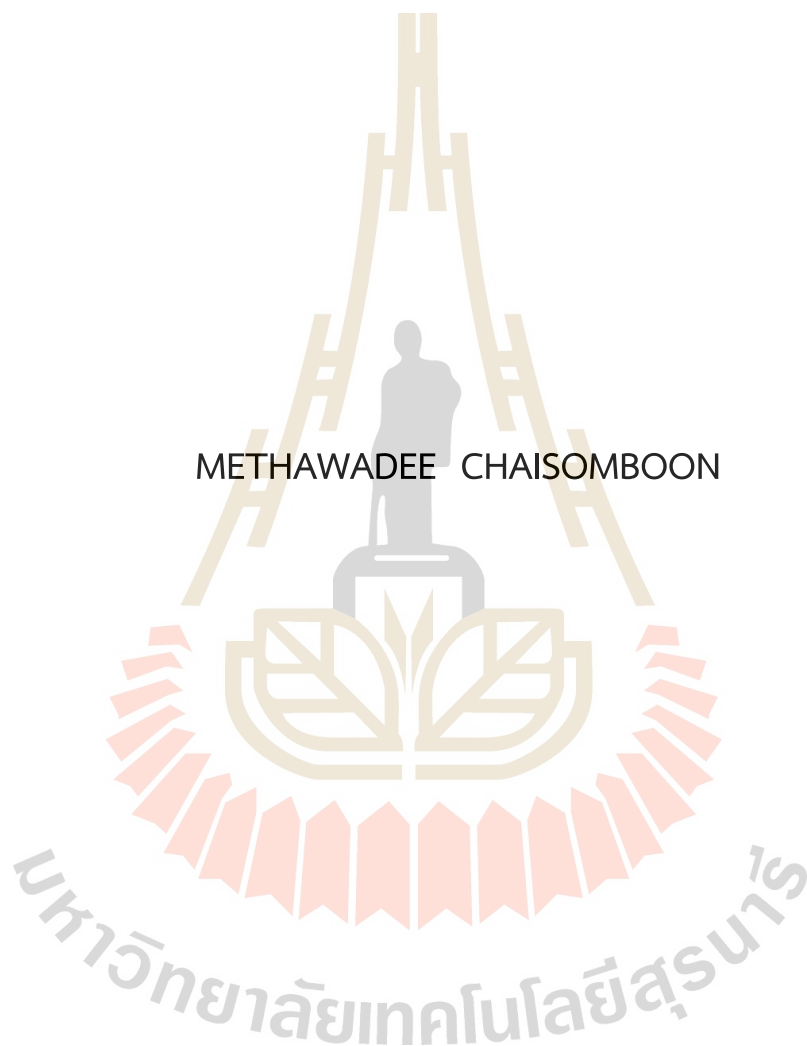


THE STUDY OF TRAVEL BEHAVIOR OF ELDERLY PEOPLE USING
PUBLIC TRANSPORTATION IN THAILAND

METHAWADEE CHAISOMBOON



A Thesis Submitted in Partial Fulfillment of the Requirements for the
Degree of Doctor of Philosophy in Civil,
Transportation and Geo-Resources Engineering
Suranaree University of Technology
Academic Year 2025

การศึกษาพฤติกรรมการเดินทางของผู้สูงอายุด้วยระบบขนส่งสาธารณะใน
ประเทศไทย



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาปรัชญาดุษฎีบัณฑิต
สาขาวิชาวิศวกรรมโยธา ขนส่ง และทรัพยากรธรณี
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THE STUDY OF TRAVEL BEHAVIOR OF ELDERLY PEOPLE USING PUBLIC TRANSPORTATION IN THAILAND

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สาธารณะในประเทศไทย (THE STUDY OF TRAVEL BEHAVIOR OF ELDERLY PEOPLE
USING PUBLIC TRANSPORTATION IN THAILAND)

อาจารย์ที่ปรึกษา: ศาสตราจารย์ ดร.วัฒนวงศ์ รัตนวราห, 135 หน้า.

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การศึกษาที่ 1: งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาปัจจัยที่ส่งผลต่อ ความตั้งใจใช้ระบบขนส่ง
สาธารณะ ในกลุ่มผู้สูงอายุไทย (อายุ 60 ปีขึ้นไป) โดยใช้การวิเคราะห์สมการโครงสร้าง (SEM) ซึ่ง
ประยุกต์ใช้ทฤษฎีพฤติกรรมตามแผน (TPB) ร่วมกับการออกแบบทัศนภาพบริการ (SERVQUAL)
ผลการวิจัยสรุปได้ว่า ความพึงพอใจของผู้โดยสาร เป็นปัจจัยหลักที่ส่งผลอย่างแข็งแกร่งและมี
นัยสำคัญต่อความตั้งใจใช้บริการระบบขนส่งสาธารณะ โดยพบว่าทัศนคติที่ดีต่อคุณภาพบริการส่งผล
กระทบทั้งทางตรงและทางอ้อมผ่านตัวแปรความพึงพอใจไปยังเจตนาของผู้สูงอายุ ในทางกลับกัน
ความเคยชินในการใช้รถยนต์ส่วนบุคคล เป็นอิทธิพลเชิงลบที่ขัดขวางความตั้งใจในการเปลี่ยนมาใช้
บริการขนส่งสาธารณะ

การศึกษาที่ 2: การศึกษานี้มีวัตถุประสงค์เพื่อวิเคราะห์ ความคาดหวังและความพึงพอใจ
ของผู้ใช้บริการระบบขนส่งสาธารณะในประเทศไทย โดยดำเนินการเปรียบเทียบระหว่าง กลุ่ม
ผู้สูงอายุ และ กลุ่มผู้ใหญ่ทั่วไปจากเก็บรวบรวมข้อมูลจาก 5 ภูมิภาคหลักของประเทศ (ภาคเหนือ,
ภาคตะวันออกเฉียงเหนือ, ภาคกลาง, ภาคใต้, และเขตกรุงเทพมหานครและปริมณฑล) ภูมิภาคละ
450 ตัวอย่าง และใช้วิธีการวิเคราะห์ 3 รูปแบบ ได้แก่ การวิเคราะห์ความสำคัญ-ประสิทธิภาพแบบ
ดั้งเดิม (IPA), การวิเคราะห์ช่องว่าง (Gap Analysis), และการวิเคราะห์แบบบูรณาการผลลัพธ์จาก
การวิเคราะห์แต่ละวิธีได้ให้มุมมองและการตีความที่แตกต่างกัน แต่ข้อสรุปหลักที่สอดคล้องจากทั้ง
สามวิธีคือ ปัจจัยด้าน "ความปลอดภัย" เป็นประเด็นเร่งด่วนที่สุดที่ต้องได้รับการปรับปรุงสำหรับกลุ่ม
ผู้สูงอายุ นอกจากนี้ยังได้เสนอแนะให้มีการปรับปรุงการให้บริการขนส่งสาธารณะให้มีความ
สม่ำเสมอและเชื่อถือได้ ในทุกภูมิภาค เพื่อตอบสนองความต้องการของผู้ใช้บริการได้อย่างมี
ประสิทธิภาพและทั่วถึง

การศึกษาที่ 3: การวิจัยนี้มีวัตถุประสงค์เพื่อวิเคราะห์ ปัจจัยที่ส่งผลต่อการเลือกรูปแบบการ
เดินทางของผู้สูงอายุ (รถเมล์/รถสองแถว, รถโดยสารใหญ่, รถตู้, รถไฟฟ้า) โดยใช้ แบบจำลองลอจิสต์

พหุนาม (MNL) ผลการศึกษาพบว่า ปัจจัยทางสังคมเศรษฐกิจ เช่น ระดับการศึกษาและการอาศัยอยู่
ลำพัง มีอิทธิพลอย่างมีนัยสำคัญต่อการตัดสินใจเลือกโหมด โดยผู้สูงอายุที่มีการศึกษาสูงและอยู่ลำพัง
มีแนวโน้มเลือกใช้รถโดยสารใหญ่และรถไฟฟ้า ปัจจัยด้าน เวลา โดยเฉพาะ เวลารอคอยที่นาน ลด
โอกาสการเลือกรถเมล์ แต่เพิ่มโอกาสเลือกโหมดที่มีความตรงต่อเวลา . ส่วนปัจจัยด้าน ค่าโดยสาร
ผู้สูงอายุมีความอ่อนไหวต่อราคาของรถไฟฟ้ามากที่สุด และพบว่ารถไฟฟ้าเหมาะสมที่สุดสำหรับการ
เดินทางระยะไกล โดยข้อมูลเชิงประจักษ์นี้เป็นประโยชน์อย่างยิ่งในการกำหนดนโยบายเพื่อพัฒนา
ระบบขนส่งสาธารณะที่ เป็นมิตรกับผู้สูงอายุ ซึ่งจะช่วยยกระดับคุณภาพชีวิตและความสามารถในการ
เดินทางอย่างยั่งยืนในสังคมสูงวัย



สาขาวิชาวิศวกรรมขนส่ง

ปีการศึกษา 2568

ลายมือชื่อนักศึกษา 

ลายมือชื่ออาจารย์ที่ปรึกษา 

METHAWADEE CHAISOMBOON: THE STUDY OF TRAVEL BEHAVIOR OF ELDERLY PEOPLE USING PUBLIC TRANSPORTATION IN THAILAND.

THESIS ADVISOR: VATANAVONGS RATANAVARAHA, Ph.D. 135 PP.

Keyword: Elderly Travel Behavior/Public Transportation/Intention to Use/Service Quality/Passenger Satisfaction/Travel Safety/Mode Choice/Aging Society

Study 1: This study aims to examine the factors influencing the intention to use public transportation among elderly people in Thailand (aged 60 years and above) by employing Structural Equation Modeling (SEM). The analysis integrates the Theory of Planned Behavior (TPB) with the SERVQUAL service quality framework. The findings indicate that passenger satisfaction is the primary determinant exerting a strong and statistically significant effect on the intention to use public transportation. Specifically, a positive attitude toward service quality influences elderly individuals' intentions both directly and indirectly through the mediating role of satisfaction. In contrast, habitual reliance on private car use constitutes a negative influence that hinders the intention to shift toward public transportation.

Study 2: The objective of this study is to analyze the expectations and satisfaction of public transportation users in Thailand through a comparative assessment between elderly users and the general adult population. Data were collected from five major regions of the country—the Northern, Northeastern, Central, and Southern regions, as well as the Bangkok Metropolitan Area and its vicinity—with 450 samples obtained from each region. Three analytical approaches were applied: traditional Importance–Performance Analysis (IPA), Gap Analysis, and an integrated analysis synthesizing the results of each method. Although each approach provided distinct perspectives and interpretations, a consistent conclusion across all three methods was that the factor of “safety” represents the most urgent issue requiring improvement for the elderly group. In addition, the study recommends enhancing the consistency and reliability of public transportation services across all regions to effectively and equitably meet user needs.

Study 3: This research aims to analyze the factors affecting elderly individuals' travel mode choice (bus/songthaew, large bus, van, and rail transit) using the Multinomial Logit (MNL) model. The results reveal that socioeconomic factors, such as educational attainment and living alone, have statistically significant effects on mode choice decisions. Elderly individuals with higher education levels and those living alone are more likely to choose large buses and rail transit. Time-related factors, particularly long waiting times, reduce the likelihood of choosing buses while increasing the probability of selecting modes with greater punctuality. Regarding fare-related factors, elderly users are most sensitive to the pricing of rail transit, and the findings indicate that rail transit is the most suitable option for long-distance travel. This empirical evidence is highly valuable for policy formulation aimed at developing elderly-friendly public transportation systems, thereby enhancing quality of life and promoting sustainable mobility in an aging society.

มหาวิทยาลัยเทคโนโลยีสุรนารี

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ACKNOWLEDGEMENT

This thesis, which investigates the travel behavior of elderly individuals using public transportation in Thailand, could not have been successfully completed without the support and guidance of many individuals.

First, I would like to express my sincere gratitude to the Royal Golden Jubilee Ph.D. Scholarship for its financial assistance and continuous support throughout this program.

Second, I would like to convey my deepest appreciation to my advisor, Prof. Dr. Vatanavongs Ratanavaraha, and his wife for their invaluable guidance, constructive advice, and unwavering encouragement throughout my academic journey.

I would also like to extend my heartfelt thanks to the members of the thesis examination committee for their valuable time and insightful comments. Special appreciation is given to Prof. Dr. Thaned Satiennam (Chair), Assoc. Prof. Dr. Sajjakaj Jomnonkwao, Asst. Prof. Dr. Duangdao Watthanaklang, and Dr. I-soon Raungratanaamporn. Their expertise in transportation planning and behavioral modeling constituted a critical foundation for this research and significantly enhanced the academic quality of this thesis.

I express my sincere gratitude to all lecturers, past and present, for their knowledge, support, and guidance, and to the university and administrative staff for their assistance with documentation and coordination throughout my studies.

I also thank all survey respondents for providing the data essential to this research.

Finally, I am deeply grateful to my family, friends, and colleagues for their encouragement and support, without which this thesis would not have been possible. This thesis is dedicated to those who contribute to the advancement of sustainable transportation development in Thailand and beyond.

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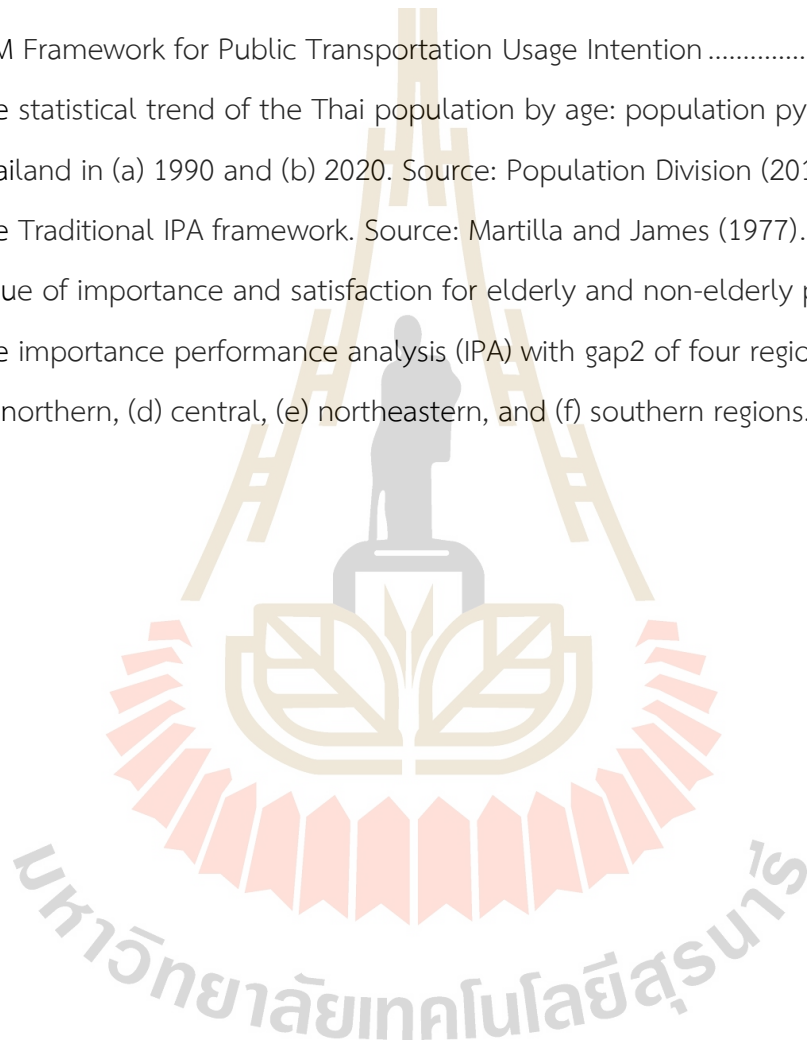
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LIST OF ABBREVIATIONS

α	=	Statistically significant level
β	=	Structural coefficient
λ	=	Factor loading coefficient
χ^2	=	Chi-square
df	=	Degree of freedom
$\bar{x}$	=	Mean
R^2	=	R-Squared
RMSEA	=	Root mean square of approximation
SRMR	=	Standardized root mean residual
CFI	=	Comparative fit index
TLI	=	Tucker Lewis Index
SEM	=	Structural equation modeling
CFA	=	Confirmatory factor analysis
EFA	=	Exploratory factor analysis
IPA	=	Importance-performance analysis
CR	=	Construct reliability
AVE	=	Average variance extracted
MCDM	=	Multi-Criteria Decision Making
SD	=	Standard deviation
SK	=	Skewness
KU	=	Kurtosis

CHAPTER I

INTRODUCTION

1.1 Rationale of the research

The United Nations defines older persons as both males and females aged 60 years and above. The transition of a country into an aging society can be assessed based on the proportion of older persons within its population. Accordingly, the level of population aging is classified into three stages as follows.

1) “Aging society” refers to a society in which the population aged 60 years and above accounts for more than 10 percent of the total population, or where the proportion of residents aged 65 years and above, relative to the total population across all age groups within the same area, is equal to or greater than 7 percent.

2) “Complete Aged Society” refers to a society in which the population aged 60 years and above exceeds 20 percent of the total population, or where the proportion of residents aged 65 years and above, relative to the total population across all age groups within the same area, is equal to or greater than 14 percent.

3) “Super-aged society” refers to a society or country in which the population aged 65 years and above exceeds 20 percent of the total national population, indicating that the country has fully entered an advanced stage of population aging.

Demographic change under conditions of population aging has become a critical issue receiving increasing attention worldwide. This phenomenon is primarily the result of a rapid decline in fertility, leading to a reduction in the fertility rate. According to the United Nations (2017), the global average fertility rate during the period 2015–2020 was 2.47 births per woman. At the same time, significant advancements in medical technology have contributed to increased life expectancy, which constitutes another key factor driving the rapid growth in both the number and proportion of older persons in many countries. Under these circumstances, population aging represents a major challenge faced by all countries, although the severity and implications vary across contexts

Developed countries tend to enter aging societies earlier than developing countries. Japan, for example, became an aging society in 1970 and transitioned to a completely aged society in 1994. At present, Japan has entered a super-aged society, with older persons accounting for approximately 33 percent of the population, or one in three individuals aged over 65 years, representing the highest proportion globally. Nevertheless, two-thirds of the world's older population reside in developing regions, where population aging is occurring more rapidly than in developed regions. In 2017, the global population was approximately 962 million, with individuals aged 60 years and above accounting for 13 percent of the total population and growing at an annual rate of about 3 percent. It is projected that the global older population will reach 1.4 billion by 2030 and 2.1 billion by 2050. The United Nations (2017) further projects that within just over the next 30 years, nearly one-quarter or more of the population in all regions worldwide—except Africa—will consist of older persons, increasing continuously to 3.1 billion by 2100.

Regarding the aging society situation in ASEAN, the Association of Southeast Asian Nations comprises ten member states: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Viet Nam, and Thailand. In 2015, ASEAN had a total population of 623.31 million (United Nations, 2015). The proportion of the child population (aged 0–14 years) began to decline in 2015 in Thailand and Viet Nam. The working-age population (aged 15–59 years), which constitutes the labor force of each country, is projected to begin declining by 2030 in Thailand and Singapore. The older population (aged 60 years and above) in ASEAN amounted to 55 million people, representing approximately 9 percent of the total population during the period 1980–2050, with an overall trend of continuous increase. In 2017, Singapore had the highest proportion of older persons in ASEAN at 20 percent, followed by Thailand at 17 percent and Viet Nam at 11 percent (Ministry of Social Development and Human Security, 2016).

In Thailand, the country entered an aging society in 2005, when the proportion of the population aged over 60 years reached 10.5 percent. By 2015, the number of individuals aged 60 years and above had increased to 15.8 million and is projected to rise to 18.35 million by 2030 and further to 26.9 million by 2050. At that point, older

persons are expected to account for 37 out of every 100 individuals in the Thai population, reflecting a rapidly increasing proportion of older persons National Statistical Office (2014). This trend contrasts with the declining trajectories of the child and working-age populations (United Nations Department of Economic and Social Affairs Population Division, 2015).

These demographic changes are largely attributable to a rapid decline in fertility in Thailand, resulting in a lower fertility rate. The country's fertility rate stands at 1.4 births per woman, which is below the global average fertility rate (United Nations, 2015). This reflects a substantial reduction in family size, from approximately four children per woman four decades ago to only one to two children at present. Concurrently, declining mortality rates have led to increased life expectancy among the Thai population, rising from an average of approximately 58 years 50 years ago to 75 years today. These combined factors have resulted in a rapid and pronounced increase in both the number and proportion of older persons. Thailand is currently undergoing a transition toward a complete aged society. The Foundation For Older Persons' Development (2018) indicates that in 2017, the number of children (aged 0–14 years) in Thailand was already lower than the number of older individuals aged 60 years and above.

1.1.1 Background problem

The transition into older age is a natural process that is unavoidable for all individuals. The changes that occur during this stage of life are predominantly characterized by decline and can be broadly categorized into three main dimensions. First, physical changes include deterioration in bodily functions, the five sensory systems, and hormonal regulation, among others. Second, psychological and emotional changes arise, in part, as consequences of declining physical conditions. Third, social changes occur, as older persons are often subject to reduced social roles and diminished perceived importance. This is largely because they are commonly viewed as a population group with declining health, increased susceptibility to illness and accidents, and greater difficulty in communicating with the general population. As a result, many older persons are confined to their homes, which may lead to feelings of loss of self-worth. This is particularly evident among older individuals who were

previously self-reliant or served as key supporters within their families but must subsequently assume the role of care recipients. Consequently, participation in social life and engagement in activities outside the home enable older persons to maintain social connections and to take part in activities that enhance their overall quality of life.

