP levels may have had more resources available for promoting sustainable transportation options, such as cycling infrastructure development, public awareness campaigns, and bike-sharing programs.

Therefore, while the direct impact of GPP on bicycle use may not have been immediately evident, it was likely to have indirectly influenced bicycle use patterns through its association with economic development, infrastructure quality, and urban planning initiatives in the surrounding areas of university campuses. Further research could explore the specific mechanisms through which GPP influences bicycle use on campuses and identify strategies to leverage economic development for promoting sustainable transportation options.

5.2 Recommendations

5.2.1 Recommendations for Promoting Bicycle Use on Campus

To promote bicycle use on university campuses, policymakers and stakeholders should prioritize the development of cycling infrastructure and initiatives aimed at enhancing the cycling experience. This includes investing in bicycle lanes, bike-sharing programs, and secure parking facilities. Additionally, efforts should be made to raise awareness about the benefits of cycling and address concerns related to safety and convenience. Collaborative efforts between universities, local governments, and transportation authorities are essential to create a supportive environment for cycling.

Based on observations and interviews, specific recommendations have been developed for each university campus to enhance and promote sustainable transportation options. For campuses that may not be entirely suitable for commuting by bicycle due to challenging terrain or infrastructure limitations, such as Chiang Mai University (CMU), Mae Fah Luang University (MFU), and Suranaree University of Technology (SUT), promoting recreational and leisure cycling can be a viable alternative. Designating specific areas and paths for recreational cycling can encourage students to use bicycles for fitness and enjoyment without the pressure of daily commuting.

The university campuses with robust cycling infrastructure, such as Chulalongkorn University (CU) and Thammasat University (TU), can focus on promoting bicycles as a primary mode of commuting. Cycling can be a more practical option for daily commutes by providing safe, dedicated bike lanes and integrating bike-sharing systems with public transport.

The university campuses suitable for park-and-ride schemes and integrating bicycle use with other transportation modes, including Loei Rajabhat University (LRU), Nakhon Ratchasima Rajabhat University (NRRU), Prince of Songkla University (PSU), and Mahasarakham University (MSU) can be effective by providing bike parking and facilitating seamless transitions between cycling and other transport options. These universities can promote a mixed-mode commuting strategy.

King Mongkut's University of Technology North Bangkok (KMUTNB) and King Mongkut's University of Technology Thonburi (KMUTT) should prioritize pedestrian-friendly environments and promote walking as a primary mode of commuting. Establishing dedicated bike lanes and conducting workshops on bicycle maintenance and safety can build a supportive cycling culture, making cycling a safer and more attractive option.

King Mongkut's Institute of Technology Ladkrabang (KMITL), Srinakharinwirot University (SWU), and Ubon Ratchathani University (UBU) should introduce electric bike programs to complement their existing electric bus services, making cycling more accessible and convenient. Connecting bike lanes with enhanced covered walkways will ensure all-weather accessibility and can encourage more students to cycle. Educating students on the benefits of sustainable transportation, including cycling, through workshops and seminars can further promote bicycle use and foster a culture of sustainability on campus.

Mahidol University (MU) and Silpakorn University (SU) can enhance bicycle use by expanding their network of bicycle lanes to ensure safe and convenient routes across the campus. Installing bike maintenance stations and implementing bicycle safety programs can further promote a safe and supportive cycling environment, making cycling a preferred mode of transport for students.

5.2.2 Limitations and Future Research

Our study provides valuable insights into bicycle use on Thai university campuses, it is important to acknowledge its limitations. Firstly, our research focuses exclusively on Thailand, and therefore, the findings may not be directly applicable to other regions or countries with different geographical and demographic characteristics. Additionally, our analysis was conducted at the national level, which may obscure localized variations in physical infrastructure and commuting behavior. Furthermore, our data collection method relied on an online survey distributed through social networks, which may introduce biases such as self-selection and response bias. Future studies could address these limitations by conducting more localized research and employing diverse data collection methods to ensure comprehensive coverage and representation.

Moreover, future research should explore localized factors influencing bicycle use and conduct in-depth studies on individual campuses to inform targeted interventions and policy recommendations. By adopting a holistic approach and leveraging the insights from our study, stakeholders can work towards creating more sustainable and cyclist-friendly university campuses.

References

Abasahl, F., Kelarestaghi, K. B., & Ermagun, A. (2018). Gender gap generators for bicycle mode choice in Baltimore college campuses. *Travel Behaviour and Society*, *11*(April 2017), 78–85. https://doi.org/10.1016/j.tbs.2018.01.002

Akar, G., Flynn, C., & Namgung, M. (2012). Travel choices and links to transportation demand management. Transportation Research Record, 2319, 77–85. https://doi.org/10.3141/2319-09

Ashley, J. (2012). Bike sharing as alternative transportation at Bridgewater State University. *Undergraduate Review, 8*(1), 16-25.

Attard, M., Cañas, C., & Maas, S. (2021). Determinants for walking and cycling to a university campus: insights from a participatory Active Travel workshop in Malta. *Transportation research procedia*, *52*, 501-508.

Audikana, A., Ravalet, E., Baranger, V., & Kaufmann, V. (2017). Implementing bikesharing systems in small cities: Evidence from the Swiss experience. *Transport Policy, 55*, 18-28.

Bachand-Marleau, J., Lee, B. H., & El-Geneidy, A. M. (2012). Better understanding of factors influencing likelihood of using shared bicycle systems and frequency of use. *Transportation Research Record*, *2314*(1), 66-71.

Bai, Y., Cao, M., Wang, R., Liu, Y., & Wang, S. (2022). How street greenery facilitates active travel for university students. Journal of Transport & Health, 26(August 2021), 101393. https://doi.org/10.1016/j.jth.2022.101393.

Bakker, S., Guillen, M. D., Nanthachatchavankul, P., Zuidgeest, M., Pardo, C., & Van Maarseveen, M. (2018). Hot or not? The role of cycling in ASEAN megacities: Case studies of Bangkok and Manila. *International journal of sustainable transportation*, *12*(6), 416-431.

Bakogiannis, E., Siti, M., Tsigdinos, S., Vassi, A., & Nikitas, A. (2019). Monitoring the first dockless bike sharing system in Greece: Understanding user perceptions, usage patterns and adoption barriers. Research in Transportation Business & Management, 33, https://doi.org/10.1016/j.rtbm.2020.100432.

Balsas, C. J. (2003). Sustainable transportation planning on college campuses. *Transport Policy*, *10*(1), 35-49.

Barbour, N., Zhang, Y., & Mannering, F. (2019). A statistical analysis of bike sharing usage and its potential as an auto-trip substitute. *Journal of Transport & Health, 12*, 253-262.

Bezerra, I., & Cunha, D. A. (2018). Evaluating the potential mobility patterns changing towards bicycle. June. http://www.fe.up.pt.

"Bike share fact sheet," Earth Policy Institute. (2015). [Online]. Available: http://www.earth-policy.org/images/uploads/press_room/Bicycle_Share.pdf. [Accessed Nov 30, 2019].

binti Zakaria, N. F. F., Mat Yazid, M. R. bin, & Fadilah Yaacob, N. F. (2021). Quantifying Carbon Emission from Campus Transportation: A Case Study in Universiti Kebangsaan Malaysia. IOP Conference Series: Materials Science and Engineering, 1101(1), 012011. https://doi.org/10.1088/1757-899x/1101/1/012011

Black, J., Mason, C., & Stanley, K. (1999). Travel demand management: Policy context and an application by the University of New South Wales (UNSW) as a large trip generator. *Transport Engineering in Australia*, *5*(2), 1-11.