In 2021, Thailand entered the stage of a completely aged society and is projected to become a super-aged society by 2031. Accordingly, the rapid increase in the proportion of the aging population, which poses a significant challenge for many countries worldwide, has likewise become a critical issue for Thailand, with multidimensional impacts. According to the Bank of Thailand (2018), population aging directly affects the labor market through an increase in the average age of the workforce, resulting in a decline in labor supply, which constitutes a key factor of production. Indirect effects are also observed, as working-age individuals may withdraw from employment to provide care for elderly family members at home or may relocate to work closer to their place of origin. In the financial and consumer markets, changes in consumption patterns accompany the growth of the older population, leading to shifts in demand toward goods and services tailored to older persons, such as assistive products and transportation services. Additionally, gradual changes in family structure further compound these effects. Such rapid transformations inevitably have implications for the transport system, which must be adapted to accommodate the continuously growing older population in order to support their daily activities. Transport systems must enable all individuals to access destinations without barriers or constraints arising from age-related physical limitations. This entails not only improving existing transport infrastructure but also enhancing service provision to reach the widest possible range of users, based on the principle of equitable access to a good quality of life for all travelers. Mobility is a fundamental necessity for individuals of all ages, and older persons require travel for various purposes, including medical appointments, shopping, socializing with friends, visiting relatives, and leisure travel. Therefore, older persons require an environment and facilities that support independent living and mobility, allowing them to conduct their daily lives without imposing concern on family members. At present, however, there remains limited

preparation in terms of facilities for older persons, both in public spaces and within the home, as well as insufficient provision of accessible and safe transport systems.

Given these age-related changes and constraints, mobility emerges as a crucial determinant of older adults' ability to participate in social life and maintain an adequate quality of life. Age-related physical decline—such as reduced muscular strength, slower reaction times, and diminished sensory capacities—may limit older adults' ability to safely operate private vehicles. Consequently, reliance on private car use becomes increasingly constrained for this population.

In light of these limitations, the present study places greater emphasis on older adults' travel behavior related to public transportation systems rather than on their private vehicle driving behavior. Public transportation represents a vital means of mobility for older persons, particularly for those experiencing physical and functional decline. By focusing on older adults' interactions with public transport, this research seeks to identify key behavioral and contextual factors that influence their mobility choices and to provide empirical evidence to support the development of more inclusive and age-friendly public transportation systems to align with the 20-year transport infrastructure development strategy established by the Ministry of Transport, the promotion of development and enhancement of the quality of life for persons with disabilities and older persons is identified as a key objective. This strategy emphasizes the development of transport systems that facilitate mobility and reduce travel barriers, ensuring that all individuals have equitable access to public transport services. Such efforts aim to reduce social disparities and promote the ability of persons with disabilities and older persons to participate fully in society (Thailand Transport Portal, 2016). Consequently, the development of public transport systems necessitates a comprehensive understanding of attitudinal issues and influencing factors that affect the use of public transport for travel. This knowledge is essential for effective planning and policy formulation that responds to public needs and appropriately addresses existing challenges in public transport usage.

1.2 Purpose of the research

1) To examine and analyze the factors that influence the travel demand of older persons for public transport use.

2) To assess perceptions and develop indicators of satisfaction with public transport services among older persons.

3) To develop a travel mode choice model for public transport usage among older persons.

1.3 Scope of the research

1) This study covers older persons aged 60 years and above who reside in urban areas where public transport services are available.

2) The study is conducted within the context of travel behavior involving various forms of public transport modes.

1.4 Research questions

1) Which factors influence the demand for public transport travel among older persons?

2) How do perceptions and satisfaction with existing public transport services, as well as expectations toward public transport systems, compare between older persons and non-older population groups in terms of similarities and differences?

3) Which factors affect travel mode choice among older persons?

1.5 Contribution of the research

The objective of this study is to identify key factors associated with the intention to use public transport and to develop a service quality measurement model for older persons. The resulting findings are expected to provide useful insights and practical guidance for stakeholders in improving and developing public transport systems, thereby promoting public transport use among both existing users and potential new users. The anticipated contributions of the study are as follows:

1) Influential factors affecting the travel behavior of older persons can be applied as a basis for promoting public transport usage among both new and existing users.

2) Factors influencing satisfaction can be systematically prioritized to guide government agencies in improving and developing public transport systems in a manner that maximizes benefits under limited budget constraints.

3) The findings can assist government agencies in formulating strategies and promoting the development of both existing and future public transport systems in preparation for a complete aged society.

1.6 Overview of the study

The structure of this thesis consists of five chapters;

Chapter 1: Background: This section discusses the background, significance of each research topic, research objectives, research scope, research questions, research contributions, and study overview.

Chapter 2: Analysis of Travel Intentions of Elderly Passengers on Thailand's Public Transport System: A Structural Equation Modeling Approach

Chapter 3: Study of Elderly Satisfaction with Public Transportation in Thailand Using Different Efficiency Analysis Methods

Chapter 4: Analysis of Determinants of Elderly People's Travel Mode Choice

Chapter 5: A summary of the analysis of all 3 studies.

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CHAPTER II

ANALYZING THE TRAVEL INTENTION OF ELDERLY PASSENGERS IN THAILAND'S PUBLIC TRANSPORTATION SYSTEM: A STRUCTURAL EQUATION MODELING APPROACH

2.1 Abstract

This study aims to investigate the factors influencing the intention to use public transportation among older adults in Thailand. The analysis was conducted using Structural Equation Modeling (SEM), guided by the Theory of Planned Behavior (TPB) and the SERVQUAL framework. Data were collected from 2,250 individuals aged 60 and above, across five regions of the country, through structured questionnaires and in-depth interviews. The survey instrument consisted of sections on demographic information, travel experience, and perceived service quality. The findings reveal that passenger satisfaction plays a significant and strong role in shaping the intention to use public transport. Positive attitudes toward public transportation were found to have both direct and indirect effects—mediated by satisfaction—on the behavioral intentions of elderly individuals. In contrast, habitual use of private cars exerts a negative influence on the intention to use public transport. This highlights the need to foster an environment that supports the development of new travel habits, encouraging older adults to shift from private vehicle dependence to public transportation. These insights offer valuable implications for policymakers and relevant stakeholders in understanding the perspectives and needs of elderly public transport users. By implementing a policy framework that promote inclusive and age-friendly public transportation, the results of this study can contribute to advancing social equity and long-term societal resilience.

2.2 Introduction

The 21st century has witnessed a rapid demographic shift toward an "aged society," particularly in Asia, where population aging is accelerating at an unprecedented rate. According to estimates from the United Nations (UN) (United Nations, 2025), the global population aged 60 and over is expected to increase from approximately 1 billion today to over 2 billion by the year 2050. By 2030, the number of people aged 80 and above will surpass the number of infants. Asia will be the region with both the largest number and the highest proportion of older adults worldwide.

Thailand officially entered the status of an "aged society" in 2022 and is projected to become the first developing country in Asia to reach "super-aged society" status by 2030—in just five years—with over 28% of the population, or roughly 18 million people, aged 60 and above. This demographic transformation has far-reaching implications beyond the economy and healthcare systems. One of the most immediate and significant areas of impact is transportation, particularly public transit, which plays a critical role in the daily lives of older adults. A significant proportion of older Thais rely heavily on public transportation due to limitations in income and physical mobility. Consequently, their travel behavior tends to center around "essential trips," such as visiting healthcare providers, going to markets, or attending to government-related matters, rather than recreational or social travel. The quality of life for older adults may significantly diminish if public transportation systems fail to meet these essential needs. Thailand must therefore prepare for this major demographic shift by developing public transport systems that are inclusive and accessible to aging populations. Addressing this issue is not merely a matter of infrastructure; it is central to building an equitable society and achieving long-term social sustainability. Previous research in this field has employed various approaches to evaluate public transport satisfaction. Studies have explored user perceptions regarding accessibility and service quality among Thai residents aged 20–60 (Watthanaklang et al., 2024), decision-making processes of school travel among children through surveys of their parents (Nanthawong et al., 2024), and the effectiveness of key attributes influencing satisfaction among older passengers (Chaisomboon et al., 2020). Additional investigations have analyzed retrospective

travel behaviors during the COVID-19 pandemic in the Bangkok area (Thaithatkul et al., 2023), as well as examined the application of universal design principles in public projects with a focus on elderly needs (Srichuae et al., 2016). Furthermore, factors influencing the travel mode choice of the elderly in Thailand have been analyzed (Philuek et al., 2025). In addition, a study was conducted to examine the impact of elderly individuals' attitudes toward the acceptance of high-speed rail technology in Thailand, employing a multigroup structural equation modeling (Multigroup SEM) approach to compare differences between urban and rural elderly populations (Dangbut et al., 2024).

The present study adopts a Structural Equation Modeling (SEM) approach to investigate travel intention among older adults, drawing upon key constructs from the Theory of Planned Behavior (TPB)—including attitude, subjective norms, and perceived behavioral control (Ajzen, 1991). The model also incorporates satisfaction and habitual behavior, the latter reflecting past tendencies toward private transport use. By doing so, the study seeks to bridge the gap in public policy design related to elderly mobility and promote the use of public transportation among older populations. The findings aim to offer practical recommendations for public policy improvements and contribute toward fostering equality in everyday living for one of the fastest-growing demographic segments in the country.

2.3 Literature Reviews

2.3.1 Habit and Intention

In the context of explaining human behavior in daily life, previous studies have noted that past behavior can be a strong predictor of future actions (Ouellette & Wood, 1998). However, this predictive power does not necessarily stem from conscious memory or deliberate intention. Intention plays a significant role primarily when a behavior has not yet become habitual or still requires active decision-making. As behaviors become more habitual, actions tend to be triggered more by situational cues than by conscious intention—for example, entering a coffee shop every morning without deliberate thought (Lee, 2022). Therefore, changing behavior requires more than simply altering intentions. It also demands modifications to the

environmental or situational cues that reinforce habitual behavior. This is particularly relevant in the context of public transportation systems, where behavioral patterns can be shaped by routine, accessibility, and environmental factors. Prior research in the field of public transportation has provided robust conceptual frameworks that are valuable for guiding the design and development of infrastructure and services that align with diverse user needs. In the Thai context, investigations into the link between accessibility perception and public transport quality have found that user attitudes are the strongest predictors of the intention to use such services (Watthanaklang et al., 2024). Habits influence individuals' intentions and behaviors in selecting modes of transportation. For instance, habitual use of private vehicles has been shown to affect changes in travel behavior among vehicle users (Jaensirisak, 2015). Similarly, González (2008) found that a strong car-use habit is positively associated with favorable attitudes and emotions toward car usage, indicating that altering such behavior can be challenging (Kaewklueklom et al., 2017). In line with these findings, a study conducted in Thailand revealed that although participants expressed positive opinions about BRT, recognizing it as a superior new mode of transportation, they continued to exhibit habitual reliance on private vehicles in daily life. This was attributed to the low cost and maintenance of motorcycles. It was also found that individuals with a high level of private vehicle use habit demonstrated lower intention to adopt BRT, a finding that can be used to support Hypothesis 7.

In light of this, the current study aims to examine the factors influencing travel intention among older adults in relation to public transportation, a population with specific limitations concerning physical ability, accessibility, and travel safety. To achieve this, Structural Equation Modeling (SEM) is employed as the primary analytical tool to assess the relationships among variables such as satisfaction, perceived service quality, attitude, and subjective norms. Additionally, this study introduces a novel hypothesis by incorporating habit as a mediating variable. Habit, in this context, refers to prior patterns of using private transportation, which may influence an individual's intention to shift toward public transport usage. This relationship is presented in Hypothesis 7, as summarized in Table 2.1. The inclusion of the habit construct enhances the explanatory power of the model and contributes to more accurate

recommendations for developing public transportation systems that truly support the daily lives of older adults.

Table 2.1 Overview of Research Hypotheses

Hypothesis	Relationship
H ₁	Satisfaction →(+) Intention
H ₂	Attitude →(+) Intention
H ₃	NORM →(+) Intention
H ₄	PCB →(+) Intention
H ₅	Expectation →(+) Perceived Service
H ₆	Perceived Service →(+) Satisfaction
H ₇	Habit →(-) Intention
H ₈	Attitude →(+) Satisfaction

The research hypotheses are as follows:

- 1) H₁: Satisfaction with public transportation directly enhances users' intention to continue using the service.
- 2) H₂: Holding a favorable view of public transportation positively influences the intention to use it.
- 3) H₃: Social influence (subjective norms) significantly contributes to the intention to use public transportation.
- 4) H₄: Users' perceived control over their travel choices positively affects their intention to use public transit.
- 5) H₅: Customer expectations positively shape how service quality is perceived in public transportation.
- 6) H₆: Perceived quality of service plays a key role in shaping customer satisfaction with public transit systems.
- 7) H₇: Regular reliance on private transport negatively impacts the intention to switch to public transportation.
- 8) H₈: A positive attitude toward public transit contributes directly to user satisfaction with the service.

2.3.2 Perceived Service Quality, Expectation and Satisfaction

The relationship between Perceived Service Quality (PSQ) and customer satisfaction is notably close and interdependent. Service quality is widely recognized as a key determinant in shaping customer satisfaction (Chumpitaz Caceres & Paparoidamis, 2007). According to James et al. (2017), *Service Quality Satisfaction* refers to a customer's positive emotional response—such as satisfaction or happiness—arising from the perceived alignment between their expectations and the service they voluntarily received from the provider. Felix (2017) further conceptualizes it as a form of attitude related to service experiences, although it should not be conflated with satisfaction that results specifically from the comparison between expectations and actual service outcomes. When the service delivered exceeds the customer's expectations, the customer is considered to have had a positively disconfirmed experience, resulting in a level of satisfaction greater than initially anticipated (Parasuraman & Berry, 1990). This notion underscores the critical importance of understanding customer satisfaction, particularly in the context of public transportation. For public transport operators and agencies, recognizing how expectations and perceived service quality interact to shape satisfaction is essential. Such understanding provides the foundation for developing targeted service improvements aimed at elevating the overall satisfaction levels among passengers. In this regard, continuous investment in service quality not only enhances customer loyalty but also contributes to more sustainable and inclusive transportation systems.

Within the context of public transportation systems, considerable attention has been paid to the key service quality dimensions that influence passenger satisfaction, especially in multimodal transport networks. In India, a study conducted in a medium-sized urban area identified the major latent factors contributing to passenger satisfaction in multimodal systems. Using Structural Equation Modeling (SEM), the researchers tested the relationships among six latent variables—reliability, comfort, safety, accessibility, information, and customer service—and found them to be significantly associated with overall satisfaction levels (Tanwar & Agarwal, 2024). In Malaysia, another study examined passenger satisfaction with Malaysia Airlines using Partial Least Squares SEM (PLS-SEM). The research explored how service quality and

satisfaction impact passengers' intention to shift travel modes, employing the SERVQUAL model as the conceptual framework for its survey instrument (Farooq et al., 2018; Hamzah et al., 2023). In Europe, a study conducted in three Italian cities surveyed individuals aged 65 and above to assess satisfaction with residential environments and local public transport. The findings, analyzed using both Structural Equation Modeling and the Ordered Logit Model, confirmed that satisfaction with transport services significantly contributed to the perceived quality of life among the elderly (Rossi et al., 2023). A broader literature review of 16 peer-reviewed studies focused on public transport accessibility for older adults, emphasizing equity and age-friendliness. Notably, all of these studies originated from developed countries, underscoring a research gap in developing regions such as Thailand and the ASEAN bloc. These regions remain underrepresented in global research on aging populations and transport accessibility (Ravensbergen et al., 2022). In Thailand, service quality in public transport has likewise emerged as a growing area of focus. Comparative studies on intercity rail services have applied various analytical techniques to evaluate the gaps and opportunities for improvement (Jomnonkwao et al., 2020). Additionally, a domestic study assessed the needs of parents concerning children's travel safety and used SEM to examine the relationships among variables such as service quality, expectations, satisfaction, and trust in a Thai context (Nanthawong et al., 2024). The analysis results indicated that expectations influence service perceptions, which in turn lead to higher satisfaction. Perception acts as a mediating variable between expectations and satisfaction. These findings can be applied to support Hypotheses 5 and 6.

Research also points to the mediating role of service quality attributes—particularly convenience, responsiveness, and safety—influencing how users perceive accessibility and their decision to use public transport (Watthanaklang et al., 2024). In rural Thailand, accessibility to healthcare services among older adults has been studied using GIS-based network analysis, revealing how poorly connected or deteriorated roads adversely affect health outcomes and restrict daily functioning (Iamtrakul et al., 2023). Other studies have emphasized the importance of applying universal design principles in public infrastructure and transport planning to ensure accessibility for all

age groups (Srichuae et al., 2016). A recent study focusing on older adult rail passengers in Thailand (Lieophairot et al., 2025), who utilize the services of the State Railway of Thailand (SRT), found that perceived value significantly influences passenger loyalty among the elderly through enhanced satisfaction. The study further emphasized the importance of maintaining service quality—such as facilities, assistance, and cleanliness—as satisfaction serves as a key mediating factor. These findings can therefore be used to support Hypothesis 1. Moreover, during the COVID-19 pandemic, changes in travel behavior were observed in Bangkok, where the overall demand for public transportation significantly declined. Yet, there remains a notable absence of targeted research on how such changes have impacted older adult populations specifically. In response to this research gap, this study seeks to support the creation of inclusive transportation policies and designs that reflect Thailand's shift toward an aging population (Thaithatkul et al., 2023).

2.3.3 Intention to Use Public Transportation

The Theory of Planned Behavior (TPB) is an extension of the Theory of Reasoned Action and is widely used to study attitudes and their influence on behavioral change. According to TPB, human behavior is influenced by behavioral intention, which in turn is shaped by three key factors (Ajzen, 1991):

1) Attitudes toward the behavior refer to an individual's overall evaluation of a behavior, derived from both positive and negative beliefs about that behavior. Previous studies have shown that the intention to use public transportation systems can be explained by attitude, subjective norm, and perceived behavioral control (PBC) in accordance with the TPB model. Elderly individuals with a positive attitude toward high-speed rail (HSR) are more likely to intend to use it (Dangbut et al., 2024; Watthanaklang et al., 2024). Attitude has been found to be the most significant factor, supporting Hypotheses 2 and 8.

2) Subjective norms refer to an individual's perception of social pressure or expectations regarding certain behavior, especially from close relations such as family members.

3) Perceived Behavioral Control (PBC) relates to how easy or difficult an individual feels it is to perform a behavior, based on their beliefs about facilitating

or hindering factors (control beliefs). PBC also has a direct influence on behavior. For example, a study investigating the psychological factors influencing travel mode choice in the case of the Bus Rapid Transit (BRT) system in Khon Kaen found that if passengers perceive BRT as a quality and viable option, their intention to use it increases. Moreover, the influence of family, friends, or society can make the BRT seem "less complicated"—for example, through accessible platforms and clear fare information—thereby enhancing elderly individuals' intention to use the service (Kaewklueklom et al., 2017).

Another study in China extended the TPB model by incorporating Descriptive Norms (DN) and elements of the walking environment to understand the factors affecting elderly individuals' behavioral intention to walk within their residential neighborhoods (Liu et al., 2022). It was found that those with a positive attitude toward walking had a higher intention to walk. PBC was a key predictor—when elderly individuals perceived walking near home as easy and low in barriers, their intention increased. DN had a significant influence on intention, while Subjective Norms (SN) did not. These findings support Hypotheses 3 and 4. Although TPB posits intention as the primary determinant of behavior, habit has been shown to directly predict actual behavior. For example, even if someone intends to try using BRT, those accustomed to private car use may continue driving. Habit serves as an additional variable that enhances the explanatory power of the model. When habit is integrated into TPB, the model better explains travel mode choice behavior than TPB alone (Kaewklueklom et al., 2017). Similarly, a study conducted in Beijing developed an integrated model combining TPB with habit to examine the influence of psychological variables on travel mode choice, particularly subway usage. The results indicated that intention was positively influenced by attitude, while habit negatively moderated the relationship between intention and behavior (Huang et al., 2016).

These findings are summarized in Table 2.1 of this study and are intended to inform the development of a truly elderly-friendly public transportation system.

2.4 Materials and Methods

2.4.1 Participants

Attention was given to older adults (60+ years) identified as vulnerable, with an emphasis on those using public transit. The sample was drawn from five major regions across Thailand. Provinces were selected based on medium to high population densities of older adults (defined as provinces with more than 100,000 elderly individuals). The selected provinces include Chiang Mai, Chiang Rai, Lampang, Nakhon Sawan, Phetchabun, Khon Kaen, Nakhon Ratchasima, Buriram, Ubon Ratchathani, Sisaket, Udon Thani, Surin, Roi Et, Chaiyaphum, Maha Sarakham, Ayutthaya, Pathum Thani, Suphan Buri, Ratchaburi, Chonburi, Nakhon Si Thammarat, Songkhla, Surat Thani, Nonthaburi, Samut Prakan, Samut Songkhram, Samut Sakhon, and Bangkok. To analyze behavioral intentions and travel-related perceptions among older adults, Structural Equation Modeling (SEM) was employed. SEM has been widely adopted in travel behavior research, particularly in the fields of travel demand forecasting and travel attitude analysis, due to its robustness in modeling both physical and psychological variables such as attitude, perceived service quality, information access, and travel intention. According to Golob (2003), SEM application requires adherence to several sampling standards: (1) A minimum sample size of 200 respondents is generally considered acceptable for SEM analysis (). (2) For Maximum Likelihood Estimation (MLE), the number of cases should be at least 15 times the number of observed variables. Stevens (2002) also suggests that there should be at least 15–20 respondents per indicator, or a minimum of 10 respondents per item, to ensure statistical reliability. (3) To ensure statistical reliability, a widely recognized standard recommends at least 10 respondents for each estimated parameter. This study collected 450 responses per region, satisfying the minimum requirements for robust SEM application.

2.4.2 Data collection and questionnaires

This study focuses on a vulnerable population group—older adults aged 60 and above. A pilot test was conducted with a subset of passengers prior to the main data collection phase in order to refine the language and improve respondent comprehension. Visual aids were included in the survey materials, and face-to-face

interviews were employed due to their flexibility in accommodating participant needs. Content validity was verified by transportation experts. Moreover, the study received approval from the Human Research Ethics Office (Project Code: EC-72-62). The trained data collection team conducted fieldwork at various locations such as public transport stations, bus stops, elderly activity centers, shopping malls, government offices, and healthcare facilities. A convenience sampling method was used, selecting participants based on accessibility, willingness, and availability rather than random sampling. As such, the sample may not fully represent the broader population due to the limitations inherent in this sampling technique.

A total of 2,250 questionnaires were administered across the selected regions. The questionnaire was structured into three sections as follows:

- 1) Section 1: This section gathered socio-demographic and travel behavior data, including variables such as gender, monthly income, household composition, travel purpose, and travel time periods, among others.
- 2) Section 2: This section included items assessing respondents' expectations and perceived service quality regarding public transportation systems. The items were developed based on a thorough literature review and aligned with validated service quality dimensions.
- 3) Section 3: This section measured attitudes toward public transportation, using statements evaluated through a 5-point Likert scale, where 1 indicated "strongly disagree" or "least satisfied" and 5 represented "strongly agree" or "most satisfied."

Validation of the questionnaire content was conducted by experts using the IOC framework to evaluate item relevance. The items were assessed by professionals in transportation and statistical analysis to ensure they corresponded with the defined constructs. Reliability of the questionnaire was assessed using Cronbach's Alpha, with an acceptable threshold set at 0.70 (Tavakol & Dennick, 2011). The results indicated that all constructs achieved reliability values ranging from 0.70 to 0.805, which fall within an acceptable range, confirming internal consistency of the instrument. All measurement items and public transport service quality indicators were derived from an extensive review of related literature and are presented in Table 2.3.

2.4.3 Data analysis

In this study, exploratory factor analysis (EFA) was employed using principal component extraction as the core technique for identifying underlying structures among observed variables. This method served to develop appropriate measurement scales and classify survey items into relevant dimensions. To improve interpretability of the extracted components, Varimax rotation was applied. This orthogonal rotation technique is particularly effective at maximizing the variance shared among items within each factor, thereby clarifying the separation between components. Only items with factor loadings greater than 0.50 were retained, as this threshold indicates practical significance in applied behavioral research. To ensure structural robustness, each latent construct was designed to include at least three to five observable indicators, and sampling adequacy was maintained in accordance with methodological guidance provided by Velicer and Fava (1998). The selection of factors also adhered to the criterion of eigenvalues exceeding 1.0, consistent with the standard set forth by Joseph F. Hair et al. (2010), indicating that each retained factor explained a meaningful proportion of the total variance. The study further employed structural equation modeling (SEM), which integrates both measurement and structural models. The measurement model specifies the relationships between latent constructs and their observed indicators, while the structural model outlines the hypothesized relationships among the latent constructs themselves. To evaluate the fit between the hypothesized model and the empirical data, multiple fit indices were considered. A non-significant chi-square statistic ($p > 0.05$) suggests acceptable model fit (Kline, 2011), and the ratio of chi-square to degrees of freedom χ^2/df is expected to be less than 3. As Hu and Bentler (1999) suggest, comprehensive model assessment should incorporate both absolute and incremental fit indices. These include the standardized root mean square residual (SRMR), the comparative fit index (CFI), and the Tucker–Lewis index (TLI). For complex models, the root mean square error of approximation (RMSEA) should be below 0.06, while values of 0.95 or higher are recommended for both CFI and TLI, and SRMR should not exceed 0.08. The internal consistency and reliability of each latent construct were evaluated through composite reliability (CR) and average variance extracted (AVE). As Bagozzi and Yi (1988) noted, CR values above

0.60 reflect acceptable internal reliability. Fornell and Larcker (1981) further explained that even in cases where AVE falls below 0.50, the construct may still demonstrate adequate convergent validity if CR exceeds 0.60. Nonetheless, Hair and Anderson (2006) recommends an AVE threshold of 0.50 or greater to ensure sufficient shared variance among indicators. The results of reliability and validity assessments are reported in Table 2.3.

2.5 Results

2.5.1 Descriptive Statistics

The sample comprised a total of 2,250 respondents, including 1,259 males (55.96%) and 991 females (44.04%). A substantial proportion of the participants, accounting for 41.56%, reported an average monthly income ranging between 20,000 and 30,000 Thai baht. More than half of the respondents (56.27%) indicated that they typically spent more than one hour per trip using public transportation. Travel behavior data further revealed that 44.93% of older adults preferred to travel during the morning hours between 7:00 and 10:00 a.m., while only 11% reported traveling after 4:00 p.m., and a mere 3% after 6:00 p.m. Regarding travel companionship, 41.29% of the respondents reported traveling alone, whereas 45.60% commonly traveled in pairs. Among the respondents, 2.76% reported using public transportation on a daily basis, while 18.2% used it weekly and 11.9% used it monthly. The majority, however, indicated that they used public transportation once every two to three months, accounting for 28% of the sample.

These findings are summarized in Table 2.2. The measurement of public transport service quality in this study was based on eight key dimensions comprising a total of 31 observed indicators. The dimensions included vehicle characteristics, accessibility, safety, reliability, convenience, staff, information, and station/stop facilities. These factors were identified based on an extensive literature review and validated through factor analysis to reflect service quality as perceived by elderly passengers.

Table 2.2 Overview of Respondent Characteristics

Demographics		Frequency	Percentage (%)
Gender	Male	1259	55.96
	Female	991	44.04
Age	60-69 Years	1563	69.47
	70-79 Years	457	20.31
	over 80 Years	230	10.22
Monthly income	Less than 10,000 THB	31	1.38
	10,000-20,000 THB	653	29.02
	20,000-30,000 THB	935	41.56
	30,000-40,000 THB	264	11.73
	40,000-50,000 THB	217	9.64
	50,000-60,000 THB	94	4.18
	60,000-70,000 THB	37	1.64
	Over 70000 THB	19	0.84
Travel Time	Less than 15 mins	183	8.13
	15-30 mins	253	11.24
	30-60 mins	548	24.36
	more than 1 hour	1266	56.27
Travel Purpose	back to hometown	160	7.11
	Travel	935	41.56
	Work	183	8.13
	Visit	288	12.80
	Healthy	163	7.24
	Shopping	258	11.47
	Govenment	230	10.22
	Religion	1	0.04
	Study	2	0.09
	Others	30	1.33
Travel Period	5-7 am.	284	12.62

Table 2.2 Overview of Respondent Characteristics (Continued)

Demographics		Frequency	Percentage (%)
Travel Member	7-10 am.	1011	44.93
	10 am- 1 pm	501	22.27
	1-4 pm.	201	8.93
	4-6 pm	166	7.38
	6-9 pm	87	3.87
	Travel alone	929	41.29
	2 Persons	1026	45.60
	3 Persons	262	11.64
	4 Persons	31	1.38
	5 Persons	2	0.09
Living Status	Alone	227	10.09
	With Mate	973	43.24
	With Young	1050	46.67

2.5.2 Reliability analysis

The reliability of the questionnaire was assessed through internal consistency testing using Cronbach's alpha, which is generally considered acceptable when exceeding a threshold of 0.70 (Joseph F. Hair et al., 2010). In this study, the Cronbach's alpha values for the measured constructs ranged from 0.700 to 0.791, indicating acceptable reliability for all items. Within the measurement model, the composite reliability (CR) values for public transport service quality constructs ranged from 0.602 to 0.820, while the average variance extracted (AVE) ranged from 0.521 to 0.626. When evaluated against established benchmarks, these values meet the recommended thresholds, suggesting that the observed indicators are both reliable and valid for representing their respective latent constructs. These results support the suitability of the items within the context of the measurement model and are detailed in Table 2.3 and Table 2.4.

2.5.3 Measurement Model: Confirmatory Factor Analysis (CFA)

The outcomes of the confirmatory factor analysis (CFA) for the measurement model are detailed in Table 2.5, offering empirical evidence on public transport users' expectations. The model's fit indices are as follows: $\chi^2/df = 2.394$, CFI = 0.964, TLI = 0.959, RMSEA = 0.025, and SRMR = 0.026. These values surpass commonly recommended thresholds, indicating a strong model-data fit. Similarly, the CFA evaluating perceived service quality yielded favorable fit metrics: $\chi^2/df = 2.791$, CFI = 0.960, TLI = 0.953, RMSEA = 0.028, and SRMR = 0.027. These results confirm that the measurement model effectively represents the latent constructs and is appropriate for assessing user perceptions of public transport service quality.

Table 2.3 Expectations Scale – Factor Loadings and Cronbach's Alpha

Factor	N of Items	Variable	Description	Factor Loadings	Reliability Statistics		
			Question		Cronbach's α	AVE	CR
Vehicle characteristics	4	EV1	The vehicle is expected to be modern and kept in a hygienic condition.	.693	.703	.503	.801
		EV2	Passengers anticipate a sense of safety throughout their journey.	.656			
		EV3	The climate inside the vehicle is expected to be suitably regulated.	.786			
		EV4	Vehicles are equipped with age-friendly features such as handrails.	.694			
Access	3	EA1	Access paths and walkways should accommodate mobility needs, including wheelchair parking.	.781	.701	.594	.655
		EA2	The station should be conveniently located within a reasonable distance.	.788			

Table 2.3 Expectations Scale – Factor Loadings and Cronbach's Alpha (Continued)

Description				Reliability Statistics			
Factor	N of Items	Variable	Question	Factor Loadings	Cronbach's α	AVE	CR
Safety	3	EA3	Stations are expected to have physical support facilities like ramps, elevators, and handrails.	.742	.700	.616	.671
		ES2	Onboard environments should be secure from potential criminal activity.	.757			
		ES3	Stations should be safeguarded with adequate crime prevention measures.	.840			
Reliability	3	ES4	Vehicles should include standard safety devices like seat belts and emergency tools.	.755	.708	.618	.673
		ER2	Journey duration should be efficient and not excessively time-consuming.	.763			
		ER3	Service frequency should meet the expected intervals.	.841			
		ER4	Timeliness in departure and arrival schedules is expected.	.752			
Convenience	4	EC2	Basic amenities such as Wi-Fi, restrooms, stairs, and lifts should be available.	.660	.700	.528	.606
		EC3	Seating should be sufficient and include priority seating for older passengers.	.758			
		EC4	Adequate space should be provided for storing luggage.	.758			
		EC5	The step height into the vehicle should be comfortable and manageable for seniors.	.686			

Table 2.3 Expectations Scale – Factor Loadings and Cronbach's Alpha (Continued)

Description				Reliability Statistics			
Factor	N of Items	Variable	Question	Factor Loadings	Cronbach's α	AVE	CR
Staff	4	EF1	Driving behavior is expected to be cautious and prioritizing safety.	.705	.741	.542	.616
		EF2	Vehicles should not depart until passengers are properly seated.	.736			
		EF3	Transport personnel should exhibit a service-oriented attitude.	.803			
		EF4	Staff are expected to act courteously and respectfully.	.697			
Information	5	EI1	Clear and complete travel-related information should be available.	.698	.791	.529	.607
		EI2	Timetable changes should be communicated promptly.	.792			
		EI3	Guidance on intermodal transfers should be provided to travelers.	.713			
		EI4	A feedback or complaint mechanism should be accessible to passengers.	.713			
		EI5	Announcements at the station should be comprehensive and audible.	.716			
Station/ STOP	5	ET1	Stop signage should be legible and appropriately sized.	.684	.781	.523	.602
		ET2	Stations are expected to maintain cleanliness and hygiene.	.689			
		ET3	Sufficient seating and sun protection (e.g., roofed waiting areas) should be available.	.820			
		ET4	Parking space should meet demand and be easily accessible.	.690			

Table 2.3 Expectations Scale – Factor Loadings and Cronbach’s Alpha (Continued)

Description				Reliability Statistics		
Factor	N of Items	Variable	Question	Factor Loadings	Cronbach's α	AVE
		ET5	Commercial amenities such as food outlets, drinks, and ATM services should be present.	.722		

Note: Average Variance Extracted (AVE), Composite Reliability (CR)

Table 2.4 Factor Loadings of Perceived Service Quality and Reliability Analysis

Description				Reliability Statistics		
Factor	N of Items	Variable	Question	Factor Loadings	Cronbach's α	AVE
Vehicle characteristics	4	VC1	The vehicle is expected to be modern and kept in a hygienic condition.	.814	.720	.534
		VC2	Passengers anticipate a sense of safety throughout their journey.	.665		
		VC3	The climate inside the vehicle is expected to be suitably regulated.	.774		
		VC4	Vehicles are equipped with age-friendly features such as handrails.	.657		
Access	3	AC1	Access paths and walkways should accommodate mobility needs, including wheelchair parking.	.864	.709	.612
		AC2	The station should be conveniently located within a reasonable distance.	.776		

Table 2.4 Factor Loadings of Perceived Service Quality and Reliability Analysis
(Continued)

Description				Reliability Statistics		
Factor	N of Items	Variable	Question	Factor Loadings	Cronbach's α	AVE CR
Safety	3	AC3	Stations are expected to have physical support facilities like ramps, elevators, and handrails.	.699	.718	.626 .679
		ST2	Onboard environments should be secure from potential criminal activity.	.775		
		ST3	Stations should be safeguarded with adequate crime prevention measures.	.822		
		ST4	Vehicles should include standard safety devices like seat belts and emergency tools.	.776		
Reliability	3	RL2	Journey duration should be efficient and not excessively time-consuming.	.771	.722	.614 .670
		RL3	Service frequency should meet the expected intervals.	.762		
		RL4	Timeliness in departure and arrival schedules is expected.	.818		
Convenience	4	CN2	Basic amenities such as Wi-Fi, restrooms, stairs, and lifts should be available.	.821	.709	.545 .618
		CN3	Seating should be sufficient and include priority seating for older passengers.	.685		
		CN4	Adequate space should be provided for storing luggage.	.700		

Table 2.4 Factor Loadings of Perceived Service Quality and Reliability Analysis
(Continued)

Description				Reliability Statistics			
Factor	N of Items	Variable	Question	Factor Loadings	Cronbach's α	AVE	CR
Staff	4	CN5	The step height into the vehicle should be comfortable and manageable for seniors.	.681	.703	.521	.601
		FF1	Driving behavior is expected to be cautious and prioritizing safety.	.789			
		FF2	Vehicles should not depart until passengers are properly seated.	.729			
		FF3	Transport personnel should exhibit a service-oriented attitude.	.689			
Information	5	FF4	Staff are expected to act courteously and respectfully.	.675	.775	.526	.602
		IN1	Clear and complete travel-related information should be available.	.849			
		IN2	Timetable changes should be communicated promptly.	.622			
		IN3	Guidance on intermodal transfers should be provided to travelers.	.640			
		IN4	A feedback or complaint mechanism should be accessible to passengers.	.843			
Station/STOP	5	IN5	Announcements at the station should be comprehensive and audible.	.635	.786	.533	.607
		SP1	Stop signage should be legible and appropriately sized.	.824			

Table 2.4 Factor Loadings of Perceived Service Quality and Reliability Analysis
(Continued)

Description				Reliability Statistics		
Factor	N of Items	Variable	Question	Factor Loadings	Cronbach's α	AVE CR
		SP2	Stations are expected to maintain cleanliness and hygiene.	.627		
		SP3	Sufficient seating and sun protection (e.g., roofed waiting areas) should be available.	.641		
		SP4	Parking space should meet demand and be easily accessible.	.884		
		SP5	Commercial amenities such as food outlets, drinks, and ATM services should be present.	.633		

Note: Average Variance Extracted (AVE), Composite Reliability (CR)



Table 2.5 Summary of Confirmatory Factor Analysis Outcomes

Expected Services				Perceived Services			
Factors		Standardized Estimates	R ²	Factors		Standardized Estimates	R ²
EQ1: Vehicle characteristics				PQ1: Vehicle characteristics			
(Cronbach's α =0.703, CR=0.503, AVE=0.801)	EV1	0.569***	.324	(Cronbach's α =0.720, CR=0.534, AVE=0.820)	VC1	0.708***	.501
(Cronbach's α =0.701, CR=0.594, AVE=0.655)	EV2	0.549***	.301	(Cronbach's α =0.709, CR=0.612, AVE=0.668)	VC2	0.604***	.365
	EV3	0.728***	.529		VC3	0.781***	.610
	EV4	0.606***	.367		VC4	0.491***	.241
EQ2: Access				PQ2: Access			
(Cronbach's α =0.700, CR=0.616, AVE=0.671)	EA1	0.683***	.466	(Cronbach's α =0.718, CR=0.626, AVE=0.679)	AC1	0.577***	.332
	EA2	0.681***	.464		AC2	0.955***	.913
	EA3	0.628***	.394		AC3	0.827***	.684
EQ3: Safety				PQ3: Safety			
(Cronbach's α =0.708, CR=0.618, AVE=0.673)	ES2	0.586***	.343	(Cronbach's α =0.722, CR=0.614, AVE=0.670)	ST2	0.611***	.373
	ES3	0.821***	.673		ST3	0.753***	.567
	ES4	0.600***	.360		ST4	0.669***	.447
EQ4: Reliability				PQ4: Reliability			
(Cronbach's α =0.700, CR=0.528, AVE=0.606)	ER2	0.656***	.431	(Cronbach's α =0.709, CR=0.545, AVE=0.618)	RL2	0.622***	.387
	ER3	0.781***	.610		RL3	0.660***	.436
	ER4	0.585***	.343		RL4	0.768***	.590
EQ5: Convenience				PQ5: Convenience			
(Cronbach's α =0.700, CR=0.528, AVE=0.606)	EC2	0.456***	.208	(Cronbach's α =0.709, CR=0.545, AVE=0.618)	CN2	0.724***	.524
	EC3	0.591***	.349		CN3	0.601***	.362
	EC4	0.728***	.530		CN4	0.663***	.440
EQ6: Staff	EC5	0.650***	.423	PQ6: Staff	CN5	0.545***	.297

Table 2.5 Summary of Confirmatory Factor Analysis Outcomes (Continued)

Expected Services				Perceived Services			
Factors		Standardized Estimates	R ²	Factors		Standardized Estimates	R ²
(Cronbach's α =0.741, CR=0.542, AVE=0.616) EQ7: Information	EF1	0.552***	.304	(Cronbach's α =0.703, CR=0.521, AVE=0.601) PQ7: Information	FF1	0.785***	.616
	EF2	0.657***	.432		FF2	0.657***	.432
	EF3	0.782***	.611		FF3	0.506***	.257
	EF4	0.600***	.360		FF4	0.463***	.215
(Cronbach's α =0.791, CR=0.529, AVE=0.607) EQ8: Station/STO P	EI1	0.616***	.379	(Cronbach's α =0.775, CR=0.526, AVE=0.602) PQ8: Station/STO P	IN1	0.898***	.807
	EI2	0.739***	.547		IN2	0.492***	.242
	EI3	0.638***	.407		IN3	0.492***	.242
	EI4	0.633***	.400		IN4	0.805***	.648
	EI5	0.663***	.439		IN5	0.576***	.331
(Cronbach's α =0.781, CR=0.523, AVE=0.602)	ET1	0.604***	.365	(Cronbach's α =0.786, CR=0.533, AVE=0.607)	SP1	0.585***	.342
	ET2	0.597***	.356		SP2	0.436***	.190
	ET3	0.805***	.647		SP3	0.635***	.404
	ET4	0.600***	.359		SP4	0.742***	.551
	ET5	0.638***	.407		SP5	0.612***	.375

Note: ***p < 0.001; Composite Reliability (CR); Average Variance Extracted (AVE).

2.5.4 Structural equation modeling results

The structural model demonstrated an excellent fit with the observed data, satisfying all established benchmarks for model adequacy. The fit indices were $\chi^2/df = 354.988/305$, CFI = 0.998, TLI = 0.997, RMSEA = 0.009, and SRMR = 0.026, all of which indicate strong model performance. The results of the SEM analysis, as presented in Figure 2.1, Table 2.6, and Table 2.8, demonstrate the statistical significance of all the hypotheses proposed in this study. The measurement model analysis revealed that some indicators exhibited factor loadings approaching 1. This

may reflect a high degree of response homogeneity (Kline, 2011), particularly among older adults, who often share similar characteristics, behaviors, or experiences. Consequently, their responses to the questionnaire tend to align in a consistent direction, which represents a specific feature of the data unique to this population group rather than a broader demographic. Therefore, while high factor loadings indicate strong consistency between indicators and latent constructs, it is important to interpret such results with caution. Potential redundancy among indicators should be considered to maintain model parsimony and efficiency.

When examining the hypotheses regarding causal relationships among latent variables representing factors influencing elderly passengers' intentions to use public transportation, all proposed hypotheses were supported. The statistical significance of these relationships is evaluated as follows:

- 1) H_1 : Passenger satisfaction has a direct positive effect on the intention to use public transportation ($\beta = 0.912, p < 0.01$).
- 2) H_2 : A favorable attitude toward public transportation has a direct positive effect on intention ($\beta = 0.582, p < 0.05$).
- 3) H_3 : Subjective norms exert a direct positive effect on the intention to use public transportation ($\beta = 0.085, p < 0.01$).
- 4) H_4 : Perceived behavioral control (PBC) has a significant direct effect on intention ($\beta = 0.112, p < 0.001$).
- 5) H_5 : Customer expectations positively influence perceived service quality (PSQ) ($\beta = 0.570, p < 0.05$).
- 6) H_6 : Perceived service quality (PSQ) positively influences customer satisfaction with public transportation ($\beta = 0.286, p < 0.01$).
- 7) H_7 : Habit exerts a negative influence on intention ($\beta = -0.100, p < 0.01$).
- 8) H_8 : Public transportation satisfaction is enhanced by a favorable user attitude ($\beta = 0.649, p < 0.01$).