Bond, A., & Steiner, R. L. (2006). Sustainable campus transportation through transit partnership and transportation demand management: A case study from the University of Florida. Berkeley Planning Journal, 19, 125–142. https://doi.org/10.5070/bp319111492

Boonpan, T, Budthimedhee, K, Phothisuwan, S. (2022). White Paper: Why don't Thai people walk and bike?. Thai Health Promotion Foundation and Thailand Walking and Cycling Institute. (in Thai).

Bridhikitti, A. (2022). Carbon footprint and cost analysis of a bicycle lane in a municipality. *Global Journal of Environmental Science & Management (GJESM)*, *8*(2).

Buehler, R., & Pucher, J. (2021). COVID-19 Impacts on Cycling, 2019–2020. Transport Reviews, 41(4), 393–400. https://doi.org/10.1080/01441647.2021.1914900

Campbell, A. A., Cherry, C. R., Ryerson, M. S., & Yang, X. (2016). Factors influencing the choice of shared bicycles and shared electric bikes in Beijing. *Transportation research part C: emerging technologies, 67*, 399-414.

Campbell, K. B., & Brakewood, C. (2017). Sharing riders: How bikesharing impacts bus ridership in New York City. *Transportation Research Part A: Policy and Practice, 100*, 264-282.

Caulfield, B., O'Mahony, M., Brazil, W., & Weldon, P. (2017). Examining usage patterns of a bike-sharing scheme in a medium sized city. *Transportation research part A: policy and practice*, *100*, 152-161.

Chaichannawatik, B., Boonyoo, T., Punurai, S., Leuanpech, P., & Lueangvilai, E. (2017). Travel Demand Forecasting on Bicycle Route under Expressway in Thailand. International Journal of Structural and Civil Engineering Research, 6(4), 293-297.

Chaikaew, N., Sukpromsun, B., & Wongchum, S. (2018). Bicycling Network Development for Tourism and Travel in Wiang Phayao, Thailand. *International Journal of Geoinformatics*.

Charmondusit, K., Wattanawinitchai, W., & Mahisavariya, B. (2022). Implementation of Sustainable Transportation at Mahidol University, Salaya Campus, Thailand. Journal of Sustainability Perspectives, 2, 301-307.

Chen, J., Zhou, D., Zhao, Y., Wu, B., & Wu, T. (2020). Life cycle carbon dioxide emissions of bike sharing in China: Production, operation, and recycling. Resources, conservation and recycling, 162, 105011.

Chevalier, A., Charlemagne, M., & Xu, L. (2019). Bicycle acceptance on campus: Influence of the built environment and shared bikes. *Transportation research part D: transport and environment*, *76*, 211-235.

Çolakkadıoğlu, D., Yücel, M., Kahveci, B., & Aydınol, Ö. (2018). Determination of noise pollution on university campuses: a case study at Çukurova University campus in Turkey. Environmental Monitoring and Assessment, 190(4). https://doi.org/10.1007/s10661-018-6568-8

Corcoran, J., Li, T., Rohde, D., Charles-Edwards, E., & Mateo-Babiano, D. (2014). Spatio-temporal patterns of a Public Bicycle Sharing Program: the effect of weather and calendar events. *Journal of Transport Geography, 41*, 292-305.

Davidson, R. P. (2002). The impact of bicycle patrol on a university of college campus setting.

da Silva, D. C., & da Silva, A. N. R. (2020). Sustainable modes and violence: Perceived safety and exposure to crimes on trips to and from a Brazilian university campus. Journal of Transport & Health, 16, 100817.

DeMaio, P. (2009). Bike-sharing: History, impacts, models of provision, and future. Journal of public transportation, 12(4), 41-56.

de Chardon, C. M., & Caruso, G. (2015). Estimating bike-share trips using station level data. *Transportation Research Part B: Methodological, 78*, 260-279.

Ding, H., Sze, N. N., Li, H., & Guo, Y. (2020). Roles of infrastructure and land use in bicycle crash exposure and frequency: A case study using Greater London bike sharing data. Accident Analysis and Prevention, 144(November 2019), 105652. https://doi.org/10.1016/j.aap.2020.105652

Efthymiou, D., Antoniou, C., & Waddell, P. (2013). Factors affecting the adoption of vehicle sharing systems by young drivers. *Transport policy, 29*, 64-73.

El-Assi, W., Mahmoud, M. S., & Habib, K. N. (2017). Effects of built environment and weather on bike sharing demand: a station level analysis of commercial bike sharing in Toronto. *Transportation, 44*(3), 589-613.

Eren, E., & Uz, V. E. (2020). A review on bike-sharing: The factors affecting bike-sharing demand. *Sustainable Cities and Society, 54*, 101882.

Faghih-Imani, A., & Eluru, N. (2015). Analysing bicycle-sharing system user destination choice preferences: Chicago's Divvy system. *Journal of transport geography, 44*, 53-64.

Faghih-Imani, A., & Eluru, N. (2016). Incorporating the impact of spatio-temporal interactions on bicycle sharing system demand: A case study of New York CitiBike system. *Journal of Transport Geography, 54*, 218-227.

Fernández-Heredia, Á., Jara-Díaz, S., & Monzón, A. (2016). Modelling bicycle use intention: the role of perceptions. Transportation, 43(1), 1–23. https://doi.org/10.1007/S11116-014-9559-9/TABLES/3

Fernández-Heredia, Á., Monzón, A., & Jara-Díaz, S. (2014). Understanding cyclists' perceptions, keys for a successful bicycle promotion. *Transportation Research Part A: Policy and Practice*, *63*, 1–11. https://doi.org/10.1016/J.TRA.2014.02.013

Fishman, E., Washington, S., & Haworth, N. (2014). Bike share's impact on car use: Evidence from the United States, Great Britain, and Australia. *Transportation Research Part D: Transport and Environment, 31*, 13-20.

Fishman, E., Washington, S., Haworth, N., & Watson, A. (2015). Factors influencing bike share membership: An analysis of Melbourne and Brisbane. *Transportation research part A: policy and practice, 71*, 17-30.

Fraszczyk, A., Weerawat, W., & Kirawanich, P. (2019). Commuters' Willingness to Shift to Metro: a Case Study of Salaya, Thailand. Urban Rail Transit, 5(4), 240–253. https://doi.org/10.1007/s40864-019-00113-3

Godavarthy, R. P., & Taleqani, A. R. (2017). Winter bikesharing in US: User willingness, and operator's challenges and best practices. *Sustainable cities and society, 30*, 254-262.

Goodman, A., & Cheshire, J. (2014). Inequalities in the London bicycle sharing system revisited: impacts of extending the scheme to poorer areas but then doubling prices. *Journal of Transport Geography*, *41*, 272-279.