These results underscore the multifaceted nature of intention formation among elderly users and highlight the critical roles of satisfaction, service quality, and habitual behavior in shaping future mobility choices.

Based on the results of the structural equation modeling and mediation analysis, as presented in Table 2.7, both the direct and indirect effects of attitude on behavioral intention through satisfaction were observed. These findings indicate that higher levels of satisfaction with public transportation among older adults positively influence their intention to use such services. Satisfaction acts as a mediating factor linking attitude to behavioral intention. When older adults are satisfied, they are more likely to reuse the service, recommend it to others, or intend to use it again in the future.

Attitude plays a preceding role in shaping satisfaction. For example, attitudes toward travel safety, service reliability, fare affordability in relation to income, and improvements in service quality—especially those features relevant to the elderly, such as ease of boarding and alighting, station accessibility, and amenities like handrails, elevators, and designated seating—help determine the level of satisfaction. In turn, satisfaction enhances the likelihood of future service usage.

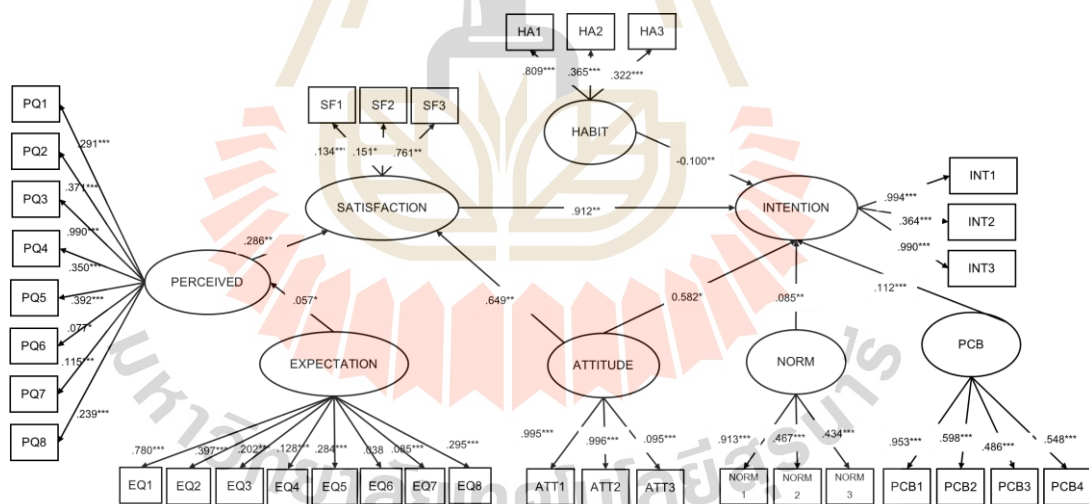


Figure 2.1 SEM Framework for Public Transportation Usage Intention

Note: Model fit information: Chi-square value (χ^2) = 354.988, degree of freedom (df) = 305 (p-value = 0.000), Root mean square error of approximation (RMSEA) = 0.009, CFI = 0.998, TLI = 0.997, Standardized Root Mean Square Residual (SRMR) = 0.026

Table 2.6 Standardized Loadings in the SEM Analysis

Independent Variables	Std. Estimates	Std. Error	P-Value
Intention			
INT1	0.994	0.000	<0.001***
INT2	0.364	0.017	<0.001***
INT3	0.990	0.001	<0.001***
Attitude			
ATT1	0.995	0.000	<0.001***
ATT2	0.996	0.000	<0.001***
ATT3	0.095	0.027	<0.001***
Subject Norm			
NORM1	0.913	0.099	<0.001***
NORM2	0.467	0.052	<0.001***
NORM3	0.434	0.049	<0.001***
PCB			
PCB1	0.953	0.035	<0.001***
PCB2	0.598	0.026	<0.001***
PCB3	0.486	0.023	<0.001***
PCB4	0.548	0.027	<0.001***
Habit			
HA1	0.809	0.180	<0.001***
HA2	0.365	0.083	<0.001***
HA3	0.322	0.073	<0.001***
Satisfaction			
SF1	0.134	0.049	<0.01**
SF2	0.151	0.070	<0.05*
SF3	0.761	0.250	<0.05*
Perceived Services			
PQ1	0.291	0.037	<0.001***
PQ2	0.371	0.038	<0.001***
PQ3	0.990	0.000	<0.001***

Table 2.6 Standardized Loadings in the SEM Analysis (Continued)

Independent Variables	Std. Estimates	Std. Error	P-Value
PQ4	0.350	0.040	<0.001***
PQ5	0.392	0.048	<0.001***
PQ6	0.077	0.033	<0.05*
PQ7	0.115	0.035	<0.001***
PQ8	0.239	0.030	<0.001***
Expected Services			
EQ1	0.780	0.053	<0.001***
EQ2	0.397	0.033	<0.001***
EQ3	0.202	0.045	<0.001***
EQ4	0.128	0.026	<0.001***
EQ5	0.284	0.027	<0.001***
EQ6	0.038	0.026	<0.001***
EQ7	0.085	0.026	<0.001***
EQ8	0.295	0.030	<0.001***

Note; *** p < 0.001, ** p<0.01, * p<0.05.

Table 2.7 Result of Structural Model.

Relationship	Standardize Coefficients	Result
Attitude →(+) Intention	0.582*	Supported
NORM →(+) Intention	0.085*	Supported
PCB →(+) Intention	0.112***	Supported
Expectation →(+) Perceived	0.015**	Supported
Service→(+)Satisfaction→(+)Intention		
Habit →(-) Intention	-0.100**	Supported
Attitude →(+) Satisfaction→(+)Intention	0.591**	Supported

Note; *** p < 0.001, ** p<0.01, * p<0.05.

Table 2.8 Comparison of Fit Indices and Recommended Thresholds for the Structural Equation Model

Fit Index / Statistical Measure	Recommended Threshold	Analysis Result	Index Interpretation
χ^2/df	>5	1.16	Good model fit
Comparative Fit Index: CFI	≥ 0.90	0.998	Good model fit
Tucker-Lewis Index: TLI	≥ 0.80	0.997	Good model fit
Standardized Root Mean Square Residual: SRMR	≤ 0.08	0.026	Good model fit
Root Mean Square Error of Approximation: RMSEA	≤ 0.05	0.009	Good model fit

Table 2.9 Summary of related research

Authors	Country	Methodology	Data used	Key findings
Kuo and Tang (2013)	Taiwan	SEM (service quality, corporate image, customer satisfaction, and behavioral intention)	341 elderly participants	Satisfaction directly affected travel behaviors, while service quality and corporate image played indirect roles. Service quality plays a significant role on the effect of satisfaction.
Kulachai (2014)	Thailand / Bangkok	SEM / Quality of life	400 elderly participants	Mobility and social inclusion affect quality of life in terms of mental health, independence, and sense of worth.

Table 2.9 Summary of related research (Continued)

Authors	Country	Methodology	Data used	Key findings
Suangka (2015)	Thailand	SEM / CFA	325 elderly from 3 Provinces	The quality of public transportation systems and the health of the elderly directly influence how often they use public transportation.
Srichuae et al. (2016)	Thailand	Logistic regression	Elderly survey data: 292 elderly participants in Bangkok	The community urban development and planning and neighborhood design is important for supporting elderly mobility.
Kaewklue ngklom et al. (2017)	Khonkan, Thailand	Habit/TPB / The utility function	215 private car users, 220 motorcycle users, and 165 public transport users (Non- elderly)	Attitude and habit are the most important variables influencing the intention to use BRT.
Wong et al. (2017)	Hong Kong	SEM / Satisfaction	613 elderly participants	The factors that have the greatest influence on satisfaction are accessibility and comfort & safety.

Table 2.9 Summary of related research (Continued)

Authors	Country	Methodology	Data used	Key findings
Wong et al. (2018)	Hong Kong	A binary logistic regression	613 elderly participants	Elderly people place more importance on the accessibility of bus stops and the short waiting time than on other factors.
Norasan and Seeboonruang (2019)	Thailand	CFA (Quality of public transport system)	Elderly people and entering the elderly age (45-60 Years): 204 tourists	The factor that most affects the evaluation of public transport system quality is the physical characteristics of the transport stations.
Sun et al. (2020)	China	MIMIC, the ecological model	438 elderly participants	The elderly believe that public transport, AVs, and SAVs are useful and convenient travel modes for themselves.
Liu et al. (2022)	Nanjing, China	SEM /TPB (walking behavioral intention)	501 elderly participants	PBC is highly correlated with older people's behavior intention.
Hamzah et al. (2023)	Kuala Lumpur, Malaysia	SEM/ Satisfaction	Survey of 421 rail and bus passengers (Non-elderly)	Satisfaction affected to switching intention and WOM.

Table 2.9 Summary of related research (Continued)

Authors	Country	Methodology	Data used	Key findings
Iamtrakul et al. (2023)	Thailand	spatial analysis	Examining health care access in older adults aged 60 years and older in the Ban Phaeo, Samut Sakhon	Geospatial modelling shows that access to health care was impacted by poor road connectivity and road conditions.
Dangbut et al. (2024)	Thailand	SEM /the technology readiness index (TRI)/TAM	3200 elderly, in the areas along high-speed rail routes in Thailand (Urban & Rural area)	Attitudes toward using high-speed rail are important in urban areas, whereas attitudes and perceived benefits are important in rural areas.
Wattthana klang et al. (2024)	Thailand	SEM/TPB	400 public transport users (Non-elderly)	Attitude has the highest influence on intention to use public transport, Service quality has a direct impact on perceived accessibility.

Table 2.9 Summary of related research (Continued)

Authors	Country	Methodology	Data used	Key findings
Nanthawong et al. (2024)	Nakhonratchasima, Thailand	SEM/ Loyalty /Satisfaction	750 parents (Non-elderly)	If parents are satisfied with public transportation services, they are more likely to choose to use them.
Lieophairat et al. (2025)	Thailand	SEM / Loyalty	625 older rail passengers	Innovation exerted the strongest overall effect on Loyalty, both directly and through its influence on service quality and passenger satisfaction.
Philuek et al. (2025)	Thailand	Multinomial Logit model	Elderly survey data: 1,000 elderly participants Thailand's four regions,	This study analyzes the factors influencing travel mode choice among the elderly in Thailand by comparing traditional statistical methods with modern machine learning techniques.

Table 2.9 Summary of related research (Continued)

Authors	Country	Methodology	Data used	Key findings
This research	Thailand	CFA/SEM/ TPB/Habit/Sat isfaction	2250 elderly participants Thailand's 5 regions	Satisfaction has the greatest influence on intention, followed by positive attitudes, which also directly affect the intention to use public transportation. Additionally, attitude exerts an indirect effect on intention through satisfaction. At the same time, the habit of using private vehicles remains a barrier to this intention among older adults.

2.6 Discussion

This study demonstrates that, even when considering different passenger age groups, a positive attitude toward public transportation exerts a favorable influence on the elderly's intention to travel using public transit. To promote the use of public transit instead of private cars, emphasis should be placed on nurturing positive attitudes toward public transportation—consistent with the findings of Watthanaklang et al. (2024), which examined public transit intention in Thailand. That study suggests public transit systems should be designed to meet users' needs and ensure equitable accessibility. The present findings indicate that enhancing capacity or shifting intentions is valuable not only for older adults but also for making transit more user-friendly across all age groups.

From our results, a favorable attitude toward public transportation has both direct and indirect effects on behavioral intention, mediated by satisfaction. Indeed,

the most powerful predictor of intention among elderly passengers is satisfaction with the service. This aligns with earlier Thai studies (Dangbut et al., 2024) on the effect of attitudes toward high-speed rail technology in urban and rural areas. When infrastructure is well designed—e.g., adequate lighting, nonslippery surfaces, handrails, clear signage—older adults feel more confident and safe, thereby improving perceptions of usability and perceived benefits, which in turn influence attitude and behavioral intention. If positive attitudes are cultivated, satisfaction and intention among elderly users increase. Similarly, research in China (Sun et al., 2020) (using an extended ecological model rather than strict TPB) found that perceived usefulness and perceived convenience positively affect mode-choice intention. Older adults perceive public transport as useful and convenient, thereby raising their intention to choose that mode. This highlights that older adults' attitudes toward public transport as a practical and reliable mode are critical. Parallel findings have been recorded in Kuala Lumpur and peri-urban areas, where service quality and satisfaction positively influence users' intention to switch modes and generate word-of-mouth (WOM) advocacy (Hamzah et al., 2023). This suggests that in developing countries like Malaysia, policies promoting modal shift from private vehicles to public transit should focus on fostering positive attitudes, which improve satisfaction, thereby driving intention to use public transport over private cars.

The satisfaction factor exerts the strongest influence on elderly persons' intention to travel by public transport. This result aligns with Kuo and Tang (2013), a Taiwanese study of individuals aged 65 or older that examined their intention to use high-speed rail via SEM. Although that study did not adopt the Theory of Planned Behavior, it still used behavioral intention as the endpoint variable—as in TPB—and found that service quality has a significant positive effect on customer satisfaction, and satisfaction in turn directly and strongly affects future usage intention. Moreover, it reflects that the cohort aged 45–60 in Bangkok is approaching old age; in a study of travel behavior for tourism in Bangkok, it was similarly observed (Norasan & Seeboonruang, 2019). Station or bus-stop design should consider elder-friendly facilities such as ramps, shade, rest seats, toilets, and safe, clean walkways. The main problems faced by elderly bus users in Bangkok (Kulachai, 2014) include difficulty

boarding and alighting, inadequate infrastructure, and lack of information about schedules and fares. If buses run punctually, offer easy boarding and alighting, and provide comprehensive routes, elderly individuals could travel for daily needs (e.g., to markets, hospitals, or to meet friends), thereby improving quality of life.

Likewise, a study on older Thai adults in three northeastern provinces (Nakhon Ratchasima, Buriram, and Khon Kaen). Suangka (2015) found that service quality—particularly vehicle condition, staff service, schedules, and station condition—directly influences the elderly’s choice and frequency of use. An Importance–Satisfaction analysis (Wong et al., 2017) showed that station or stop condition is the most influential factor on overall satisfaction among elderly passengers; notably, 17.8% of respondents expressed strong dissatisfaction with “seat availability,” emphasizing the need to improve pedestrian environments for older adults (Liu et al., 2022). In both Thailand and abroad, satisfaction has a major effect on intention among elderly passengers. When comparing the statistical influence of satisfaction factors, the effect size on use intention among older Thai adults is higher than in studies conducted in Taiwan and Malaysia. This suggests that Thai elders place special importance on “creating a satisfying service experience.” Considering the Thai cultural context, older persons often receive assistance from children or family members—such as being escorted to stations, ticket booking, or help with luggage. Having supportive or empathetic service (service empathy) aligns with the cultural norm of filial piety and respect for elders, which affects older Thais emotionally. Receiving such assistance from family or community strengthens confidence, safety, and perceived ease of use (PEU), which in turn fosters more positive attitudes toward public transport use. It is thus recommended to train drivers to adopt positive, respectful, attentive attitudes toward elders (driver attitude). Because of this cultural value of gratitude, meeting this need influences satisfaction, and encouragement from close ones helps increase the elderly’s intention to try or accept public transport modes (Sun et al., 2020).

Beyond contributing to the SERVQUAL framework, this research expands existing theory by demonstrating that the negative impact of private car usage also influences older adults’ intention to use public transport. Dependence on private vehicles lowers the intention to use public transport; older adults often rely on public modes only

when necessary (e.g., car breakdowns or lack of alternatives). Long periods of private car use foster habits anchored in travel comfort, reducing the tendency for elders to experiment with or adapt to public transport. Accordingly, public transport promotion policies should target reducing the habitual reliance on private cars by making them less convenient or more costly and by creating opportunities for new habits—such as monthly passes, easily accessible stations, and consistently reliable services. Fu (2021) recommended that to effect behavioral change (mode shift), friction from habitual behaviors must be lowered—either by making alternative modes more efficient or restricting strong modes such as private car use and by giving privileges to public transit—consistent with Bangkok’s context (Thaithatkul et al., 2023). It was found that demand for public transport dropped markedly during key events like the COVID-19 pandemic, with people switching to private cars, walking, or biking rather than using major transit stations. Similar trends were observed in Iran during COVID-19: although service quality improved and satisfaction rose, user loyalty declined. The main factor reducing loyalty during the pandemic was the shift to private cars. Therefore, in post-COVID-19 (the “new normal”) studies—in which daily life and technology (especially online) have shifted (Raghavan et al., 2021)—it is advisable to explore applications of technology for elderly passengers (e.g., mobility apps), as well as aspects of safety and health such as seat distancing and reserved seating, since this group is particularly vulnerable to health risks. In Hong Kong (Wong et al., 2018), the top priorities for improvement were seat availability and station or stop condition—areas with high importance but low satisfaction. Also critical is communication that reassures passengers the transport system is safe and disease-prevention measures are in place.

Esmailpour et al. (2022) note that customer expectation factors have a positive influence on perceived service quality (PSQ), which in turn positively influences customer satisfaction in public transport usage. This is consistent with Thai guardians who have high expectations: seeing good service quality leads to satisfaction and trust, and they are more inclined to let their children use public transport (Nanthawong et al., 2024). Behavioral change thus must not only shift attitudes but also adjust or transform the situational circumstances that lead to habitual behaviors. For example,

a study of older adults in Italy (Rossi et al., 2023) revealed that developing elder-supportive communities and an accessible, high-quality, friendly public transport system affects seniors' life satisfaction. Moreover, research on Kuala Lumpur's public transport suggests that improving only structural quality (tangibles or reliability) is insufficient to trigger behavioral change; services must also be empathetic, responsive to users' needs, comfortable, and capable of generating satisfaction, thereby fostering public transport adoption and positive word-of-mouth (WOM).

2.7 Conclusion

This study examined the causal factors influencing travel intention among elderly passengers in Thailand and revealed that a positive attitude toward public transportation has a direct and significant effect on user satisfaction. These findings offer important implications for policymakers and relevant stakeholders, highlighting the necessity to incorporate the perspectives of elderly passengers in the formulation of public transportation policies. Such policies should aim to promote equitable access to transit services for all, particularly aging populations. A critical factor emerging from the analysis is habit—specifically, the habitual use of private vehicles, which represents a behavioral pattern contrary to public transport usage. This habitual reliance on self-directed modes of transport negatively impacts the intention to use public transportation among older adults. To encourage habit formation aligned with public transit use, it is essential to foster environments and circumstances that consistently reinforce such behavior. One promising example is Thailand's fare reduction policy for elderly bus riders, which has been widely recognized as a socially progressive subsidy. This initiative reduces reliance on private vehicles among non-working elderly individuals and promotes equitable access to public services. If elderly passengers can experience seamless and stress-free travel, their satisfaction and long-term commitment to using public transportation can be significantly enhanced. To ensure services meet real user needs, it is recommended that public transportation systems be developed through a value co-creation approach, involving elderly passengers in the design and improvement of services. This participatory process not only aligns services with the lived experiences of older users but also builds trust and satisfaction. The findings of this study suggest that for public transport systems in Thailand to

become truly sustainable, greater attention must be paid to the role of past behavior in shaping travel habits. Predicting and influencing future behavior requires more than simply altering intention—it necessitates interventions that also reshape habitual responses over time.

Based on the findings of this study, a policy framework can be developed to promote the use of public transportation among Thai elderly individuals as follows:

1) Implementation Stages

a. Short-term: Focus on improving basic services such as cleanliness, safety, and clear, accessible information. This includes well-marked signage and fare reduction measures specifically for older adults.

b. Medium-term: Invest in elder-friendly infrastructure, including elevators, ramps, and designated seating.

c. Long-term: Aim to cultivate a sustainable travel culture through public awareness campaigns, educational programs, and integration with social welfare systems.

2) Resource Requirements

Policy implementation requires budget allocations from both central and local government authorities. It also involves the development of trained personnel equipped to serve elderly passengers and the application of technology to enhance accessibility. This may include user-friendly mobile applications with large fonts, audio instructions, or information presented in simplified Thai language.

3) Evaluation Metrics

Key performance indicators may include: the proportion of elderly individuals shifting from private cars to public transportation, satisfaction levels with public transport services, frequency of use, and improvements in social equity outcomes.

4) Barriers and Strategies

Potential barriers include habitual reliance on private vehicles, budget constraints, and unequal access to services. Suggested strategies to overcome these challenges include:

a. Providing economic incentives for elderly users.

- b. Encouraging participation of older adults in service design and pilot testing (co-creation).
- c. Offering free or discounted trial programs for the elderly.
- d. Launching initiatives such as a “Buddy System” involving volunteers assisting elderly passengers with boarding and alighting.
- e. Organizing training programs to familiarize seniors with public transport technologies.
- f. Conducting guided excursions to help older adults learn new routes and services.
- g. Introducing user trials of new transport systems (e.g., new bus models or BRT) to collect feedback before full-scale implementation.
- h. Integrating public transport policy with urban development and public health strategies to build strong and sustainable linkages.