Hamad, K., Htun, P. T. T., & Obaid, L. (2021). Characterization of travel behavior at a university campus: A case study of Sharjah University City, UAE. *Transportation Research Interdisciplinary Perspectives*, *12*(June), 100488. https://doi.org/10.1016/j.trip.2021.100488

Health Assembly 5/Main 1/Annex 1. (2012). *Fifth National Health Assembly Agenda 2.1 Supportive Systems and Structures for Walking and Cycling in Daily Living* https://en.nationalhealth.or.th/wp-content/uploads/2017/09/NHA-1-main1-Bicycle-final-Eng-18Nov2012.pdf.

Heinisch, O. (1965). Cochran, WG: sampling techniques, 2. Aufl. John wiley and sons, New York, london 1963. Preis s.

Hosmer Jr, D. W., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (Vol. 398). John Wiley & Sons.

Hyland, M., Hong, Z., de Farias Pinto, H. K. R., & Chen, Y. (2018). Hybrid cluster-regression approach to model bikeshare station usage. *Transportation Research Part A: Policy and Practice*, *115*, 71-89.

Ismail, A., & Zakaria, S. (2014). Development of bicycle shift models in Universiti Kebangsaan Malaysia campus. Jurnal Kejuruteraan, 26(2014), 69–76.

Israel, G. D. (1992). *Sampling the evidence of extension program impact*. Gainesville, FL: University of Florida Cooperative Extension Service, Institute of Food and Agriculture Sciences, EDIS.

Jiménez, P., Nogal, M., Caulfield, B., & Pilla, F. (2016). Perceptually important points of mobility patterns to characterise bike sharing systems: The Dublin case. *Journal of Transport Geography, 54*, 228-239.

Jomnonkwao, S., Sangphong, O., Khampirat, B., Siridhara, S., & Ratanavaraha, V. (2016). Public transport promotion policy on campus: evidence from Suranaree University in Thailand. Public Transport, 8(2), 185–203. https://doi.org/10.1007/s12469-016-0122-2

KANCHANASUT, W., & Preyawanit, N. (2018). Factors Affecting The Use of Bicycles and Placement Station: A Case Study of Bangkok Public Bicycle Service in Commercial Area (Doctoral dissertation, Silpakorn University).

Kaplan, S., Manca, F., Nielsen, T. A. S., & Prato, C. G. (2015). Intentions to use bike-sharing for holiday cycling: An application of the Theory of Planned Behavior. *Tourism Management, 47*, 34-46.

Kelarestaghi, K. B., Ermagun, A., & Heaslip, K. P. (2019). Cycling usage and frequency determinants in college campuses. *Cities*, *90*, 216-228.

Kellstedt, D., Spengler, J. O., Bradley, K., & Maddock, J. E. (2019). Evaluation of free-floating bike-share on a university campus using a multi-method approach. *Preventive medicine reports, 16*, 100981.

Khongouan, W., & Sakulrattanakulchai, S. (2014). Guidelines to promote cycling on university campus: case study of Kasetsart University, Mahidol University and Thammasat University. *Journal Of Architectural/Planning Research and Studies (JARS), 11*(1), 59-72.

Kim, D., Shin, H., Im, H., & Park, J. (2012). Factors influencing travel behaviors in bikesharing. Transportation Research Board 91st Annual Meeting,

Kim, K. (2018). Investigation on the effects of weather and calendar events on bike-sharing according to the trip patterns of bike rentals of stations. *Journal of transport geography, 66*, 309-320.

Kish, L. (1965). Survey sampling. new york: John wesley & sons. *Am Polit Sci Rev*, *59*(4), 1025.

Kocianova, A., & Slebodnik, L. (2021). Sustainability obstacles of free bike-sharing model. In IOP Conference Series: Materials Science and Engineering (Vol. 1015, No. 1, p. 012104). IOP Publishing.

Leopairojna, S. K., Lambregts, B., & Denpaiboon, C. (2017). Promoting Cycling with Help of Participatory Mapping on Samui Island, Thailand. *Spaces & Flows: An International Journal of Urban & Extra Urban Studies*, *8*(3).

Leopairojna, S. K., & Trakulvech, S. (2008). APPLICATION OF PUBLIC-USE BIKE SYSTEM IN KASETSART UNIVERSITY, BANGKHEN CAMPUS: Research and reality. *Journal of society for transportation and traffic studies (JSTS) Vol, 2*.

Li, X., Zhang, Y., Sun, L., & Liu, Q. (2018). Free-floating bike sharing in jiangsu: Users' behaviors and influencing factors. Energies, 11(7), 1–18. https://doi.org/10.3390/en11071664

Limanond, T., Butsingkorn, T., & Chermkhunthod, C. (2011). Travel behavior of university students who live on campus: A case study of a rural university in Asia. *Transport policy*, *18*(1), 163-171.

Lord-Farmer, C. K., Riggs, W. W., & Greve, A. (2017). Transportation policy for campus climate action planning: Process and policy implications. Focus, 13(1). http://digitalcommons.calpoly.edu/focus/vol13/iss1/19

Lowe, W. U. A., & Piantanakulchai, M. (2023). Investigation of behavioral influences of carpool adoption for educational trips – A case study of Thammasat University, Thailand. Case Studies on Transport Policy, 12(January), 100970. https://doi.org/10.1016/j.cstp.2023.100970

Lu, M., An, K., Hsu, S. C., & Zhu, R. (2019). Considering user behavior in free-floating bike sharing system design: A data-informed spatial agent-based model. Sustainable cities and society, 49, 101567.

Ma, L., Zhang, X., Ding, X., & Wang, G. (2018). Bike sharing and users' subjective well-being: An empirical study in China. Transportation research part A: policy and practice, 118, 14-24.

Ma, X., Ji, Y., Jin, Y., Wang, J., & He, M. (2018a). Modeling the factors influencing the activity spaces of bikeshare around metro stations: A spatial regression model. *Sustainability, 10*(11), 3949.

Ma, Y., Lan, J., Thornton, T., Mangalagiu, D., & Zhu, D. (2018b). Challenges of collaborative governance in the sharing economy: The case of free-floating bike sharing in Shanghai. Journal of cleaner production, 197, 356-365.

Manaugh, K., Boisjoly, G., & El-Geneidy, A. (2017). Overcoming barriers to cycling: understanding frequency of cycling in a University setting and the factors preventing commuters from cycling on a regular basis. *Transportation, 44*(4), 871-884.

Martin, E., Shaheen, S., & Cohen, A. (2013). Public Bikesharing in North America: Early Operator and User Understanding.

Mateo-Babiano, I. (2015). Public bicycle sharing in Asian cities. Journal of the Eastern Asia Society for Transportation Studies, 11, 60-74.

Mattson, J., & Godavarthy, R. (2017). Bike share in Fargo, North Dakota: Keys to success and factors affecting ridership. *Sustainable cities and society, 34*, 174-182.

Meesit, R., Puntoomjinda, S., Chaturabong, P., Sontikul, S., & Arunnapa, S. (2023). Factors affecting travel behaviour change towards active mobility: a case study in a thai university. *Sustainability*, *15*(14), 11393.

Midgley, P. (2009). The role of smart bike-sharing systems in urban mobility. Journeys, 2(1), 23-31.

Mitchell, J. C. (1969). The concept and use of social networks. *Social networks in urban situations*.

MOHD-NOR MFI, M., RAZAK, I. U., AI, C., & NAG ABDULLAH, M. T. (2010). The University Development Planning From The Aspects Of Accessibility And Circulation: A Comparative Study Of Four Malaysian Universities.

Murphy, E., & Usher, J. (2011). An analysis of the role of bicycle-sharing in a European city. *Journal of Public Transportation*, *12*(4), 41-56.

Nahal, T., & Mitra, R. (2018). Facilitators and barriers to winter cycling: Case study of a downtown university in Toronto, Canada. Journal of Transport and Health, 10(May), 262–271. https://doi.org/10.1016/j.jth.2018.05.012

Narupiti, S., Tippichai, A., Nanthachatchavankul, P., Sutjaritthanarak, M., & Bakker, S. (2014). Thailand Stocktaking report on Sustainable Transport and Climate Change. Data, policy, monitoring.

National Economic and Social Development Council (NESDC). (2021). Gross Regional and Provincial Product Chain Volume Measures 2021 Edition. https://www.nesdc.go.th/main.php?filename=gross_regional

National Health Commission Office. (2012). Health Assembly Resolution: Supportive Systems and Structures for Walking and Cycling in Daily Living https://en.nationalhealth.or.th/wp-content/uploads/2017/09/NHA2013-1-resolution1-Bicycle-Final-Eng-edited.pdf.

National Statistical Office of Thailand. (2022). THE INFORMATION COMMUNICATION AND TECHNOLOGIES USING OF POPULATION AND HOUSEHOLD IN THAILAND BY QUARTER. https://ittdashboard.nso.go.th/preview2en.php?id_project=138.

Nikitas, A. (2018). Understanding bike-sharing acceptability and expected usage patterns in the context of a small city novel to the concept: A story of 'Greek Drama'. *Transportation research part F: traffic psychology and behaviour, 56*, 306-321.

Noland, R. B., Smart, M. J., & Guo, Z. (2016). Bikeshare trip generation in New York city. *Transportation Research Part A: Policy and Practice, 94*, 164-181.

Nosal, T., & Miranda-Moreno, L. F. (2014). The effect of weather on the use of North American bicycle facilities: A multi-city analysis using automatic counts. *Transportation research part A: policy and practice, 66*, 213-225.

Otero, I., Nieuwenhuijsen, M. J., & Rojas-Rueda, D. (2018). Health impacts of bike sharing systems in Europe. Environment international, 115, 387-394.

Pakdeewanich, C., Tiyarattanachai, R., & Anantavrasilp, I. (2020a, April). Locally designed campus smart bike sharing system: lessons learned and design optimization for Thailand. In 2020 IEEE 7th International Conference on Industrial Engineering and Applications (ICIEA) (pp. 721-725). IEEE.

Pakdeewanich, C., Tiyarattanachai, R., & Anantavrasilp, I. (2020b, June). Development of locally designed smart bike-sharing system on Thai campus: Lessons learnt of a pilot-scale study. The 6th International Conference on Engineering, Applied Sciences and Technology (ICEAST 2020). 30-35.

Parkes, S. D., Marsden, G., Shaheen, S. A., & Cohen, A. P. (2013). Understanding the diffusion of public bikesharing systems: evidence from Europe and North America. Journal of transport geography, 31, 94-103.

Pettinga, A., Rouwette, A., Braakman, B., Pardo, C., Kuijper, D., de Jong, H., ... & Godefrooij, T. (2009). Cycling-inclusive policy development: A handbook.

Pinthong, J., Limsuwan, K., & Stitmannaithum, B. (2018). Green transportation system to promote sustainable lifestyle in Chulalongkorn University. In *E3S Web of Conferences* (Vol. 48, p. 07001). EDP Sciences.

Pooley, C. G., Horton, D., Scheldeman, G., Mullen, C., Jones, T., Tight, M., Jopson, A., & Chisholm, A. (2013). Policies for promoting walking and cycling in England: A view from the street. Transport Policy, 27, 66–72. https://doi.org/10.1016/j.tranpol.2013.01.003=

Pribyl, O., Opasanon, S., & Horák, T. (2018). Student perception of smart campus: A case study of Czech Republic and Thailand. In 2018 Smart City Symposium Prague (SCSP) (pp. 1-7). IEEE.

Promjittiphong, C., Junead, J., & Hanpattanakit, P. (2017). Sport Tourism through Low Carbon Initiatives Experiences from Benja Burapha Cycling Rally, Sa Kaeo, THAILAND. *CHEMICAL ENGINEERING*, *61*.

Raha, U. (2015). Analysis of the characteristics of bike-sharing program in Bangkok. Dep. Civil Engineering, Ramkhamhaeng University.

Rao NSN. (1985). Elements of Health Statsitics, First edition, R. Publication, Varanasi, India.

Ratanaburi, N., Alade, T., & Saçli, F. (2021). Effects of stakeholder participation on the quality of bicycle infrastructure. A case of Rattanakosin bicycle lane, Bangkok, Thailand. *Case studies on transport policy*, *9*(2), 637-650.

Rattanapong, C., & Nilavajara, N., (2003). Study on Rules, Regulations and Laws Related to Bicycle Uses in Thailand. https://kamanakom.files.wordpress.com/2013/07/2546.pdf.

Raux, C., Zoubir, A., & Geyik, M. (2017). Who are bike sharing schemes members and do they travel differently? The case of Lyon’s “Velo’v” scheme. Transportation research part A: policy and practice, 106, 350-363.

Ribeiro, P., Fonseca, F., & Meireles, T. (2020). Sustainable mobility patterns to university campuses: Evaluation and constraints. Case Studies on Transport Policy, 8(2), 639–647. https://doi.org/10.1016/J.CSTP.2020.02.005.

Ricci, M. (2015). Bike sharing: A review of evidence on impacts and processes of implementation and operation. *Research in Transportation Business & Management*, *15*, 28-38.

Saksith CHALERMPONG;, & Nitipol AMPANSIRIRAT. (2011). Modeling Chulalongkorn University Campus Parking Demand. Journal of the Eastern Asia Society for Transportation Studies, 9, 567–574.

Sangveraphunsiri, T., Fukushige, T., Jongwiriyanurak, N., Tanaksaranond, G., & Jarumaneeroj, P. (2022). Impacts of the COVID-19 pandemic on the spatio-temporal characteristics of a bicycle-sharing system: A case study of Pun Pun, Bangkok, Thailand. PloS one, 17(8), e0272537.

Santos, G., Maoh, H., Potoglou, D., & von Brunn, T. (2013). Factors influencing modal split of commuting journeys in medium-size European cities. *Journal of Transport Geography, 30*, 127-137.

Saul, B., Niazi, O., Sutker, T., & Larry, L. (2018). Bicycle Friendliness on The University of Illinois's Campus. ACE 471/FALL/2017.

Sengers, F. (2016). Transforming transport in Thailand. *Experimenting for Transitions to Sustainable Urban Mobility. Uitgeverij BOXPress,'s-Hertogenbosch. doi*, *10*.

Shaheen, S. A., Guzman, S., & Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia: past, present, and future. *Transportation research record*, *2143*(1), 159-167.

Shaheen, S., & Guzman, S. (2011). Worldwide bikesharing. *Access Magazine*, *1*(39), 22-27.