2.8 Limitations and future studies

Due to the global disruption caused by the COVID-19 pandemic, this study incorporates insights from the pandemic period, during which public transport usage significantly declined as individuals increasingly turned to private vehicles. However, as COVID-19 transitions into an endemic disease and conditions normalize, travel patterns may gradually return to pre-pandemic levels. Nonetheless, the emergence of new lifestyles and behavioral patterns could result in long-term shifts in mobility choices. It is important to note that this study does not include any variables related to COVID-19 prevention measures, as the data were collected prior to the outbreak. If future studies explore the behavior of elderly passengers during the pandemic, they may uncover how COVID-19 prompted this demographic to become more cautious and adaptive in using public transport. Notably, the pandemic influenced changes in attitudes, subjective norms, perceived behavioral control, and satisfaction—each of which affected elderly individuals' travel behavior during and after the outbreak. Health concerns played a significant role, as older adults became increasingly worried about infection risks associated with public transport, leading to more cautious attitudes toward travel in public spaces. Additionally, the need to adapt to technology—for

instance, in ticket booking or accessing travel information—helped increase confidence and convenience among elderly passengers.

Moreover, improvements in public transport service quality—such as enhanced cleanliness, social distancing measures, and service accessibility—have also contributed to greater satisfaction among older adults with public transport in Thailand. As the situation normalizes, future research should examine underlying heterogeneity in the behaviors and attitudes of older adults by segmenting the population based on various demographic factors, such as gender, age groups (60–69 years, 70–79 years), or geographic regions. Identifying these underlying differences would provide valuable insights that may not be evident from aggregate analyses and would contribute to a more comprehensive understanding, thereby supporting the development of more targeted policies and interventions.

In addition, future studies should consider the context of the COVID-19 pandemic, as this situation may have significantly influenced changes in the behaviors and attitudes of older adults. Comparative analyses of behavioral patterns before, during, and after the pandemic would help clarify the dynamics of behavioral change and offer important directions for further research.

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CHAPTER III

ELDERLY USERS' SATISFACTION WITH PUBLIC TRANSPORT IN THAILAND USING DIFFERENT IMPORTANCE PERFORMANCE ANALYSIS APPROACHES

3.1 Abstract

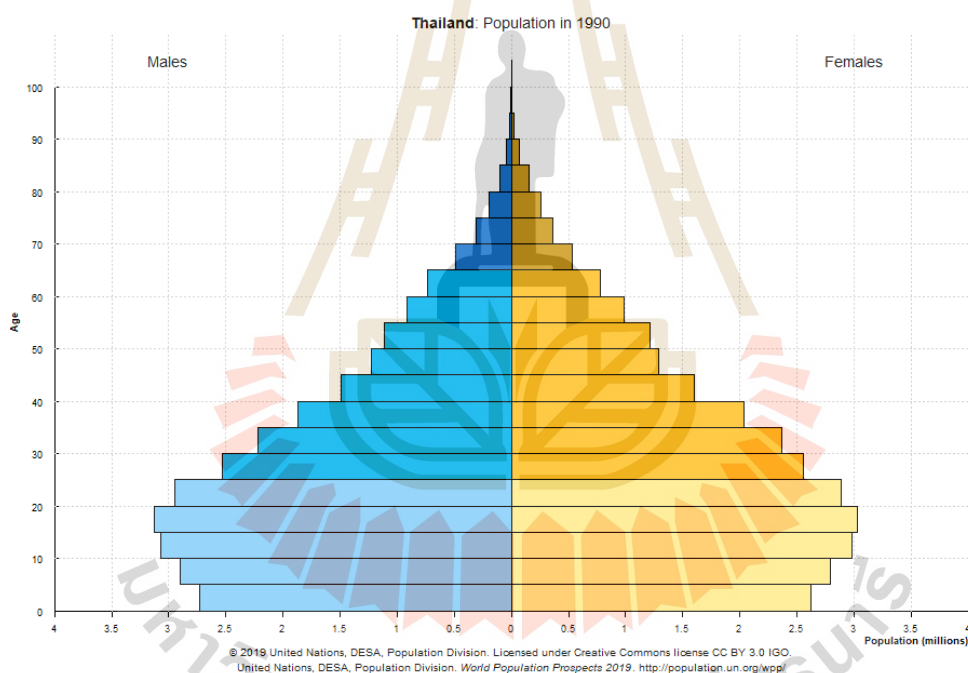
Due to the rapid increase in population and the change in age structure toward the elderly, the phenomenon of societal ageing is being witnessed in many countries. The elderly travel less than the adult population due to decreasing mobility with an increasing age. In this study, we aimed to analyze the expectations and satisfaction of public transport users in Thailand using traditional importance performance analysis (IPA), gap analysis, and IPA integrated with competitor performance. We aimed to explain the differences in the analysis results produced by the three methods. The data were obtained from surveying 2250 elderly and 450 non-elderly adults. This study presents guidelines for improving the public transport service quality in Thailand to meet user needs. The results of this research showed that each approach provides its own distinctive aspects and theoretical differences, which lead to different interpretations. The results from the three approaches showed that equipment that increases safety for public transportation service users is an important factor for all elderly passengers that must be improved. Public transportation service in different regions should be developed to provide more reliable and regular services.

3.2 Introduction

3.2.1 The Ageing Society

In 2019, the number of elderly (aged 65 years and over) increased to 703 million worldwide, highlighting the global phenomenon of population ageing. Southeast Asia has the world's largest number of elderly people, estimated at 260 million people, or 37% of the world's total. This number is expected to remain stable

until 2050 (Population Division, 2019a). The World Health Organization (2018) predicted that in 2030, the number of elderly (60 years and over) around the world will reach 1.4 billion people, and increase to 2.1 billion by 2050. In 2019, Thailand had a population of 66.56 million (The Bureau of Registration Administration, 2020) and had a proportional population of the elderly (aged 60 years and over) of 16.73% or 11.13 million people (Department of Older Person, 2020). The number of elderly people in Thailand is as high as that of many developed countries. By 2022, Thailand will be categorized as a super-aged society as the proportion of the elderly will rise to 26.9% in 2030 and to 37% in 2050. The pressure produced by the rapidly increasing elderly population is posing a considerable challenge, as illustrated in Figures 3.1a, b.



(a)

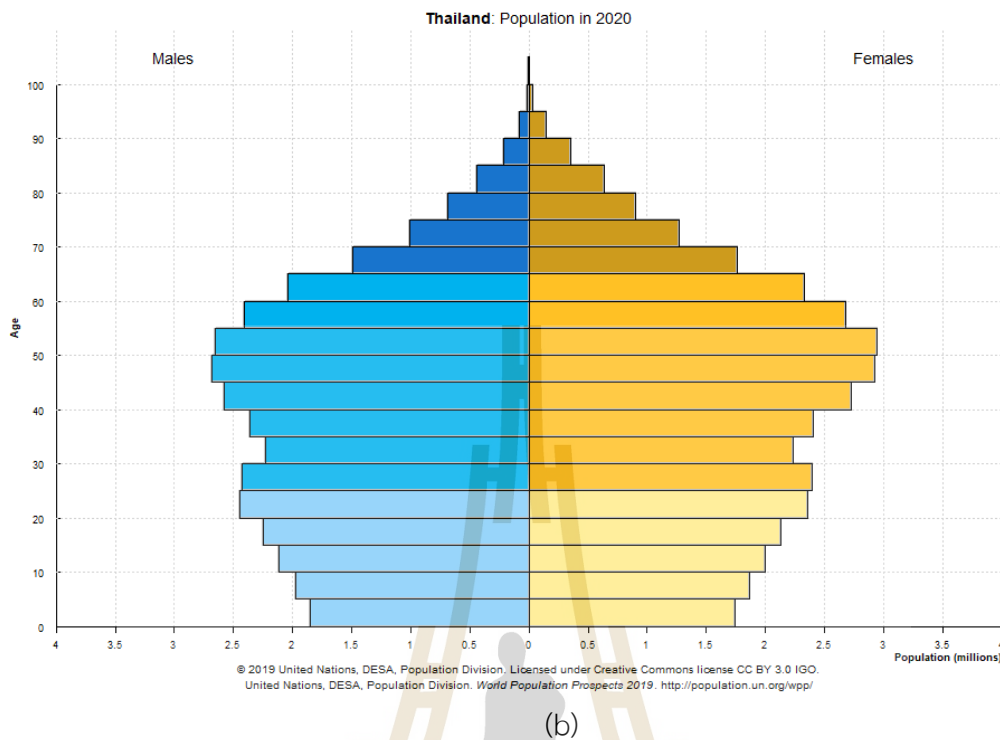


Figure 3.1 The statistical trend of the Thai population by age: population pyramids of Thailand in (a) 1990 and (b) 2020. Source: Population Division (2019b)

3.2.2 Literature Review of Elderly and Travel

Travel is undertaken by those of all ages and the elderly travel for a variety of purposes. Thus, the unavailability of public transportation service readiness causes future problems for the elderly because public transport benefits them by providing freedom to travel (2016).

3.2.2.1 Public Transport Factors

Service quality is studied in many research fields. The transport sector places importance on the service quality, as travel is considered an important aspect of daily life. The different contexts of developing and developed countries affect travel behavior, for example, personal car travel is a form of travel that competes with public transport in developing countries (LuisMachado-León, Oña, TaharBaouni, & Oña, 2017). The factors of service quality using 24 attributes of bus service (2019) were studied in Cambodia using the traditional importance performance analysis (IPA) method to provide guidelines for the government to improve bus service

quality. Research related to improving the quality of retail delivery services suggests that it should focus on improving logistics services and overall satisfaction rather than only a single variable (2009). Travel behavior and attitudes toward high-speed trains were studied in the United Kingdom (2014), and the service quality for train passengers in India was studied based on service quality (2010). For Thailand, the service quality of the public transport system was examined through a comparative study of the service quality of intercity trains using various analysis methods (Jomnonkwao, Champahom, & Ratanavaraha, 2020).

3.2.2.2 The Elderly

Most research related to the elderly has been based on medical treatment guidelines; research related to public transport of the elderly is a relatively new concept in developing countries. Hu, Wang, and Wang (2013) conducted a comparative study of the difference between the elderly's travel behavior in developed and developing countries like China. The results indicated that 30% of the elderly in developed countries chose to travel by private car. Similarly in Taiwan, elderly passengers tended to use public transport less than cars due to safety, which is an important factor considered when choosing an airport access mode by elderly passengers (Yu-ChunChang, 2013). The elderly were not satisfied if there no assigned seats for them, and also expressed dissatisfaction with the environments at stations or transit stops (Wong, zeto, Yang, Li, & Wong, 2017). The fare and sufficient seats were important factors for the elderly who traveled by train and by bus in Hong Kong (Wong, zeto, Yang, Li, & Wong, 2018). In Thailand, the research was conducted on factors affecting the elderly's mobility, with an emphasis on the development of city plans and transportation planning. The research objective was to enhance ageing mobility when traveling (Srichuae, Nitivattananon, & Perera, 2016) by analyzing data in specific urban areas such as Bangkok.

From the literature review, we found that the studies on transportation service quality were conducted to increase service user satisfaction. Previously, only one or two methods were used for analysis. To fill the knowledge gap, we aimed to compare the three methods of analysis for assessing the elderly's expectations and satisfaction toward public transport in a city: (1) traditional IPA, (2)

gap analysis, and (3) IPA integrated with competitors' efficiency to develop transportation system management measures. In this research, we compared the analysis of expectations and satisfaction of users of all three methods to demonstrate the uniqueness of each theory, its results, and different interpretations. We also examined users' viewpoints in different age range groups by considering 10 dimensions of factors for high satisfaction; the findings from the three methods can be applied to help develop this society that is ageing and to ensure the sustainability of future development.

3.3 Materials and Methods

3.3.1 Data Collection

We focused on a vulnerable population—the elderly (60 years and over). This research was approved by Ethics Committee for Researches Involving Human Subjects, Suranaree University of Technology (Project code: EC-72-62). Face-to-face interviews were chosen to collect data due to their flexibility. The question items were tested using item-objective congruence (IOC) by experts in transportation. Statistics were used to determine the consistency between each question, which was successively adjusted according to the recommendations from the pilot test. For data collection, a total of 2700 questionnaires were obtained from 5 regions—which are the north, central, southern, and northeast regions—and divided in line with the Thailand National Statistical Office's common practices by collecting 450 samples from each region. An additional 450 surveys were collected from people using public transport, both elderly and non-elderly (aged 18–59 years) in Bangkok and metropolitan areas, where the management and transportation systems are different from the aforementioned four regions. The questionnaire was divided into 2 parts: Part 1 included social-demographic characteristics and travel behavior, such as sex, income, living status, travel purpose, travel time, and travel members; Part 2 included question items consisting of 10 dimensions or 39 attributes regarding service quality, which were acquired from the literature review, as shown in Table 3.1. The satisfaction level with service was measured using a 5-point Likert scale (1, the lowest satisfaction level; 5, the highest satisfaction level).

Table 3.1 Summary of factors influencing public transit service quality

Author	Country	Methodology					Factor												Uniqueness		
		CFA	SEM	LR	Traditional -IPA	Other	P	R	T	F	C	W	S	A	I	B	V	Other	Comparison	Older	
Maruvada and Bellamkonda (2010)	India	-	-	-	-	✓	-	✓	-	-	-	-	-	-	-	-	-	✓	-	-	
Irfan, Kee, and Shahbaz (2012)	Pakistan	-	✓	-	-	-	-	✓	-	-	✓	-	✓	-	✓	-	-	✓	-	-	
Hu et al. (2013)	China	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	Age group and developing/developed country	✓	
Yu-ChunChang (2013)	Taiwan	-	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	non-elderly and elderly	✓	
Harvey et al. (2014)	U.K.	-	-	-	-	✓	-	-	-	-	✓	✓	-	-	✓	-	✓	-	-	-	
Srichuae et al. (2016)	Thailand	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	population density	✓	

Table 3.1 Summary of factors influencing public transit service quality (Continued)

Author	Country	Methodology					Factor											Uniqueness			
		CFA	SEM	LR	Traditional	IPA	Other	P	R	T	F	C	W	S	A	I	B	V	Other	Comparison	Older
Wong et al. (2017)	Hong Kong	-	-	-	-	-	✓	✓	✓	✓	✓	✓	✓	-	-	-	✓	-	-	-	✓
Mayo and Taboada (2020)	Philippines	-	-	-	-	-	✓	✓	-	✓	-	✓	-	✓	-	-	-	-	✓	-	-
LuisMachado-León et al. (2017)	Algiers	-	-	-	✓	-	✓	-	-	✓	-	✓	-	✓	✓	✓	✓	-	✓	-	-
Baumann, Hoadley, Hamin, and Nugraha (2017)	Australia	✓	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Wong et al. (2018)	Hong Kong	-	-	✓	-	-	-	✓	-	-	-	-	✓	-	-	-	-	-	-	-	✓
SUM et al. (2019)	Cambodia	-	-	-	✓	-	-	-	-	✓	✓	-	-	-	-	-	-	-	✓	-	-

Table 3.1 Summary of factors influencing public transit service quality (Continued)

Author	Country	Methodology					Factor													Uniqueness	
		CFA	SEM	LR	Traditi onal - IPA	Other	P	R	T	F	C	W	S	A	I	B	V	Other	Comparison	Older	
Lunke (2020)	Norway	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Adlakha and Parra (2020)	India	-	-	-	-	✓	-	-	-	-	-	-	-	-	-	-	-	-	Gender	-	
This research	Thailand	-	-	-	✓	Integrated-IPA & Gap Analysis	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	-	Between Method and non- elderly and elderly	✓	

Note: CFA = Confirmatory Factor analysis; SEM = Structural Equation Modeling; LR = Logistic Regression;

A, accessibility; B, travel time; C, convenience/comfort; F, driver's attitude/staff; I, information; P, fare/travel cost; R, reliability/timeliness/punctuality; S, travel security/safety; T, station/stop/environment; V, vehicle characteristics; W, waiting time.

3.3.2 Methodology

The objective of this research was to analyze the passengers' expectations and perceptions focusing on the elderly and public transportation areas in different regions in Thailand. The 10 dimensions that were considered included (1) vehicle characteristics, (2) access, (3) safety, (4) reliability, (5) convenience, (6) waiting time, (7) staff, (8) information, (9) station/stop, and (10) affordability. The analyses were classified into three approaches. Firstly, traditional importance-performance analysis (Traditional IPA) is the technique widely used for analyzing user expectations and satisfaction to improve service quality based on the priorities of product or service attributes based on the concept of Martilla and James (1977). The results of the IPA are displayed in the form of a grid in a two-dimensional graph with plotted importance and efficiency values. The x-axis shows the level of efficiency or customer satisfaction; the y-axis indicates the degree of importance. As a result, the graph is divided into four quadrants, as shown in Figure 3.2. Quadrant I, or "concentrate here", indicates the priorities for improvement as the service efficiency is lower than the median value, but user expectation on its importance is high. For Quadrant II, or "keep up the good work", operators or service providers should maintain the efficiency of service levels. Quadrant III, or "low priority", is the area where the attributes are of low importance and low efficiency. Therefore, it is not important to quickly improve the attributes in this area. Quadrant IV, or "possible overkill", is the area in which the operators are least interested because it is considered low priority but very high proficiency.

The second approach, gap analysis, involves analyzing the difference between service perception and user expectations. The level of service provision is determined by the comparison between customer expectations and actual performance perceptions. When customers are satisfied with the service they receive, services are perceived by customers as being better than expected. Passenger satisfaction is therefore important for organizations aiming to increase the service quality of public transport operation (1990). The difference in value is calculated as $Gap_i = Perception_i - Expectation_i$ where i is an indicator of service quality of public transport. In this paper, this is called Gap1 Analysis. The final approach is based on the basic principles of IPA but the essential aspect of this approach is the integration

performed by comparing differences in the effectiveness of the attributes and the areas of interest with those of competitors (2014). This is different from the traditional IPA method, which only considers focal areas of interest. This approach can help identify the attributes needing improvement when comparing performance with competitors by plotting the importance value on the y-axis as in the traditional IPA approach and plotting the performance gap on the x-axis. The performance gap is calculated as $\text{Gap_between_performance} = \text{Performance}_{\text{bench - marker}} - \text{Performance}_{\text{competitors}}$. Here, we did not focus on comparison with competitors but instead used data of attitudes toward public transport in the country's capital compared with those of other regions in Thailand. We called this method IPA with Gap2 Analysis, as summarized in Table 3.2.

Table 3.2 Comparison of 3 methods related to passenger expectations and perceptions

Methods	Details	Key points/issues
Traditional IPA	Explicit importance and explicit performance	Dividing graphs using median values based on importance and performance
Gap 1 Analysis	Difference between importance and performance	A comparison between expectations and satisfaction
IPA with Gap 2 Analysis	Importance vs. performance gap (between the benchmark and competitors)	A comparison of the service performance between the areas of interest and the competitors

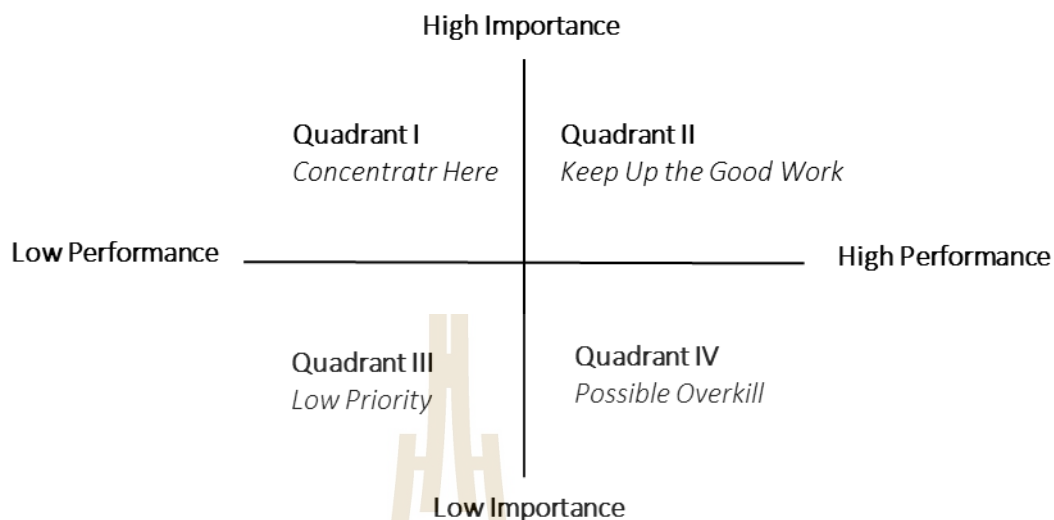


Figure 3.2 The Traditional IPA framework. Source: Martilla and James (1977)

3.4 Results and Discussion

3.4.1 Respondents' Social-Demographic Characteristics and Travel Behavior

According to statistical analysis, of the 2250 elderly people, divided into 1259 men and 991 women, 46.67% live with their children. They have different careers: 47.73% were business owners, 26.98% were employees, 12% were farmers, and 11.8% were general contractors. Of these respondents, 70% have personal income not exceeding 30,000 baht per month (calculated from the total regular income of the elderly, income from children, and pension income).

From the survey, we found that all elderly chose to travel in the morning and 80% of them spent more than 30 minutes on a public transportation trip. The majority of the elderly traveled alone or together with another person. The travel purposes were mainly to travel or relax, visit relatives or friends, shopping, and government transactions; the unpunctuality of public transport was a travel experience that the elderly had experienced, as shown in Tables 3.3 and 3.4.