Shen, Y., Zhang, X., & Zhao, J. (2018). Understanding the usage of dockless bike sharing in Singapore. International Journal of Sustainable Transportation, 12(9), 686-700.

Shi, J.-g., Si, H., Wu, G., Su, Y., & Lan, J. (2018). Critical factors to achieve dockless bike-sharing sustainability in China: A stakeholder-oriented network perspective. *Sustainability, 10*(6), 2090.

Singh, A. S., & Masuku, M. B. (2014). Sampling techniques & determination of sample size in applied statistics research: An overview. *International Journal of economics, commerce and management*, *2*(11), 1-22.

Singhirunnusorn, W., & Sahachaisaeree, N. (2013). Campus Bicycle Route Design and Changes in Students' Traveling Behavior.

Singsaktrakul, P., & Muneenam, U. (2019). Cycling Tourism Situation in Songkhla Special Economic Zone. *Veridian E-Journal, Silpakorn University (Humanities, Social Sciences and arts)*, *12*(2), 890-909.

Sisiopikou, V. (2018). Travel Patterns and Preferences of Urban University Students. Athens Journal of Technology & Engineering, 5(1), 19–32. https://doi.org/10.30958/ajte.5-1-2

Snodin, N. (2019). Mobility experiences of international students in Thai higher education. International Journal of Educational Management, 33(7), 1653-1669.

Srinuan, C. (2007). *Bicycle Use of Residentes and Tourists in Songkhla Municipal Area: Suitable Bicycle Routes and Patterns* (Doctoral dissertation, Mahidol University).

Sun, F., Chen, P., & Jiao, J. (2018). Promoting public bike-sharing: A lesson from the unsuccessful Pronto system. *Transportation Research Part D: Transport and Environment, 63*, 533-547.

Taekratok, T., & Luansak, S. (2018). CO2 emission estimation from transportation usage and cyclingconsideration in the context of green campus, Naresuan University, Thailand. *International Journal of Agricultural Sciences*, *2*(1), 1-9.

Tang, Y., Pan, H., & Fei, Y. (2017). Research on users' frequency of ride in Shanghai Minhang bike-sharing system. *Transportation research procedia, 25*, 4979-4987.

Tran, T. D., Ovtracht, N., & D'arcier, B. F. (2015). Modeling bike sharing system using built environment factors. *Procedia Cirp, 30*, 293-298.

THE. (2020). Times Higher Education Impact Rankings 2020. https://www.timeshighereducation.com/impactrankings#!/page/0/length/25/loca locat/TH/sort_by/rank/sort_order/asc/cols/undefined.

Thiwaree, S. (2013). Open up the Bike Route around Suvarnabhumi Airport. Airport Authority of Thailand.

Tiwari, A., & Aljoufie, M. (2021). Modeling spatial distribution and determinant of PM2.5 at micro-level using geographically weighted regression (GWR) to inform sustainable mobility policies in campus based on evidence from King Abdulaziz university, Jeddah, Saudi Arabia. Sustainability (Switzerland), 13(21). https://doi.org/10.3390/su132112043

Toor, W., and Havlick, S. (2004). Transportation and sustainable campus communities: Issues, examples, solutions, Island Press, Washington, DC.

Ungsuchaval, T., Kantamaturapoj, K., Leelahavarong, P., Yothasamut, J., Ponragdee, K., Prawjaeng, J., & Hadnorntun, P. (2022). Advocating evidence-informed policy in Thailand: The case of the development of bicycle commuting policy framework. *Case Studies on Transport Policy*, *10*(3), 1727-1734.

United Nations. (2020). *Sustainable Development Goals: Guidelines for the Use of the SDG Logo Including the Colour Wheel, and 17 Icons* (Issued May 2020).

United Nations. (2021). *Our Work on the Sustainable Development Goals in Thailand*. https://thailand.un.org/en/sdgs.

Vogel, M., Hamon, R., Lozenguez, G., Merchez, L., Abry, P., Barnier, J., Borgnat, P., Flandrin, P., Mallon, I., & Robardet, C. (2014). From bicycle sharing system movements to users: a typology of Vélo'v cyclists in Lyon based on large-scale behavioural dataset. *Journal of Transport Geography, 41*, 280-291.

Wang, K., & Akar, G. (2019). Gender gap generators for bike share ridership: evidence from Citi bike system in New York City. *Journal of transport geography, 76*, 1-9.

Wang, M., & Zhou, X. (2017). Bike-sharing systems and congestion: Evidence from US cities. *Journal of transport geography, 65*, 147-154.

Wang, X., Wang, Y., & Hu, C. (2020). About the Optimized Design of the Parking Space on the Campus of a College. American Journal of Computational Mathematics, 10(02), 221–229. https://doi.org/10.4236/ajcm.2020.102011.

Woodcock, J., Tainio, M., Cheshire, J., O'Brien, O., & Goodman, A. (2014). Health effects of the London bicycle sharing system: health impact modelling study. *Bmj*, *348*.

Yamane, T. (1967). Statistics: an introductory analysis, 2nd edition, Harper and Row, New York.

Yang, T., Li, Y., & Zhou, S. (2019). System dynamics modeling of dockless bike-sharing program operations: A case study of mobike in Beijing, China. Sustainability, 11(6), 1601.

Younes, H., Nasri, A., Baiocchi, G., & Zhang, L. (2019). How transit service closures influence bikesharing demand; lessons learned from SafeTrack project in Washington, DC metropolitan area. *Journal of Transport Geography, 76*, 83-92.

Zhang, S., & Boamah, E. F. (2021). Managing campus parking demand through course scheduling-an approach to campus sustainability. International Journal of Sustainability in Higher Education, 22(4), 909–930. https://doi.org/10.1108/IJSHE-11-2020-0461

Zhang, Y., Thomas, T., Brussel, M., & Van Maarseveen, M. (2017). Exploring the impact of built environment factors on the use of public bikes at bike stations: case study in Zhongshan, China. *Journal of transport geography, 58*, 59-70.

Zhao, J., Deng, W., & Song, Y. (2014). Ridership and effectiveness of bikesharing: The effects of urban features and system characteristics on daily use and turnover rate of public bikes in China. *Transport Policy, 35*, 253-264.

Zhao, P., Li, S., Li, P., Liu, J., & Long, K. (2018). How does air pollution influence cycling behaviour? Evidence from Beijing. Transportation Research Part D: Transport and Environment, 63(July), 826–838. https://doi.org/10.1016/j.trd.2018.07.015

Zhao, Y., Lin, Q., Ke, S., & Yu, Y. (2020). Impact of land use on bicycle usage: A big data-based spatial approach to inform transport planning. Journal of Transport and Land Use, 13(1), 299–316. https://doi.org/10.5198/jtlu.2020.1499.

Zhou, X. (2015). Understanding spatiotemporal patterns of biking behavior by analyzing massive bike sharing data in Chicago. *PloS one*, *10*(10), e0137922.

Appendix I

Domain Expert and IOC Results

Domain Expert and IOC Results

The five domain experts, as shown in Table A.1, validate the questionnaire using the Index of Item-Objective Congruence (IOC) method. This method aims to evaluate content during the factors design stage. An IOC value greater than 0.6 is considered indicative of good content validity (Turner & Carlson, 2003).

Table A.1 The List of Domain Experts

No.	Name	Position, Organization
1.	Dr. Athakorn Kengpol	Professor, Department of Industrial Engineering, Faculty of Engineering, King Mongkut's University of Technology North Bangkok, Thailand
2.	Dr. Nuttawut Rojniruttikul	Associate Professor, Business School, King Mongkut's Institute of Technology Ladkrabang, Thailand
3.	Dr. Chodchanok Attaphong	Assistant Professor, Department of Civil Engineering, School of Engineering, King Mongkut's Institute of Technology Ladkrabang, Thailand
4.	Dr. Kankanit Kamolkittiwong	Head of Logistics Management Department, Faculty of Business Administration, Rangsit University, Thailand
5.	Dr. Weerawit Lertthaitrakul	Assistant Professor, School of Logistics and Supply Chain, Sripatum University, Thailand

Table A.2 The IOC Results

Question(s)	IOC	Comment
Demographics		
Gender	1	-
Age	0.8	-
Role	0.8	-
University affiliation	1	-
Monthly income	0.6	Income ranges may vary between students, staff, and faculty.
Residence	1	-
Car ownership	1	-
Motorcycle ownership	1	-
Modes of transportation between residence and campus	1	-
Modes of transportation on campus		
Car	1	-
Motorcycle	1	-
Bicycle	1	-
Public transport	1	-
Walk	1	-
Car/Motorcycle sharing	1	-
Bike-sharing program		
Have you ever used a bike-sharing system?	0.6	It will say "Never" if it is unavailable at the campus.
Frequency of using bike-sharing program	0.6	Once per week may not be appropriate.
The purpose of using the bike-sharing program	1	
Attitudes toward bicycle use on campus		
Lack of bicycle lane	1	-
Losing bicycles	1	-
Taking too long	1	-
Bicycle use was a problem for other road users	1	-
Good road surfaces and road signs would support cycling	1	-
Epidemics affected cycling	1	-

Appendix II

The Questionnaire

The Questionnaire

Considering that respondents are Thai, we decided to use the Thai language for the questionnaire, as depicted in Figures A.1 to A.5.

แบบสอบถามเลขที่...............

สถานที่...............

แบบสอบถามประกอบการศึกษาวิจัย

“เรื่อง การศึกษาปัจจัยที่มีผลกระทบต่อการพัฒนาระบบจักรยานสาธารณะของ มหาวิทยาลัยในประเทศไทย

กรณีศึกษา มหาวิทยาลัยในประเทศไทยที่อยู่ใน THE Impact Ranking 2020”

แบบสอบถามนี้เป็นแบบสอบถามเพื่อการรวบรวมข้อมูลประกอบวิทยานิพนธ์ปริญญาวิศวกรรมศาสตร์ หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาการจัดการโลจิสติกส์และซัพพลายเชน สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง โดยมีวัตถุประสงค์เพื่อศึกษา ปัจจัยที่มีผลกระทบต่อการพัฒนาระบบจักรยานสาธารณะของมหาวิทยาลัยในประเทศไทย และการวิจัยครั้งนี้ ได้รับทุนสนับสนุนจากคณะวิศวกรรมศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง

ดังนั้นผู้วิจัยจึงใคร่ขอความร่วมมือในการตอบแบบสอบถามตามความเป็นจริง ข้อมูลที่ท่านตอบจะไม่ส่งผลกระทบใด ๆ เนื่องจากข้อมูลที่นำเสนอในการวิจัยเป็นการนำเสนอแบบภาพรวม มิใช่นำเสนอเป็นรายบุคคล และจะใช้ข้อมูลเพื่อการวิจัยเท่านั้น

แบบสอบถามแบ่งออกเป็น 4 ส่วน คือ

ส่วนที่ 1 แบบสอบถามเกี่ยวกับข้อมูลส่วนบุคคลของผู้ตอบแบบสอบถาม

ส่วนที่ 2 พฤติกรรมการเดินทางภายในมหาวิทยาลัย

ส่วนที่ 3 ทัศนคติที่มีต่อการใช้จักรยานในมหาวิทยาลัย

ส่วนที่ 4 ข้อเสนอแนะ

ขอความกรุณาตอบแบบสอบถามตามความเป็นจริงให้ครบทุกข้อ เนื่องจากทุกคำตอบของท่านมีผลกับความถูกต้องต่อการวิเคราะห์ข้อมูล

ขอขอบพระคุณในความร่วมมือ

ชิตษณุ ภักดีวานิช

นักศึกษาระดับปริญญาเอก

อีเมล 60610003@kmitl.ac.th

Figure A.1 The Questionnaire's front page

1

<u>ส่วนที่ 1</u> แบบสอบถามเกี่ยวกับข้อมูลส่วนบุคคลของผู้ตอบแบบสอบถาม

คำชี้แจง : โปรดทำเครื่องหมาย ✓ ลงในช่องที่ตรงกับความเห็นของท่านมากที่สุดเพียงข้อเดียว

1. เพศ

☐ ชาย ☐ หญิง

2. อายุ......................ปี

3. มหาวิทยาลัยที่ท่านสังกัดในปัจจุบัน (อ้างอิงรายชื่อมหาวิทยาลัยจาก THE Impact Rankings 2020 ของ Times Higher Education)

☐ จุฬาลงกรณมหาวิทยาลัย (CU) ☐ มหาวิทยาลัยขอนแก่น (KKU)
☐ มหาวิทยาลัยมหิดล (MU) ☐ สถาบันเทคโนโลยีแห่งเอเชีย (AIT)
☐ มหาวิทยาลัยเชียงใหม่ (CMU) ☐ มหาวิทยาลัยศรีนครินทรวิโรฒ (SWU)
☐ มหาวิทยาลัยแม่ฟ้าหลวง (MFU) ☐ มหาวิทยาลัยมหาสารคาม (MSU)
☐ มหาวิทยาลัยพะเยา (UP) ☐ มหาวิทยาลัยสงขลานครินทร์ (PSU)
☐ มหาวิทยาลัยเทคโนโลยีสุรนารี (SUT) ☐ มหาวิทยาลัยธรรมศาสตร์ (TU)
☐ มหาวิทยาลัยอุบลราชธานี (UBU) ☐ มหาวิทยาลัยราชภัฏเลย (LRU)
☐ มหาวิทยาลัยราชภัฏนครราชสีมา (NRRU) ☐ มหาวิทยาลัยศิลปากร (SU)
☐ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี (KMUTT)
☐ มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าพระนครเหนือ (KMUTNB)
☐ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง (KMITL)

4. สถานะของท่านในมหาวิทยาลัยที่ท่านสังกัด

☐ นักศึกษาระดับปริญญาตรี ☐ นักศึกษาระดับบัณฑิตศึกษา (โท-เอก)
☐ เจ้าหน้าที่สายสนับสนุน ☐ คณาจารย์
☐ อื่น ๆ (โปรดระบุ)..........................