3.4.2 Descriptive Statistics

Table 3.5 provides information about importance and performance of factors and variables of service quality obtained from the elderly passenger samples

throughout Thailand. Waiting time was the most important factor with 4.60, followed by reliability and safety at 4.56, accessibility and vehicle characteristics at 4.53, convenience at 4.52, station/stop at 4.57, information at 4.45, staff at 4.44, and the least important factor was affordability at 3.69. When considering the details of attributes, the elderly passengers assigned the highest importance to W1 (there is a long waiting time while at the station or the stop) at 4.62, followed by R1 (service is stable and regular) at 4.59. From the perspective of performance, the values were comparable. Therefore, when using the importance and performance of each attribute for IPA analysis, more efficiently assessing weaknesses and improving each factor relevant to users will be useful for agencies.

Table 3.3 Social-demographic characteristics of respondents.

Social Characteristics Information		Number	Percentage (%)
Sex	Male	1259	55.96
	Female	991	44.04
Age (years)	60–69	1563	69.47
	70–79	457	20.31
	≥80	230	10.22
Total monthly income (THB)	<10,000	31	1.38
	10,000–20,000	653	29.02
	20,000–30,000	935	41.56
	30,000–40,000	264	11.73
	40,000–50,000	217	9.64
	50,000–60,000	94	4.18
	60,000–70,000	37	1.64
	>70000	19	0.84
Occupation	Employee	609	27.06
	Business Owner	1074	47.73
	Farmer	271	12.04
	General Contractor	266	11.82
	Unemployed	30	1.33

Table 3.3 Social-demographic characteristics of respondents (Continued)

Social Characteristics Information		Number	Percentage (%)
Living Status	Alone	227	10.09
	With a Partner	973	43.24
	With Children	1050	46.67

Table 3.4 Travel behavior

Travel behavior Information		Frequency	Percentage (%)
Travel Time	Less than 15 mins	183	8.13
	15–30 mins	253	11.24
	30–60 mins	548	24.36
	>1 hour	1266	56.27
Travel Purpose	To hometown	160	7.11
	Travel and relax	935	41.56
	Work	183	8.13
	Visit	288	12.80
	Healthy	163	7.24
	Shopping	258	11.47
	Government	230	10.22
	Religion	1	0.04
	Study	2	0.09
	Others	30	1.33
Travel Time	05:00 a.m. – 06:59 a.m.	284	12.62
	07:00 a.m. – 09:59 a.m.	1011	44.93
	10:00 a.m. – 12:59 p.m.	501	22.27
	01:00 p.m. – 03:59 p.m.	201	8.93

Table 3.4 Travel behavior (Continued)

Travel behavior Information		Frequency	Percentage (%)
Travel Member	04:00 p.m. – 05:59 p.m.	166	7.38
	06:00 p.m. – 09:59 p.m.	87	3.87
	Alone	929	41.29
	2 Persons	1026	45.60
	3 Persons	262	11.64
	4 Persons	31	1.38
	5 Persons	2	0.09

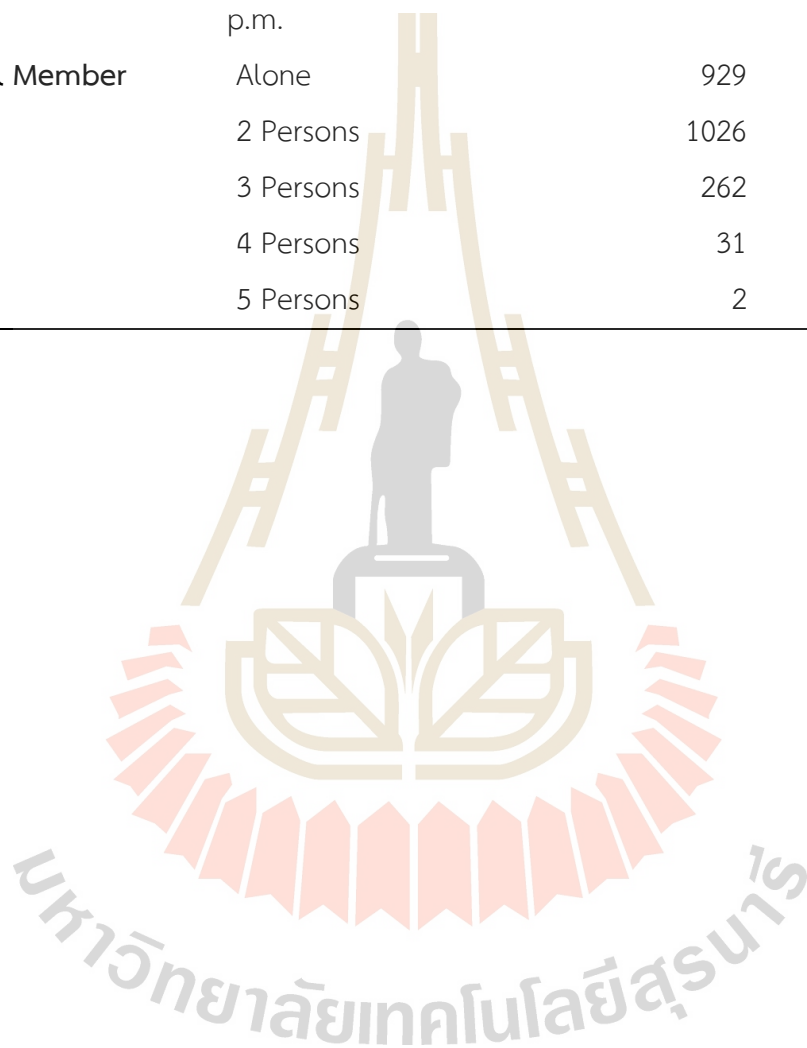


Table 3.5 Factors and variables of service quality (N = 2250)

Factor	Variable	Question	Importance					Performance				
			$\bar{X}$	Mean of factor	SD	SK	KU	$\bar{X}$	Mean of factor	SD	SK	KU
Vehicle charact eristics	V1	The vehicle is new and clean.	4.55	4.53	0.61	-1.137	0.756	3.04	3.02	0.912	-0.156	-0.60
	V2	I feel safe when traveling.	4.54		0.62	-1.235	1.712	3.06		0.887	-0.182	-0.715
	V3	The temperature inside the vehicle is appropriate	4.52		0.64	-1.17	1.175	3.02		0.929	-0.125	-0.687
	V4	The vehicle has facilities for the elderly such as handrails	4.50		0.63	-0.98	0.413	2.97		0.852	-0.099	-0.58
Access	A1	Roads or walkways are easily accessible and parking is available for wheelchair users	4.57	4.53	0.6	-1.311	1.935	2.99	2.98	0.884	-0.085	-0.582
	A2	The suitability and distance of the station location	4.53		0.63	-1.174	1.311	3.00		0.871	-0.109	-0.617
	A3	There are facilities for the elderly such as ramps, elevators, and handrails	4.52		0.63	-1.218	1.573	2.97		0.922	-0.111	-0.656
	A4	Can connect with a variety of other modes of transportation	4.49		0.66	-1.202	1.461	2.94		0.885	-0.025	-0.593

Table 3.5 Factors and variables of service quality (N = 2250) (Continued)

Factor	Variable	Question	Importance					Performance				
			$\bar{X}$	Mean of factor	SD	SK	KU	$\bar{X}$	Mean of factor	SD	SK	KU
Safety	S1	Travel safety (No accident / breakdown)	4.56	4.56	0.58	-0.903	-0.184	3.04	2.99	0.864	-0.143	-0.668
	S2	Safety from criminals while on the vehicle	4.55		0.58	-0.862	-0.254	2.97		0.869	-0.101	-0.664
	S3	Safety from criminals while at a station	4.54		0.59	-0.874	-0.229	3.05		0.917	-0.209	-0.603
	S4	vehicle such as seat belts and glass hammers	4.58		0.57	-0.980	-0.043	2.90		0.909	0.009	-0.511
Reliability	R1	Services are stable and regular.	4.59	4.56	0.56	-0.985	-0.041	2.98	3.02	0.883	-0.206	-0.726
	R2	The time spent traveling is short.	4.54		0.58	-0.846	-0.278	3.03		0.866	-0.141	-0.578
	R3	The frequency of the schedule is appropriate.	4.52		0.61	-0.866	-0.254	3.01		0.887	-0.147	-0.655
	R4	The punctuality of departure and arrival.	4.57		0.58	-0.949	-0.098	3.04		0.908	-0.133	-0.558
Waiting time	W1	There is a long waiting time while at the station or the stop	4.62	4.60	0.49	-0.481	-1.77	3.02	3.00	0.951	0.159	-0.626

Table 3.5 Factors and variables of service quality (N = 2250) (Continued)

Factor	Variable	Question	Importance					Performance				
			$\bar{X}$	Mean of factor	SD	SK	KU	$\bar{X}$	Mean of factor	SD	SK	KU
	W2	It takes a long time for the bus to wait for passengers at the stop	4.57		0.5	-0.299	-1.913	2.97		0.909	0.165	-0.499
Convenience	C1	The service is simple	4.54	4.52	0.64	-1.392	2.363	3.04	3.00	0.891	-0.091	-0.546
	C2	There are facilities such as Wi-Fi, a toilet, stair, handrail, and an elevator	4.55		0.59	-0.913	-0.164	2.98		0.896	-0.163	-0.753
	C3	The seats are adequate and there are priority seats for the elderly	4.52		0.60	-0.874	-0.236	2.88		0.861	0.004	-0.636
	C4	The luggage space is appropriate	4.46		0.66	-1.095	1.261	3.06		0.886	-0.125	-0.571
	C5	The height of the step from the floor to the vehicle is suitable	4.54		0.63	-1.391	2.626	3.03		0.908	-0.171	-0.622
Staff	F1	Safe driving occurs	4.51	4.44	0.63	-1.050	0.738	3.01	3.01	0.887	-0.035	-0.585
	F2	The car departs before the passengers are seated	4.41		0.78	-1.779	4.394	3.02		0.895	-0.238	-0.670

Table 3.5 Factors and variables of service quality (N = 2250) (Continued)

Factor	Variable	Question	Importance					Performance				
			$\bar{X}$	Mean of factor	SD	SK	KU	$\bar{X}$	Mean of factor	SD	SK	KU
	F3	The staff is dedicated and willing to serve	4.43		0.7	-1.123	1.127	2.96		0.952	-0.114	-0.714
	F4	The staff are polite	4.4		0.73	-1.192	1.501	3.04		0.854	-0.191	-0.659
Informa- -tion	I1	Complete travel information is provided	4.39	4.45	0.81	-1.466	2.216	3.07	3.00	0.92	-0.156	-0.657
	I2	Notice provided of time change	4.47		0.67	-1.261	1.813	2.93		0.879	-0.135	-0.717
	I3	Travel information is available for connecting to other modes of transport	4.48		0.67	-1.262	1.679	2.99		0.859	-0.129	-0.634
	I4	There is a channel for passengers to complain	4.48		0.7	-1.331	1.914	3.03		0.924	-0.132	-0.646
	I5	There is a thorough announcement at the station	4.45		0.74	-1.494	2.595	2.99		0.882	-0.168	-0.588
Station/	T1	The stop sign size is appropriate	4.45	4.47	0.71	-1.230	1.28	3.04	2.98	0.914	-0.171	-0.559
STOP	T2	The station is clean	4.48	4.47	0.67	-1.244	1.845	2.94	2.98	0.86	-0.163	-0.745

Table 3.5 Factors and variables of service quality (N = 2250) (Continued)

Factor	Variable	Question	Importance					Performance				
			$\bar{X}$	Mean of factor	SD	SK	KU	$\bar{X}$	Mean of factor	SD	SK	KU
	T3	The station has enough seats and a roof to block strong sunlight	4.48		0.68	-1.260	1.74	3		0.842	-0.052	-0.662
	T4	There is enough parking	4.48		0.66	-1.068	0.68	3		0.902	-0.149	-0.543
	T5	There are shops selling food and drinks, which also have ATMs	4.46		0.73	-1.521	2.81	2.92		0.922	-0.027	-0.611
Afford- ability	P1	The fare is suitable for an average income	4.58		0.55	-0.863	-0.303	3.08		0.85	-0.145	-0.764
	P2	I would pay more if service was better	2.79	3.69	0.87	0.055	-0.341	2.88	2.98	0.931	-0.038	-0.611

3.4.3 Analysis and Discussion of Each Approach

3.4.3.1 Traditional IPA

For the traditional IPA approach, we divided the analysis into two types by age group and regions to better visualize the different perspectives of the elderly and non-elderly in terms of their mobility levels.

1) Age-Based Analysis

For analysis based on age, the passengers were divided into two groups, elderly (older than 60 years) and non-elderly (aged 18–59 years), who use public transport in Bangkok and its metropolitan area. The elderly and non-elderly passengers had different service needs, as explained in Figure 3.3. Elderly passengers supported a simple transportation system that is easy to (C1 = 4.651), followed by the convenience of boarding and disembarking from the vehicle. The height from the floor to the car was considered appropriate (C5 = 4.636), as was the waiting time at the station or bus stop (W1 = 4.627). For non-elderly passengers, they firstly focused on the waiting time at the station/stop (W1 = 4.660), followed by providing complete travel information (I1 = 4.627) and long waits for passengers at stops (W2 = 4.587). These findings agree with those of Chang (Yu-ChunChang, 2013), who reported that elderly passengers value a simple system and that these passengers were worried about the physical deterioration of transportation systems. For non-elderly passengers, the waiting time was more important than to the elderly.

When analyzing with IPA, a strategy to improve the quality according to the public transport priorities in Bangkok and its metropolitan area, both groups produced the same results including the cleanliness of the station and the stop (T2); the availability of facilities for the elderly such as ramps, elevators, handrails, etc. (A3); and the availability of facilities for the elderly such as Wi-Fi, toilets, stairs, handrails, and elevators (C2). All these factors appeared in the “Concentrate Here” quadrant, as shown in Table 3.6.

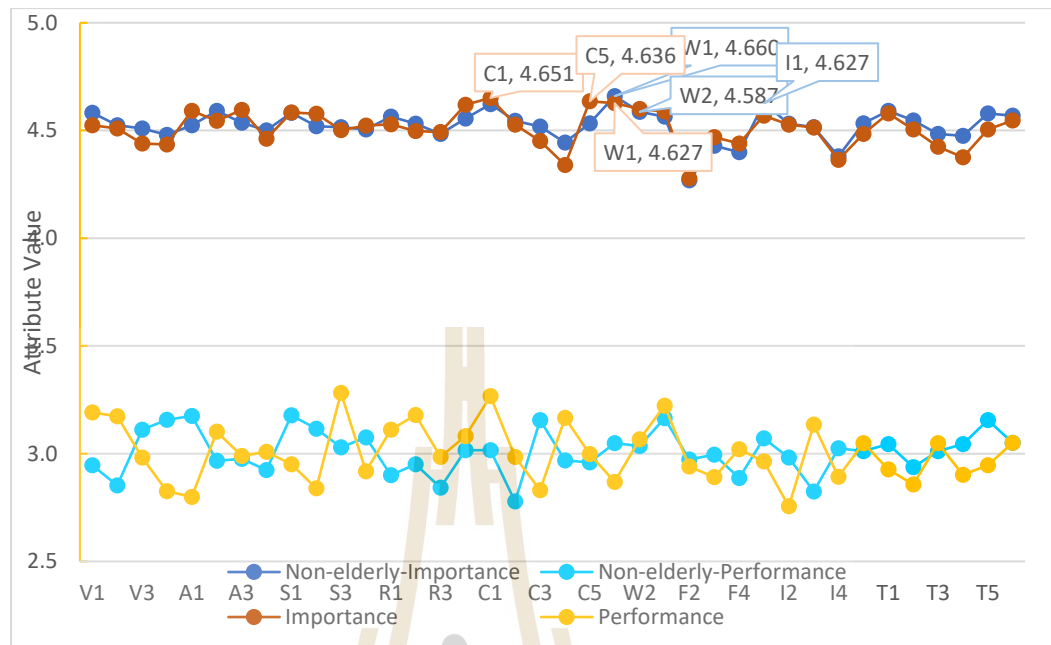


Figure 3.3 Value of importance and satisfaction for elderly and non-elderly passengers.

For the elderly, additional attributes were identified, as follows:

- a. Location, station, stop, and waiting time

From the traditional IPA approach, the elderly in Thailand assigned different values of importance than the non-elderly group in terms of font and sign size (T1, The size of the stop sign is appropriate) as well as station services such as shops, selling points, food, beverages, ATMs, etc. (T5, There are shops selling food, drinks, and ATMs), which performed more poorly than expected. We found that for the elderly in Hong Kong, the factors of having seats to accommodate the elderly and the environment of the station/stop considerably influenced their satisfaction level with public transport (2017). This finding is supported the research of Yu-ChunChang (2013) who found that both groups of passengers were least satisfied with the space and convenience of the waiting area. We also found that waiting time (W1, There is a long waiting time while at the station or the stop) should be immediately improved as a "Concentrate Here" because the elderly's mobility is reduced due to their age. According to Wong et al. (2018), elderly people want more frequent service to reduce waiting time, and improvements in waiting areas and stops. The satisfaction with the factor of frequency of the bus schedule in this research was still lower than the median

value. If improvements are made, this factor could increase the service performance and, consequently, the satisfaction of all user groups. A previous study analyzed the mode of transportation used by the elderly and found that the elderly choose cheaper modes of transportation and travel time was less important (2009). Similar to Yu-Chun Chang's research (Yu-ChunChang, 2013), the authors stated that elderly people, compared to the non-elderly, have more time and less income, so they are more interested in prices than waiting time.

Many studies showed that passengers perceive waiting time as being longer than real time as waiting incurs stress, complications, and less comfort than sitting on a vehicle (2004). In this regard, travel time includes waiting time at the station (or stop) and travel time in the vehicle. If waiting time is reduced by increasing the service frequency and facilities such as toilets, seats, Wi-Fi, shops, and ATMs at the station, benefits will be provided for all service users.

b. Convenience and service access

Hu et al. (2013) surveyed the travel behaviors of Chinese elderly people and found that walking was most popular, followed by public transport, then other travel modes, which included bicycles, private vehicles, and taxis. This is inconsistent with Su and Bell (2009) who stated that as people age, the conditions for their travel mode change. In terms of the public transport in Thailand, our findings suggested that the requirements for transportation mode are consistent with the physical characteristics of the elderly such as the height of step from the floor to the vehicle is suitable to facilitate their boarding and disembarking (C5). Public transit also provides convenient accessibility such as roads and pathways, especially ramps and lifts (A1, A3) for wheelchair users as well as providing complete and clear information regarding traveling, according to the survey.

Regarding Thai elderly travel behavior, most of them travel alone or with another person. The clear information presentation and uncomplicated services are important for this passenger group. In Yu-ChunChang's research (Yu-ChunChang, 2013), the results also indicated that the elderly ranked "user friendliness" second after safety.

c. Safety

The elderly in Thailand focus on travel safety (S1) as well as the safety equipment inside the vehicle such as seat belts and glass hammers (S4), which increase passengers' safety in addition to ensuring safe transit while on the vehicle (S2). For this issue, a study was conducted on the service quality of Thailand intercity train services for the development of security system (Jomnonkwao et al., 2020). In addition, both groups of Taiwanese elderly and non-elderly passengers have ranked safety as the first priority for choosing a mode of transport to access the airport (Yu-ChunChang, 2013). Indian passengers reported wanting to use public transport for their convenience but that it lacked security for crime prevention in addition to the transfer distance, which was not appropriate (2020). A case of tramway and commuter rail in Algiers was reported, indicating that safety is a priority that must be developed to increase passenger satisfaction (LuisMachado-León et al., 2017). Our findings support those of Harvey, Thorpe (2014) who proposed focusing on travel security to promote high speed rail travel in the U.K. Our findings are confirmed by those of Mayo and Taboada (2020) who using an analytic hierarchy process (AHP). Overall, the security factor ranked the highest for those older than 60 years, safety was ranked second after environmental factors.

Table 3.6 Summary of the attributes of passengers in Bangkok and its metropolitan area

Group/Quadrant	Q1	Q2	Q3	Q4
	Concentrate Here	Keep up the Good Work	Low Priority	Possible Overkill
Non-Elderly (18–59 years old)	T2	W2	C5	S4
	A3	C1	F4	S2
	C2	R4	R3	A1
	V1	F1	F2	V4
	A2	I1	A4	V3
		T1	C4	T4

Table 3.6 Summary of the attributes of passengers in Bangkok and its metropolitan area (Continued)

Group/Quadrant	Q1	Q2	Q3	Q4
	Concentrate Here	Keep up the Good Work	Low Priority	Possible Overkill
		T5 S1 P1 W1		I4 C3
Elderly (Over 60 years old)	T2 A3 C2 I1 T1 C5 A1 S1 S2 S4 I2 W1 T5	R4 C1 F1 W2 V1 A2 I3 P1	F4 F3 V3 R3 A4 V4 C3 F2	C4

3.4.3.2 Regional Analysis

The area analysis was divided into five regions: north, central, northeast, south, and Bangkok. When using tradition IPA analysis, the results were distinctive, all survey areas had S4 (There is safety equipment inside the vehicle such as seat belts and glass hammers) appearing in the most important quadrant and P1 (the fare is suitable for the income) in the “Keep Up the Good Work” or Q2, where it is recommended that these activities be maintained. The results are summarized in

Table 3.7. In other words, safety is an important issue from the elderly's perspective on public transport in all regions in Thailand, as well as in Pakistan where 82% of elderly people assigned importance to safety and did not specially focus on the fare factor (January 2019).



Table 3.7 Summary of the attributes of passengers by traditional IPA

Variable	Northern	Northeastern	Central	Southern	BKK	Variable	Northern	Northeastern	Central	Southern	BKK
A1	Q2	Q4	Q1	Q2	Q1	F1	Q3	Q2	Q3	Q2	Q2
A2	Q1	Q4	Q2	Q3	Q2	F2	–	Q2	Q4	Q4	Q3
A3	Q4	Q3	Q1	Q2	Q1	F3	Q4	Q1	Q4	Q4	Q3
A4	Q2	Q3	Q3	Q1	Q3	F4	Q4	Q4	Q4	Q4	Q3
S1	Q1	Q2	Q4	Q2	Q1	I1	Q2	Q4	Q4	Q4	Q1
S2	Q4	Q2	Q3	Q1	Q1	I2	Q1	Q4	Q3	Q2	Q1
S3	Q3	Q1	Q2	–	Q2	I3	Q1	Q1	Q4	Q1	Q2
S4	Q1	Q1	Q1	Q1	Q1	I4	–	Q2	Q4	Q4	Q3
R1	Q1	Q2	Q1	Q1	Q2	I5	Q4	Q3	Q3	Q4	Q3
R2	–	Q2	–	Q4	Q4	T1	Q1	Q4	Q4	Q4	Q1
R3	Q3	Q1	Q2	Q4	Q3	T2	Q3	Q3	Q2	Q3	Q1
R4	–	Q2	Q1	Q4	Q2	T3	Q4	Q4	Q1	Q1	Q3
C1	Q2	Q1	Q3	Q3	Q2	T4	Q1	Q3	Q2	Q4	Q3
C2	Q4	Q1	Q2	Q3	Q1	T5	Q4	Q3	Q3	Q3	Q1
C3	Q3	Q1	Q2	Q3	Q3	P1	Q2	Q2	Q2	Q2	Q2
C4	Q4	Q4	Q3	Q3	Q4	P2	Q3	Q3	Q3	Q3	Q3
C5	Q1	Q4	Q2	Q4	Q1	V1	Q2	Q2	Q2	Q3	Q2
W1	Q1	Q2	Q2	Q2	Q1	V2	Q2	Q3	Q2	Q2	Q2

Table 3.7 Summary of the attributes of passengers by traditional IPA (Continued)

Variable	Northern	Northeastern	Central	Southern	BKK	Variable	Northern	Northeastern	Central	Southern	BKK
W2	Q3	Q1	Q1	Q2	Q2	V3	Q1	Q4	Q3	Q2	Q3
						V4	Q2	Q3	Q4	Q3	Q3

Note: Q1: Concentrate Here, Q2: Keep Up the Good Work, Q3: Low Priority, and Q4: Possible Overkill



3.4.4 Gap between Importance and Performance (Gap1)

Gap1 indicates users' satisfaction arising from their expectations before using the service and awareness after using the service. If, after service, the customers are more satisfied with the service than expected, they are satisfied (1990). From this approach, the difference between perception and expectations was negative, which means that the service as perceived by customers after using the service was less than expected. The results were negative in all five areas, as shown in Table 3.8, and as supported by Yu-ChunChang (2013). When plotting the satisfaction and importance values of all factors on the line graph, we found that the total passenger satisfaction was low. This approach explained that after using services, customers perceive them as being unsatisfactory, or expected that the service would have been better. This analysis has limitations, as indicated by the case of cleanliness and neatness of stations and stop signs. The station is clean (T2) and the temperature inside the vehicle is appropriate (V3) received the same difference value in the Northeastern area (gap = 1.256). However, given the T2 importance (4.167) and performance (2.91) and the V3 importance (4.407) and performance (3.15), these attributes had different importance values that were not reflected in the gap value.

Table 3.8 Gap between performance (P) and importance (I)

Attribute	Area Gap (P – I)				
	Northern	Northeastern	Centra	Southern	Bangkok
V1	-1.531	-1.473	-1.550	-1.670	-1.333
V2	-1.518	-1.493	-1.499	-1.546	-1.336
V3	-1.684	-1.256	-1.559	-1.552	-1.458
V4	-1.580	-1.544	-1.346	-1.581	-1.609
A1	-1.529	-1.362	-1.603	-1.624	-1.791
A2	-1.638	-1.351	-1.572	-1.626	-1.442
A3	-1.402	-1.369	-1.800	-1.590	-1.607
A4	-1.584	-1.440	-1.503	-1.804	-1.453
S1	-1.504	-1.462	-1.364	-1.619	-1.633
S2	-1.411	-1.602	-1.479	-1.675	-1.738

Table 3.8 Gap between performance (P) and importance (I) (Continued)

Attribute	Area Gap (P – I)				
	Northern	Northeastern	Centra	Southern	Bangkok
S3	-1.529	-1.691	-1.497	-1.501	-1.220
S4	-1.718	-1.618	-1.814	-1.653	-1.604
R1	-1.667	-1.544	-1.678	-1.748	-1.418
R2	-1.551	-1.540	-1.583	-1.557	-1.318
R3	-1.576	-1.613	-1.441	-1.374	-1.509
R4	-1.449	-1.522	-1.670	-1.477	-1.538
C1	-1.520	-1.529	-1.435	-1.626	-1.384
C2	-1.529	-1.598	-1.519	-1.617	-1.542
C3	-1.538	-1.780	-1.585	-1.713	-1.620
C4	-1.318	-1.322	-1.548	-1.646	-1.173
C5	-1.669	-1.280	-1.514	-1.472	-1.638
W1	-1.667	-1.458	-1.499	-1.604	-1.758
W2	-1.567	-1.642	-1.701	-1.566	-1.533
F1	-1.711	-1.496	-1.348	-1.584	-1.367
F2	-1.484	-1.451	-1.244	-1.474	-1.338
F3	-1.467	-1.667	-1.186	-1.428	-1.578
F4	-1.293	-1.473	-1.080	-1.575	-1.420
I1	-1.580	-1.178	-0.820	-1.399	-1.604
I2	-1.700	-1.333	-1.313	-1.597	-1.771
I3	-1.638	-1.604	-1.228	-1.626	-1.378
I4	-1.631	-1.327	-1.213	-1.566	-1.471
I5	-1.531	-1.518	-1.348	-1.452	-1.436
T1	-1.644	-1.231	-1.093	-1.425	-1.653
T2	-1.751	-1.256	-1.543	-1.474	-1.647
T3	-1.391	-1.178	-1.736	-1.717	-1.376
T4	-1.660	-1.324	-1.519	-1.419	-1.473
T5	-1.502	-1.607	-1.404	-1.624	-1.558
P1	-1.529	-1.476	-1.437	-1.530	-1.496

Table 3.8 Gap between performance (P) and importance (I) (Continued)

Attribute	Area Gap (P – I)				
	Northern	Northeastern	Centra	Southern	Bangkok
P2	–0.067	0.131	0.255	–0.051	0.167

3.4.5 Gaps between Focal Performance and Benchmark Performance (Gap2)

This analysis was based on the basic principles of IPA by maintaining the core of this approach for further development. The analysis was separately conducted by region; the results are as follows: When comparing the transportation services between the north and Bangkok, the attributes appearing in the Q1 quadrant were A2, R1, C1, and I3. The attributes in the northeast region in the Q1 quadrant were S3, R1–R4, C1, W2, and I3. The attributes for the southern region had in Q1 were V2, A3, A4, S1, S4, R1, W2, I3, and T3. The attributes in Q1 in the central region were V1, V2, A2, A3, S3, S4, R1, R4, W2, and T3. The attributes in the Q1 area of the graph are values that were compared in importance between each region with the transportation service performance in Bangkok (Base). The attributes in Q1 for each region are those that should be immediately improved to equal Bangkok's service level. This approach indicated that attribute R1 appeared in Q1 for all four regions, as shown in Figure 3.4. In other words, when the analysis was conducted by comparing the base city (Bangkok) to other regions in Thailand, we found that the disadvantages of public transportation system included the lack of service stability as well as unreliability and stops.

According to Wardman's (2004), the unreliability of the arrival time of public transport and the transfers between vehicles or between travel modes are considered waiting time for passengers. Similarly, according to Maruvada and Bellamkonda (2010), Indian train passengers ranked "service reliability" as the worst dimension. This is consistent with Lunke (2020), who found that waiting and transfer to the station reduce passenger satisfaction with public transport travel.

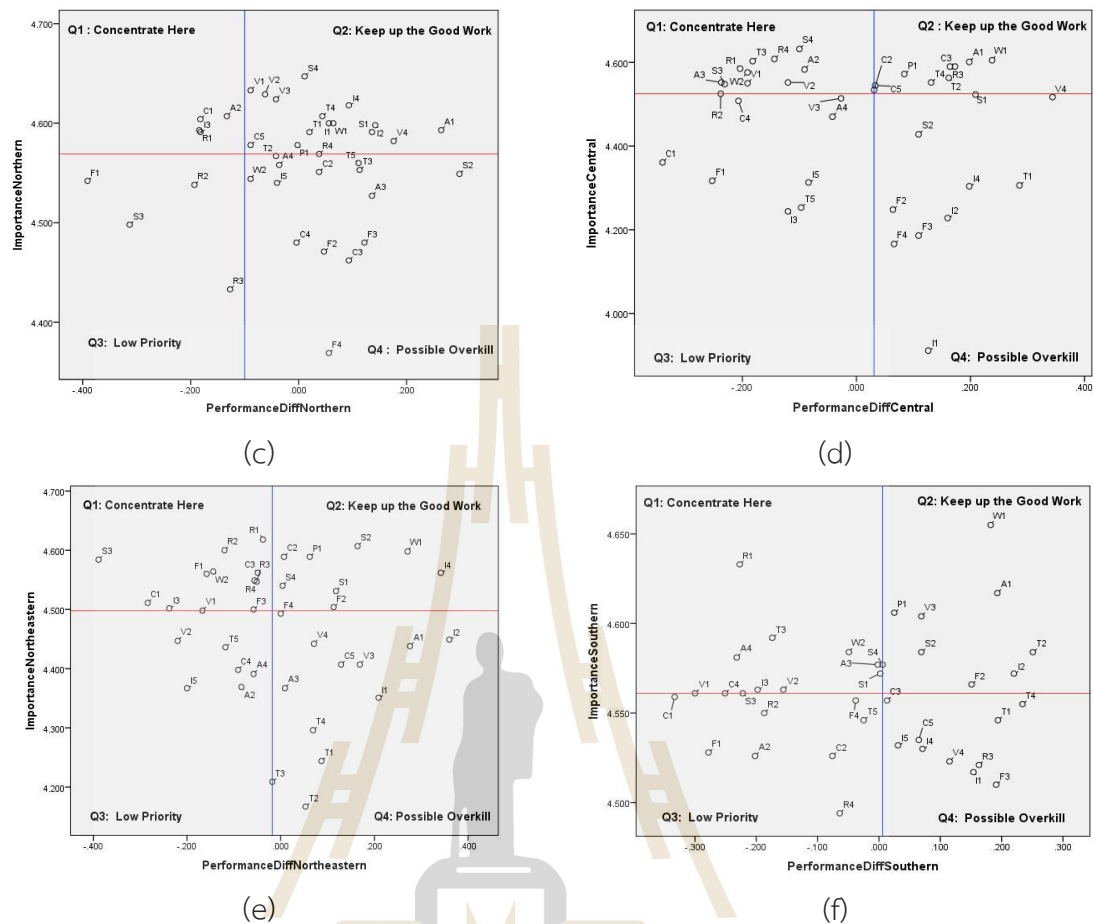


Figure 3.4 The importance performance analysis (IPA) with gap2 of four regions in Thailand: (c) northern, (d) central, (e) northeastern, and (f) southern regions.

From the three analysis methods used to determine the importance and performance of public transport services in Thailand, the elderly passengers' viewpoints are summarized according to the area in Table 3.9. We found that additional safety equipment such as seat belts, glass hammers etc. is needed. This factor is active with all regions regardless of any method, and the public transport services are stably and consistently active in every region, when compared with those of the capital.

Table 3.9 Comparison of results from different approaches (factors appearing in the most important quadrant)

Variable	Northern		Northeastern		Southern		Central		BKK
	IPA	Gap2	IPA	Gap2	IPA	Gap2	IPA	Gap2	IPA
V1								✓	
V2						✓		✓	
V3	✓								
V4									
A1									✓
A2	✓	✓						✓	
A3						✓	✓	✓	✓
A4					✓	✓			
S1	✓					✓			✓
S2					✓				✓
S3			✓	✓				✓	
S4	✓		✓	✓	✓	✓	✓	✓	✓
R1	✓	✓	✓	✓	✓	✓	✓	✓	
R2				✓					
R3				✓					
R4				✓			✓	✓	
C1		✓	✓	✓					
C2			✓						✓
C3			✓						
C4									
C5	✓								✓
W1	✓								✓
W2			✓	✓		✓	✓	✓	
F1									
F2									
F3			✓						

Table 3.9 Comparison of results from different approaches (factors appearing in the most important quadrant) (Continued)

Variable	Northern		Northeastern		Southern		Central		BKK
	IPA	Gap2	IPA	Gap2	IPA	Gap2	IPA	Gap2	IPA
F4									
I1									✓
I2	✓								✓
I3	✓	✓	✓	✓	✓	✓			
I4									
I5									
T1	✓								✓
T2									✓
T3					✓	✓	✓	✓	
T4	✓								
T5									✓
P1									
P2									

Note: The gap analysis method provided every attribute with the same direction results.

3.5 Conclusions

The analysis results of user expectations and satisfaction from all three approaches showed distinct strengths and theoretical differences that led to different interpretations. The traditional IPA method provides easily interpreted results that are suitable for guiding policy implementation. If the gap between importance and performance approach is negative, it indicates that the user expects the service/attribute to be improved. However, it is difficult for entrepreneurs to consider the Gap1 approach only. This is the weakness of this approach. The IPA with Gap2 approach is similar to traditional IPA, but it has a different objective, which is to compare the performance of a service to that of competitors. Its findings are therefore useful as guidelines for stakeholders, such as transport operators or the government,

to implement policy changes encouraging the elderly to use public transport because it is a safer mode than driving by themselves due to their physical changes and mobility reduction. To ensure sustainable development, the issues that are important to the elderly should be improved and prioritized, such as safety, to increase efficiency of travel. Despite the fare reduction policy for elderly passengers, travel safety or other services and facilities for the elderly, such as stairs, elevators, handrails, resting rooms, and wheelchairs, which are limited, cannot attract the elderly to use the service because they are more likely be at risk of accidents and crimes than other population groups.

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CHAPTER IV

AN ANALYSIS OF DETERMINANTS OF TRAVEL MODE CHOICE AMONG OLDER PERSONS USING A MULTINOMIAL LOGIT MODEL

4.1 Abstract

Thailand is entering a complete aged society, resulting in a growing demand for public transport systems that adequately address the physical constraints and travel behavior of older persons. This study aims to analyze the factors influencing travel mode choice among older persons by applying a Multinomial Logit Model (MNL) to four travel mode alternatives: bus/songthaew, large bus, van, and electric rail transit. The findings indicate that socioeconomic factors, such as educational attainment and living alone, exert a statistically significant influence on travel mode decision-making. Older persons with higher levels of education and those living alone are more likely to choose large buses and electric rail transit. In addition, time-related factors, including access time and waiting time, are identified as key determinants of mode choice. Longer waiting times reduce the likelihood of choosing buses while increasing the probability of selecting modes with greater punctuality. With respect to fare and distance factors, older persons are found to be most sensitive to the pricing of electric rail transit. For long-distance travel, electric rail transit emerges as the most appropriate mode. The empirical evidence derived from this study can be utilized to inform policy formulation for the development of age-friendly public transport systems, thereby enhancing quality of life and promoting sustainable mobility among older persons.

4.2 Introduction

Thailand is entering a complete aged society, with projections indicating that by 2035 the population aged 60 years and above will account for more than 30 percent of the total population (National Statistical Office Thailand). This demographic transition has rendered issues related to mobility and access to services among older persons a critical public policy challenge. Maintaining mobility independence is a

fundamental determinant of quality of life, health, and social participation in later life. Limited travel opportunities are closely associated with physical and mental health problems, as well as reduced capacity to perform activities of daily living. Although the Thai government has promoted the concept of universal design in transport infrastructure development to facilitate access for older persons and individuals with disabilities, the reality remains that Thailand's public transport system is characterized by considerable heterogeneity and uneven service quality. Existing modes—including buses, songthaews, vans, large buses, and electric rail transit—vary substantially in terms of accessibility, comfort, and reliability. As a result, older persons must consider multiple factors when selecting an appropriate travel mode.

Furthermore, in many countries, older persons exhibit an increasing reliance on private automobiles, despite health and safety limitations. This trend reflects persistent gaps in public transport systems that fail to adequately address the specific needs of the aging population. Accordingly, public transport systems should be developed to ensure accessibility, safety, and suitability for the daily travel requirements of older persons, thereby fostering sustainable mobility in aging societies.

Promoting safe and convenient mobility for older persons is therefore an integral component of the Active Aging policy framework (Latiff & Mohd, 2023), which emphasizes the capacity of older individuals to live independently in their daily lives. A substantial proportion of older persons continue to travel for medical appointments, social activities, and routine tasks, even in the presence of health or income constraints. Consequently, the role of public transport becomes increasingly essential (N. Zhang & Yang, 2024). In this context, the present study focuses on applying the Multinomial Logit Model (MNL) to analyze the influence of various factors on the choice among four travel modes: bus/songthaew, large bus, van, and electric rail transit. The findings are intended to inform policy recommendations for the development of transport systems that effectively respond to the needs of an aging society in a sustainable manner.

Accordingly, this study employs the Multinomial Logit Model (MNL), an econometric approach well suited to the analysis of discrete choice behavior involving multiple alternatives, to evaluate and quantify the effects of relevant factors on the

probability of selecting among the four principal travel modes—bus/songthaew, large bus, van, and electric rail transit. The resulting empirical evidence is expected to support policy formulation and the improvement of public transport systems in alignment with the long-term demands of a sustainable ageing society.

4.3 Literature Review

The study of factors determining the travel behavior of older persons has received increasing scholarly attention within the global context of population aging. This literature review is organized into four main themes: (1) socioeconomic factors influencing travel mode choice, (2) time-related factors, (3) cost and distance factors affecting decision-making, and (4) the application of the Multinomial Logit Model (MNL) in travel mode choice analysis.

Travel mode choice is a decision-making process grounded in Utility Theory, whereby travelers select the option that provides the highest utility relative to available alternatives. The mobility of older persons is affected by age-related physical and sensory limitations, resulting in stronger preferences for safety, comfort, and reliability in public transport systems compared with other age groups (R. C. P. Wong, Szeto, Yang, Li, & Wong, 2018).

4.3.1 Socioeconomic Factors Influencing Travel Mode Choice among Older Persons

Socioeconomic characteristics such as educational attainment, living arrangement, age, and income play an important role in shaping travel mode choice among older persons.

Age and health: As individuals advance in age or experience physical health limitations, reliance on public transport services that require substantial physical effort for access or involve long waiting times tends to decrease. Consequently, older persons are more likely to select more convenient modes, such as vans or taxis, or to restrict their travel activities Stjernborg, Wretstrand, and Tesfahuney (2015).

Educational attainment and income: Older persons with higher levels of education generally possess greater capacity to access and comprehend complex public transport information systems (e.g., rail transit systems or digital applications).

They also tend to seek services characterized by higher quality and reliability (R.C.P. Wong, zeto, Yang, Li, & Wong, 2018).

Household characteristics: Living alone or lacking access to a household driver (non-driver status) increases dependence on public transport. In such cases, travel mode choice is primarily guided by considerations of safety and reliability.

4.3.2 Time-Related Factors

Time-related factors, particularly **access time** and **wait time**, exert a pronounced influence on older persons, who are especially sensitive to service-related attributes of public transport systems.

Access time and wait time: Older persons exhibit heightened sensitivity to **non-travel time**, as it is closely linked to physical constraints. Prolonged walking distances and extended waiting times represent substantial negative utility.

In-vehicle travel time: Although total travel time remains an important consideration, older persons may tolerate longer in-vehicle travel times when the chosen mode offers a high level of comfort and safety, such as large air-conditioned buses.

4.3.3 Cost and Distance Factors

Cost- and distance-related factors, including fare levels and the suitability of travel modes for different trip lengths, also influence travel decisions.

Fare: Even in contexts where fare discounts are available for older persons, total travel cost remains a critical determinant, particularly for individuals with limited income. Price sensitivity (elasticity) tends to be relatively high for higher-cost modes, such as electric rail transit.

4.3.4 Multinomial Logit Model (MNL)

The Multinomial Logit Model (MNL) is an econometric approach widely applied in mode choice analysis due to its ability to estimate the probabilities associated with multiple discrete alternatives simultaneously. Operating within the framework of utility maximization, the MNL is particularly well suited for examining

choice behavior involving diverse public transport options, such as buses, rail systems, and vans, by designating one alternative as a base or reference mode for comparison.

Understanding the factors that influence travel mode choice among older persons is essential for the planning of inclusive and sustainable public transport systems. This analytical approach is grounded in utility theory, which posits that passengers select the alternative that yields the highest utility. Accordingly, the probability of choosing a given option increases with the magnitude of the “utility gap” between that option and competing alternatives.

4.4 Methods

4.4.1 Multinomial Logit Model: MNL

The study employs the Multinomial Logit Model (MNL) to analyze the probability that older persons select a particular travel mode from a set of available alternatives. The MNL is grounded in utility theory and can be expressed mathematically as follows.

The analysis of travel mode choice among older persons is based on the assumption that each alternative provides a level of utility that can be clearly perceived by travelers. The probability that a traveler selects a given alternative increases as the utility gap between that alternative and competing alternatives becomes larger. In other words, an alternative that offers higher utility is more likely to be chosen.

The Multinomial Logit Model (MNL) can be formulated as:

$$P_{(i)} = \frac{e^{U_i}}{\sum_{j \in J} e^{U_j}} \quad (4.1)$$

where

$P_{(i)}$ denotes the probability that a traveler selects alternative i ;

U_i represents the utility of alternative i ; and

J denotes the total number of alternatives in the choice set.