Figure A.2 The Demographics Question Part 1/2

2

5. รายได้เฉลี่ยต่อเดือน (สำหรับนักศึกษาปริญญาตรีเท่านั้น)

☐ ต่ำกว่า 2,000 บาท
☐ ตั้งแต่ 2,001 – 4,000 บาท
☐ ตั้งแต่ 4,001 – 6,000 บาท
☐ ตั้งแต่ 6,001 – 8,000 บาท
☐ ตั้งแต่ 8,001 – 10,000 บาท
☐ ตั้งแต่ 10,001 – 12,000 บาท
☐ ตั้งแต่ 12,001 – 14,000 บาท
☐ มากกว่า 14,000 บาทขึ้นไป

6. รายได้เฉลี่ยต่อเดือน (สำหรับนักศึกษาระดับบัณฑิตศึกษา เจ้าหน้าที่สายสนับสนุน และคณาจารย์เท่านั้น)

☐ ต่ำกว่า 10,001 บาท
☐ ตั้งแต่ 10,001 – 20,000 บาท
☐ ตั้งแต่ 20,001 – 30,000 บาท
☐ ตั้งแต่ 30,001 – 40,000 บาท
☐ ตั้งแต่ 40,001 บาทขึ้นไป

7. ที่พักอาศัยในปัจจุบัน

☐ ที่พักอาศัยภายในมหาวิทยาลัย
☐ ที่พักอาศัยภายนอกมหาวิทยาลัย

8. ท่านมีรถยนต์ส่วนบุคคลหรือไม่

☐ มี
☐ ไม่มี

9. ท่านมีรถจักรยานยนต์ส่วนบุคคลหรือไม่

☐ มี
☐ ไม่มี

10. โดยปกติท่านเดินทางไปมหาวิทยาลัยด้วยวิธีการใด

☐ รถยนต์ส่วนบุคคล
☐ รถจักรยานยนต์ส่วนบุคคล
☐ รถจักรยาน
☐ ขนส่งสาธารณะ
☐ เดิน
☐ อื่น ๆ (โปรดระบุ)...........................

Figure A.3 The Demographics Question Part 2/2

3

<u>ส่วนที่ 2</u> พฤติกรรมการเดินทางภายในมหาวิทยาลัย

รายละเอียด	ไม่เคย	1 – 2 วัน ต่อสัปดาห์	3 – 4 วัน ต่อสัปดาห์	มากกว่า 4 วัน ต่อสัปดาห์
1. ท่านใช้จักรยานสำหรับการเดินทางภายในมหาวิทยาลัย				
2. ท่านใช้จักรยานยนต์สำหรับการเดินทางภายในมหาวิทยาลัย				
3. ท่านจอดรถของท่านและใช้บริการรถสาธารณะสำหรับการเดินทางภายในมหาวิทยาลัย				
4. ท่านใช้บริการรถสาธารณะ เช่น รถสองแถว วินมอเตอร์ไซค์ สำหรับการเดินทางภายในมหาวิทยาลัย				
5. ท่านใช้การเดินสำหรับการเดินทางภายในมหาวิทยาลัย				

6. ท่านเคยใช้จักรยานสาธารณะในมหาวิทยาลัยหรือไม่

☐ เคย ☐ ไม่เคย (ถ้าท่านตอบไม่เคย ให้ข้ามไปทำข้อ 10)

7. ความถี่ในการใช้จักรยานสาธารณะ (Bike sharing)

☐ มากกว่า 4 วันต่อสัปดาห์ ☐ 3 – 4 วันต่อสัปดาห์

☐ 1 – 2 วันต่อสัปดาห์ ☐ น้อยกว่า 1 วันต่อสัปดาห์

8. วัตถุประสงค์ในการใช้จักรยานสาธารณะของท่าน

☐ เพื่อการศึกษา เช่น การเดินทางระหว่างอาคารเรียน เป็นต้น

☐ เพื่อการพักผ่อนหย่อนใจ

☐ เพื่อการเดินทางไปต่อรถสาธารณะอื่น ๆ เช่น รถเมล์ รถสองแถว

☐ เพื่อการออกกำลังกาย

☐ อื่น ๆ (โปรดระบุ)......................

Figure A.4 The Questions of Commuting Behavior on Campus

4

ส่วนที่ 3 ทัศนคติที่มีต่อการใช้จักรยานในมหาวิทยาลัย

ทัศนคติที่มีต่อการใช้จักรยานในมหาวิทยาลัย	ไม่เห็นด้วยอย่างยิ่ง	ไม่เห็นด้วย	ไม่แน่ใจ	เห็นด้วย	เห็นด้วยอย่างยิ่ง
1. ไม่มีช่องทางสำหรับจักรยานในมหาวิทยาลัย					
2. จักรยานมีการสูญหายบ่อยครั้ง					
3. การปั่นจักรยานใช้เวลานานเกินไป					
4. การใช้จักรยานสามารถเป็นปัญหาสำหรับผู้ใช้ถนนรายอื่น ๆ ในมหาวิทยาลัย					
5. พื้นผิวถนนที่ดีและการมีสัญลักษณ์สำหรับจักรยานสามารถสนับสนุนการใช้งานจักรยานในมหาวิทยาลัย					
6. ปัญหาฝุ่นละอองมีผลต่อการปั่นจักรยานในมหาวิทยาลัย เช่น ฝุ่นละออง PM 2.5 เป็นต้น					

ส่วนที่ 4 ข้อเสนอแนะอื่น ๆ

....

....

....

ขอบคุณที่ท่านสละเวลาในการตอบแบบสอบถามครั้งนี้

Figure A.5 The Question of Attitudes toward Bicycle Use on Campus

Appendix III

Letter Requesting Permission to Interview University Administrators

Letter Requesting Permission
to Interview University Administrators

ที่ อว ๗๐๐๐/๔๒๐๗

สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง
ซอยฉลองกรุง ๑ เขตลาดกระบัง กรุงเทพฯ ๑๐๕๒๐

๒๖ พฤศจิกายน ๒๕๖๓

เรื่อง ขอความอนุเคราะห์เข้าสัมภาษณ์ผู้บริหารมหาวิทยาลัย

เรียน อธิการบดี

ตามที่นายชิตษณุ ภักดีวานิช นักศึกษาระดับดุษฎีบัณฑิต รหัสนักศึกษา ๖๐๖๑๐๐๐๓ หลักสูตรการจัดการโลจิสติกส์และซัพพลายเชน คณะวิศวกรรมศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง ได้ดำเนินการทำวิจัยวิทยานิพนธ์ เรื่อง "การศึกษาปัจจัยที่มีผลกระทบต่อการพัฒนาระบบจักรยานสาธารณะของมหาวิทยาลัยในประเทศไทย กรณีศึกษา มหาวิทยาลัยในประเทศไทยที่อยู่ใน THE Impact Rankings ๒๐๒๐" นั้น

ในการนี้สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง มีความประสงค์ขอความอนุเคราะห์ผู้บริหารหรือตัวแทนของมหาวิทยาลัย ให้นายชิตษณุ ภักดีวานิช นักศึกษาของสถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง เข้าสัมภาษณ์ในเรื่อง "นโยบายการพัฒนามหาวิทยาลัยอย่างยั่งยืน หรือเป้าหมายการพัฒนาที่ยั่งยืน (Sustainable Development Goals: SDGs) และสามารถติดต่อขอข้อมูลเพิ่มเติมจากนายชิตษณุ ภักดีวานิช หมายเลขโทรศัพท์ ๐๙๖ ๓๕๑๕๖๓๙

จึงเรียนมาเพื่อโปรดพิจารณาและสถาบันหวังเป็นอย่างยิ่งว่าจะได้รับความอนุเคราะห์ดังกล่าวด้วยดีจากท่าน จะขอบคุณยิ่ง

ขอแสดงความนับถือ

(รองศาสตราจารย์สุพจน์ ศรีนิล)
รองอธิการบดีฝ่ายบริหารทรัพยากรกายภาพและสิ่งแวดล้อม ปฏิบัติการแทน
อธิการบดีสถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง

สำนักงานบริหารทรัพยากรกายภาพและสิ่งแวดล้อม
โทรศัพท์ ๐ ๒๓๒๙ ๘๑๓๐ โทรสาร ๐๒ ๓๒๙ ๘๑๓๑
www.build.kmitl.ac.th/

สมพร/พ

Figure A.6 Letter Requesting Permission to Interview University Administrators

แบบสัมภาษณ์ผู้บริหารมหาวิทยาลัย

1. ภาพรวมการจัดการเดินทางภายในมหาวิทยาลัย
   1.1. มหาวิทยาลัยมีนโยบายที่เกี่ยวข้องกับโครงสร้างพื้นฐานเพื่อตอบสนองการเดินทางภายในมหาวิทยาลัยอย่างไร
   1.2. มหาวิทยาลัยมีการสนับสนุนการเดินทางภายในมหาวิทยาลัยที่เป็นมิตรกับสิ่งแวดล้อม เช่น การเดิน การปั่นจักรยาน เป็นต้น อย่างไร
   1.3. มหาวิทยาลัยมีนโยบายที่จะสนับสนุนการใช้จักรยานสาธารณะภายในมหาวิทยาลัยหรือไม่ อย่างไร
2. การจัดการการเดินทางภายในมหาวิทยาลัย
   2.1. มหาวิทยาลัยมีการมอบหมายหน่วยใดเป็นผู้ดูแลจักรยานสาธารณะภายในมหาวิทยาลัย และหน่วยงานนั้นดูแลจักรยานสาธารณะ เช่น การปฏิบัติงานในแต่ละวัน การซ่อมบำรุง และอื่น ๆ อย่างไร (กรณีที่มหาวิทยาลัยมีจักรยานสาธารณะ)
   2.2. กรณีที่มหาวิทยาลัยมีจักรยานสาธารณะ เพื่อให้เกิดการใช้จักรยานสาธารณะอย่างต่อเนื่อง และยั่งยืน งบประมาณใดที่ถูกนำมาใช้ในการดูแลจักรยานสาธารณะ เช่น การซ่อมแซม การดูแลรักษา และอื่น ๆ
3. การประชาสัมพันธ์ (หรือการตลาด)
   3.1. มหาวิทยาลัยมีการประชาสัมพันธ์นโยบาย โครงการ และอื่น ๆ ที่เกี่ยวข้องกับเป้าหมายด้านการพัฒนาอย่างยั่งยืน (SDGs) อย่างไร
   3.2. มหาวิทยาลัยร่วมรณรงค์การเดินทางที่เป็นมิตรกับสิ่งแวดล้อมภายในมหาวิทยาลัยอย่างไร
   3.3. มหาวิทยาลัยมีการสร้างวัฒนธรรมในการใช้จักรยานภายในมหาวิทยาลัยหรือไม่ อย่างไร
4. คำถามสรุป
   4.1. ท่านอยากปรับปรุง/แก้ไข ด้านนโยบายที่เกี่ยวข้องกับเป้าหมายการพัฒนาอย่างยั่งยืน (SDGs) ด้านสุขภาพและความเป็นอยู่ที่ดี ภายในมหาวิทยาลัยของอย่างไร
   4.2. จุดแข็งของมหาวิทยาลัย ที่เกี่ยวข้องกับโครงการจักรยานสาธารณะภายในมหาวิทยาลัย คือ อะไร (ถ้ามี)
   4.3. ข้อเสนอแนะอื่น ๆ ที่เกี่ยวข้องกับการพัฒนาระบบจักรยานสาธารณะภายในมหาวิทยาลัย

Figure A.7 Interview Form for University Administrators

Appendix IV

Certificate of Exemption

Certificate of Exemption

No. 046
EC-KMITL_63_046

The Research Ethics Committee of
King Mongkut's Institute of Technology Ladkrabang
1, Chalongkrung Rd., Lat Krabang, Lat Krabang, Bangkok Thailand 10520 Tel. 02-3298000

Certificate of Exemption

The Research Ethics Committee of King Mongkut's Institute of Technology Ladkrabang has exempted the following study which is to be carried out in compliance with the International guidelines for human research protection as Declaration of Helsinki, The Belmont Report, CIOMS Guideline, International Conference on Harmonization in Good Clinical Practice (ICH GCP) and 45CFR 46.101(b)

Study title : A Study of the Factors Affecting the Development of Campus Bike-Sharing System in Thailand
Study code : EC-KMITL_63_046
Principal investigator : Mr. Chitsanu Pakdeewanich
Study center : Faculty of Engineering
Document reviewed :

1. Submission form version 1. date 15 June, 2020
2. Full protocol/proposal version 2. date 15 June, 2020
3. Participant information sheet version 2 date 15 June, 2020
4. Informed consent form version 2 date 15 June, 2020
5. Data record form version 1. dated 15 June, 2020
6. Curriculum Vitae dated 2 June, 2020

Signature Pastraporn Thipayasothorn.
(Asst. Prof. Dr. Pastraporn Thipayasothorn.)
Chair of the Human Ethics Committee
King Mongkut's Institute of Technology Ladkrabang, 2019

Date of Exemption : 17 July, 2020
Note No continuing review required

Figure A.8 Certificate of Exemption

Bibliography

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Experience

2015 – Present Lecturer at the Faculty of Business and Industrial Development
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2014 – 2015 Lecturer at the Faculty of Business Administration
Mahanakorn University of Technology

2012 – 2014 Logistics officer at Denso International Asia Co., Ltd.

Research

Kunlasap Thongprasit and Chitsanu Pakdeewanich. (2022). Consumers Expectation and Perception of the Customer' Service Usage. *Vocational Education Central Region Journal*. Volume 6(2). 36-44.

Chitsanu Pakdeewanich, Pawinee Chaichukiat, and Suchart Pankamjhon. (2022). A Modeling of Manpower Management in Material Preforming Process: A Case Study of Electronics Industry. *Journal of Industrial Technology Ubon Ratchathani Rajabhat University*. Volume 12(2). 83–96.

Chitsanu Pakdeewanich and Weeraya Yingtong. (2022). Process Improvement of goods Receiving and Quantity Checking: A Case Study of D Plus Intertrade Co., Ltd. Samut Prakan. *Journal of Business and Industrial Development*. Volume 2(1). 4–15.

Chitsanu Pakdeewanich and Suchadee Tumrongsuk. (2021). A Study of Inventory Replenishment Policy for Online Marketing Business: A Case Study of Bedding, Furniture, and Home Appliances. *Rajapark Journal*. Volume 15(42). 413–427.

Chitsanu Pakdeewanich and Supachai Veeradech. (2021). Increasing the Operation Rate of Punching Machine by Using ECRS. *PBRU Science Journal*. Volume 18(2). 86–97.