This model indicates that differences in utility across alternatives determine the probability of travel mode selection. Consequently, it provides a theoretically grounded and systematic framework for explaining travel mode choice behavior.

4.5 Results of Descriptive Statistical Analysis

Descriptive statistical analysis was conducted to summarize the general characteristics of the sample of older persons who responded to the questionnaire survey on public transport travel behavior. Basic statistical measures, including percentages, mean values, standard deviations, skewness, and kurtosis, were employed to reflect the distributional properties of the data. The data analyzed were obtained from questionnaires designed to comprehensively capture general demographic information, travel behavior characteristics, and experiences related to the use of public transport systems.

Table 4.1 Descriptive Statistics

Question	Variable / Category	Percentage (%)	Mean	S.D	SK	KU
Gender (Gen)	1 = Male	55.2	1.45	0.5	0.21	-1.96
	2 = Female	44.8				
	Total	100				
Age (Age)	Age of respondent (years)	–	68	6.48	0.95	0.08
Education Level (Edu)	1 = No formal education	0.65	4.62	1.52	-0.59	-1
	2 = Primary education	13.14				
	3 = Lower secondary education (Grade 9)	16.22				

Table 4.1 Descriptive Statistics (Continued)

Question	Variable / Category	Percentage (%)	Mean	S.D	SK	KU
	4 = Upper secondary education / Vocational Certificate	5.38				
	5 = Diploma / Higher Vocational Certificate	24.86				
	6 = Bachelor's degree	38.16				
	7 = Master's degree	1.29				
	8 = Doctoral degree	0.3				
	Total	100				
Living Arrangement (Alone)	0 = Not living alone	90.35	0.1	0.3	2.73	5.48
	1 = Living alone	9.65				
	Total	100				
Household Vehicle Use (ShareVeh)	0 = Separate vehicle use within the household	38.4	0.62	0.49	-0.48	-1.77
	1 = Shared vehicle use within the household	61.6				

Table 4.1 Descriptive Statistics (Continued)

Question	Variable / Category	Percentage (%)	Mean	S.D	SK	KU
	Total	100				
Departure Mode (DepMode)	1 = Walking	24.45	2.49	1.21	0.22	-1.55
	2 = Motorcycle	38.47				
	3 = Bicycle	0.64				
	4 = Car	36.44				
	Total	100				
Access Time	Access time (minutes)	–	25.42	21.44	1.52	2.54
Waiting Time (WaitTime)	Waiting time (minutes)	–	30.56	17	1.53	4.01
Travel Time (TravelTime)	Travel time (minutes)	–	255.34	289.3	1.16	0.08
Travel Cost (Fare)	Travel cost (Baht)	–	267.55	325.2	1.3	1.34
Travel Distance (Distance)	Travel distance (kilometers)	–	268.59	310.6	0.89	-0.75
Group Size (GroupSize)	Number of travel companions (persons)	–	1.77	0.74	0.68	0.1
Chosen Travel Mode (MODE)	1 = Bus / Songthaew	30.51	2.2	1.08	0.53	-0.99
	2 = Large public bus	38.27				
	3 = Van	11.58				
	4 = Rail-based transit (electric train)	19.64				

Table 4.1 Descriptive Statistics (Continued)

Question	Variable / Category	Percentage (%)	Mean	S.D	SK	KU
	Total	100				

Note: S.D. = Standard Deviation; SK = Skewness; KU = Kurtosis.

Based on Table 4.1, the sample consisted of 55.2 percent males and 44.8 percent females, with a mean age of 68 years (S.D. = 6.48), which falls within the older population group that constitutes the primary target of this study. With respect to educational attainment, the majority of respondents had completed a bachelor's degree (38.16 percent), followed by those holding an associate degree or higher vocational certificate (24.86 percent), while only 0.65 percent reported having no formal education. In terms of household characteristics, most respondents did not live alone (90.35 percent) and commonly shared vehicles within the household (61.6 percent). Regarding modes of travel when leaving the home, motorcycle use accounted for the largest proportion (38.47 percent), followed by private car use (36.44 percent) and walking (24.45 percent).

In addition, quantitative variables indicate that older persons spent an average of 25.42 minutes accessing the transport system, with a mean waiting time of 30.56 minutes. The average in-vehicle travel time was relatively high, at 255.34 minutes per trip. The mean travel cost was 267.5 baht, and the average travel distance was 268.59 kilometers. Most respondents traveled alone or in small groups, with an average group size of 1.77 persons. With respect to public transport mode choice, large buses were the most frequently selected mode (38.27 percent), followed by buses/songthaews (30.51 percent) and electric rail transit (19.64 percent), while vans accounted for 11.58 percent of usage.

Overall, the descriptive statistics illustrate the demographic structure, travel behavior, and patterns of public transport usage among older persons, which provide an essential foundation for subsequent analyses of factors influencing travel mode choice. Moreover, the descriptive statistical analysis confirms that the data exhibit an approximately normal distribution, with skewness (SK) values within the acceptable

range of -3.0 to $+3.0$ and kurtosis (KU) values not exceeding 10.0 (Champahom et al., 2023).



Table 4.2 Results of the Multinomial Logit Model Using Bus/Songthaew as the Reference Travel Mode for Older Persons' Travel Mode Choice

Variable	Large bus				Van				Electric rail transit			
	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)
Const	-2.8278	0.863	0.001	0.059	-3.8096	0.651	<0.001	0.022	1.1491	0.806	0.154	3.155
Gen	-0.1315	0.143	0.359	0.877	-0.1844	0.112	0.1	0.832	0.011	0.133	0.934	1.011
Age	0.006	0.011	0.591	1.006	0.0161	0.008	0.051	1.016	-0.016	0.011	0.13	0.984
Edu	0.1463	0.046	0.002	1.158	0.0298	0.036	0.411	1.030	0.1513	0.043	<0.001	1.163
Alone	0.862	0.226	<0.001	2.368	0.6203	0.189	0.001	1.859	0.4836	0.231	0.036	1.622
ShareVeh	0.0417	0.146	0.775	1.043	0.0434	0.115	0.706	1.044	0.0269	0.134	0.841	1.027
DepMode	0.3985	0.069	<0.001	1.490	0.2598	0.055	<0.001	1.297	0.3366	0.07	<0.001	1.400
AccessTime	-0.0174	0.005	<0.001	0.983	0.004	0.003	0.15	1.004	-0.0371	0.006	<0.001	0.964
WaitTime	0.0383	0.005	<0.001	1.039	0.0215	0.003	<0.001	1.022	0.0541	0.006	<0.001	1.056
TravelTime	-0.014	0.002	<0.001	0.986	0.0097	0.001	<0.001	1.010	-0.0185	0.003	<0.001	0.982
Fare	0.003	0.001	0.003	1.003	-0.0002	0	0.59	1.000	-0.033	0.004	<0.001	0.968
Distance	-0.0017	0.001	0.16	0.998	-0.0105	0.001	<0.001	0.990	0.0102	0.004	0.008	1.010
GroupSize	0.5927	0.11	<0.001	1.809	0.5103	0.084	<0.001	1.666	0.2541	0.116	0.029	1.289

Note: β denotes the estimated coefficient; S.E. denotes the standard error; McFadden pseudo- R^2 = 0.3505; Nagelkerke R^2 = 0.415; McFadden R^2 = 0.328.

Table 4.3 Results of the Multinomial Logit Model Using Large Public Bus as the Reference Travel Mode for Older Persons' Travel Mode Choice

Variable	Bus/Songthaew				Van				Electric rail transit			
	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)
Const	-3.9769	0.889	<0.001	0.019	-4.9587	0.904	<0.001	0.007	-1.1491	0.806	0.154	0.317
Gen	-0.1425	0.145	0.326	0.867	-0.1955	0.15	0.191	0.822	-0.011	0.133	0.934	0.989
Age	0.022	0.011	0.055	1.022	0.0321	0.012	0.006	1.033	0.016	0.011	0.13	1.016
Edu	-0.005	0.048	0.917	0.995	-0.1214	0.048	0.012	0.886	-0.1513	0.043	<0.001	0.860
Alone	0.3784	0.218	0.082	1.460	0.1368	0.242	0.572	1.147	-0.4836	0.231	0.036	0.617
ShareVeh	0.0147	0.146	0.92	1.015	0.0165	0.152	0.913	1.017	-0.0269	0.134	0.841	0.973
DepMode	0.062	0.07	0.373	1.064	-0.0768	0.075	0.309	0.926	-0.3366	0.07	<0.001	0.714
AccessTime	0.0197	0.007	0.003	1.020	0.0411	0.006	<0.001	1.042	0.0371	0.006	<0.001	1.038
WaitTime	-0.0158	0.006	0.006	0.984	-0.0326	0.006	<0.001	0.968	-0.0541	0.006	<0.001	0.947
TravelTime	0.0045	0.004	0.205	1.005	0.0282	0.003	<0.001	1.029	0.0185	0.003	<0.001	1.019
Fare	0.036	0.004	<0.001	1.037	0.0328	0.004	<0.001	1.033	0.033	0.004	<0.001	1.034
Distance	-0.0119	0.004	0.002	0.988	-0.0207	0.004	<0.001	0.980	-0.0102	0.004	0.008	0.990
GroupSize	0.3386	0.117	0.004	1.403	0.2562	0.124	0.038	1.292	-0.2541	0.116	0.029	0.776

Note: β denotes the estimated coefficient; S.E. denotes the standard error; McFadden pseudo- R^2 = 0.3505; Nagelkerke R^2 = 0.415; McFadden R^2 = 0.328.

Table 4.4 Results of the Multinomial Logit Model Using Van as the Reference Travel Mode for Older Persons' Travel Mode Choice

Variable	Bus/Songthaew				Large Bus				Electric rail transit			
	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)
Const	-1.1491	0.806	0.154	0.317	-4.9587	0.904	<0.001	0.007	-3.9769	0.889	<0.001	0.019
Gen	-0.011	0.133	0.934	0.989	-0.1955	0.15	0.191	0.822	-0.1425	0.145	0.326	0.867
Age	0.016	0.011	0.13	1.016	0.0321	0.012	0.006	1.033	0.022	0.011	0.055	1.022
Edu	-0.1513	0.043	<0.001	0.860	-0.1214	0.048	0.012	0.886	-0.005	0.048	0.917	0.995
Alone	-0.4836	0.231	0.036	0.617	-0.1368	0.242	0.572	1.147	0.3784	0.218	0.082	1.460
ShareVeh	-0.0269	0.134	0.841	0.973	0.0165	0.152	0.913	1.017	0.0147	0.146	0.92	1.015
DepMode	-0.3366	0.07	<0.001	0.714	-0.0768	0.075	0.309	0.926	0.062	0.07	0.373	1.064
AccessTime	0.0371	0.006	<0.001	1.038	0.0411	0.006	<0.001	1.042	0.0197	0.007	0.003	1.020
WaitTime	-0.0541	0.006	<0.001	0.947	-0.0326	0.006	<0.001	0.968	-0.0158	0.006	0.006	0.984
TravelTime	0.0185	0.003	<0.001	1.019	0.0282	0.003	<0.001	1.029	0.0045	0.004	0.205	1.005
Fare	0.033	0.004	<0.001	1.034	0.0328	0.004	<0.001	1.033	0.036	0.004	<0.001	1.037
Distance	-0.0102	0.004	0.008	0.990	-0.0207	0.004	<0.001	0.980	-0.0119	0.004	0.002	0.988
GroupSize	-0.2541	0.116	0.029	0.776	0.2562	0.124	0.038	1.292	0.3386	0.117	0.004	1.403

Note: β denotes the estimated coefficient; S.E. denotes the standard error; McFadden pseudo- R^2 = 0.3505; Nagelkerke R^2 = 0.415; McFadden R^2 = 0.328.

Table 4.5 Results of the Multinomial Logit Model Using Electric rail transit as the Reference Travel Mode for Older Persons' Travel Mode Choice

Variable	Bus/Songthaew				Large Bus				Van			
	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)	β	S.E.	p-value	Exp (B)
Const	-1.1491	0.806	0.154	0.317	-3.9769	0.889	<0.001	0.019	-4.9587	0.904	<0.001	0.007
Gen	-0.011	0.133	0.934	0.989	-0.1425	0.145	0.326	0.867	-0.1955	0.15	0.191	0.822
Age	0.016	0.011	0.13	1.016	0.022	0.011	0.055	1.022	0.0321	0.012	0.006	1.033
Edu	-0.1513	0.043	<0.001	0.860	-0.005	0.048	0.917	0.995	-0.1214	0.048	0.012	0.886
Alone	-0.4836	0.231	0.036	0.617	0.3784	0.218	0.082	1.460	0.1368	0.242	0.572	1.147
ShareVeh	-0.0269	0.134	0.841	0.973	0.0147	0.146	0.92	1.015	0.0165	0.152	0.913	1.017
DepMode	-0.3366	0.07	<0.001	0.714	0.062	0.07	0.373	1.064	-0.0768	0.075	0.309	0.926
AccessTime	0.0371	0.006	<0.001	1.038	0.0197	0.007	0.003	1.020	0.0411	0.006	<0.001	1.042
WaitTime	-0.0541	0.006	<0.001	0.947	-0.0158	0.006	0.006	0.984	-0.0326	0.006	<0.001	0.968
TravelTime	0.0185	0.003	<0.001	1.019	0.0045	0.004	0.205	1.005	0.0282	0.003	<0.001	1.029
Fare	0.033	0.004	<0.001	1.034	0.036	0.004	<0.001	1.037	0.0328	0.004	<0.001	1.033
Distance	-0.0102	0.004	0.008	0.990	-0.0119	0.004	0.002	0.988	-0.0207	0.004	<0.001	0.980
GroupSize	-0.2541	0.116	0.029	0.776	0.3386	0.117	0.004	1.403	0.2562	0.124	0.038	1.292

Note: β denotes the estimated coefficient; S.E. denotes the standard error; McFadden pseudo- R^2 = 0.3505; Nagelkerke R^2 = 0.415; McFadden R^2 = 0.328.

From Table 4.2, the gender variable (Gen) does not exhibit a statistically significant effect on the choice of large buses, vans, or electric rail when compared with buses and songthaews. This finding indicates that differences between male and female older adults do not constitute a primary determinant in travel mode choice decisions. In contrast, age (Age) demonstrates a small positive association with the selection of vans, suggesting that older individuals are slightly more inclined to use vans rather than buses. No significant age-related effects are observed for large buses or electric rail modes.

Educational attainment (Edu) emerges as a salient determinant of mode choice, with positive and statistically significant coefficients for large buses and electric rail. This indicates that older adults with higher levels of education are more likely to choose large-capacity buses and electric rail compared with buses or songthaews. In contrast, education does not exert a clear influence on van selection. These findings suggest that knowledge, technological awareness, or perceptions of service quality may motivate more highly educated individuals to favor more modern modes or those perceived to have a superior image.

Regarding living arrangements, living alone has a positive and statistically significant effect across all alternative modes. Older adults who live alone are more likely to choose large buses, vans, and electric rail rather than buses or songthaews. This pattern may be explained by the greater emphasis placed on comfort and punctuality when no caregiver is present, relative to the use of conventional bus services. Conversely, shared household vehicle use (ShareVeh) does not significantly affect the choice of alternative modes, indicating that this factor does not play a substantial role in public transport decision-making in this context.

The mode of departure from home (DepMode) exerts a statistically significant influence across all alternatives, indicating that initial travel behavior—such as using a motorcycle or private car—affects the likelihood of selecting main transport modes other than buses. This underscores the importance of public transport accessibility as a key determinant of mode choice among older adults.

With respect to temporal variables, access time (AccessTime) has a negative and statistically significant effect on the choice of large buses and electric rail. This

suggests that longer access times decrease the likelihood of choosing these two modes, whereas van choice is not significantly affected. In contrast, waiting time (WaitTime) has a positive and statistically significant coefficient across all alternative modes, suggesting that prolonged waiting times for buses or songthaews prompt older adults to shift toward other transport options.

Travel time (TravelTime) shows mode-specific effects. Large buses and electric rail are perceived as less attractive when travel times become excessive, as indicated by negative and statistically significant coefficients. Conversely, van use exhibits a positive and statistically significant coefficient, suggesting that older adults are more willing to tolerate longer travel times when using vans, potentially due to perceived advantages in comfort and reliability compared with buses. Fare is positively associated with the choice of large buses but negatively associated with electric rail use. These findings suggest that older adults may perceive large buses as providing greater value for money despite marginally higher fares, while demand for electric rail is more sensitive to fare increases.

Distance reduces the likelihood of choosing vans but increases the likelihood of selecting electric rail, consistent with the suitability of electric rail for longer and continuous trips, while vans are more commonly chosen for medium-distance travel. Finally, group size (GroupSize) has a positive and statistically significant coefficient across all alternative modes, indicating that group travel increases the probability of choosing large buses, vans, or electric rail rather than buses or songthaews.

The multinomial logit model results further indicate that gender (Gen) does not significantly influence the selection of large buses, vans, or electric rail relative to buses and songthaews, with $\text{Exp}(B)$ values close to unity (0.877–1.011). These findings indicate that gender differences exert a negligible influence on travel mode choice among older adults. Age shows a modest positive effect on van selection ($\text{Exp}(B) = 1.016$), suggesting that each additional year of age increases the likelihood of choosing a van by approximately 1.6%. In contrast, no clear age-related effects are observed for large buses or electric rail, indicating that age is not a primary determinant of mode choice for these transport options.

Educational attainment (Edu) remains a prominent factor, as individuals with higher education levels are significantly more likely to select large buses and electric rail than buses, as reflected by Exp(B) values of 1.158 and 1.163, respectively. A one-level increase in education corresponds to an approximate 16% higher probability of selecting these modes, suggesting that greater knowledge and perceptions of service quality may facilitate the adoption of modern transport modes. Living alone exerts a strong influence across all alternatives, with Exp(B) values of 2.368 for large buses, 1.859 for vans, and 1.622 for electric rail. These results indicate that older adults living alone are 2.37 times more likely to choose large buses than buses, emphasizing their preference for convenience and service reliability. Shared vehicle use within the household (ShareVeh) does not exhibit a significant effect.

Departure mode (DepMode) strongly influences all alternatives, with Exp(B) values ranging from 1.297 to 1.490, indicating that initial travel patterns increase the likelihood of choosing alternative modes by 30–49%. This finding confirms the importance of first-mile connectivity. Access time (AccessTime) negatively affects large buses and electric rail, with Exp(B) values of 0.983 and 0.964, respectively. A one-minute increase in access time reduces the likelihood of choosing electric rail by 3.6%, demonstrating older adults' sensitivity to station accessibility. Conversely, waiting time (WaitTime) has a positive effect across all modes, particularly for electric rail (Exp(B) = 1.056), implying that each additional minute of waiting for buses increases the probability of switching to electric rail by 5.6%, reflecting the role of bus unreliability as a push factor.

Travel time (TravelTime) exhibits divergent effects, with Exp(B) values below unity for electric rail and large buses (0.982 and 0.986), indicating declining attractiveness with longer travel times. Vans, however, show Exp(B) = 1.010, suggesting greater tolerance for extended travel durations. Fare sensitivity is highest for electric rail, with Exp(B) = 0.968, indicating a 3.2% reduction in choice probability per unit fare increase, while large buses show minimal price sensitivity. Distance decreases the likelihood of choosing vans (Exp(B) = 0.990) but increases the likelihood of choosing electric rail (Exp(B) = 1.010), consistent with service characteristics. Group size (GroupSize) exerts a strong influence, particularly for large buses (Exp(B) = 1.809),

indicating that group travel increases the probability of choosing this mode by 1.81 times, underscoring the importance of family context in travel decisions among older adults.

From Table 4.3, the analysis indicates that gender (Gen) does not significantly affect the choice of buses, songthaews, vans, or electric rail relative to large buses. Age (Age) shows a tendency to increase van selection, although the effect remains modest in statistical significance ($p = 0.006$), while effects on buses and electric rail are not pronounced. Educational attainment (Edu) exhibits a statistically significant negative influence on van and electric rail selection, indicating that older adults with higher education are less likely to choose these two modes relative to large buses.

Living alone does not affect bus or van choice but has a negative effect on electric rail ($p = 0.036$), suggesting that older adults living alone tend to prefer large buses over electric rail. Shared vehicle use (ShareVeh) again shows no significant influence. Departure mode (DepMode) negatively affects electric rail choice ($p < 0.001$), indicating that those who depart using other modes are less likely to select electric rail relative to large buses.

Access time (AccessTime) and waiting time (WaitTime) significantly influence all modes. Access time has positive and significant effects on buses, vans, and electric rail, implying that longer access times increase the likelihood of choosing these modes relative to large buses. In contrast, waiting time exerts a negative effect across all modes, indicating that longer waiting times prompt older adults to favor large buses instead.

Travel time (TravelTime) positively influences van and electric rail choice ($p < 0.001$), suggesting greater tolerance for longer travel durations in these modes compared with large buses. Fare (Fare) has a positive and statistically significant effect on all modes, indicating that older adults perceive value even with higher fares. Distance (Distance) has a negative and significant effect across all modes, implying that longer trips encourage the use of large buses over other options. Group size (GroupSize) positively influences bus and van choice but negatively affects electric rail choice, indicating that group travel favors buses and vans over electric rail.

When buses and songthaews are used as the reference category, the results show that gender (Gen) continues to have no statistically significant influence on mode choice, with Exp(B) values between 0.822 and 0.989. Age (Age) exerts a clear effect on van choice, with $\text{Exp(B)} = 1.033$, indicating that each additional year of age increases the likelihood of choosing a van by approximately 3.3%. Education (Edu) exhibits the opposite pattern, with Exp(B) values of 0.886 for vans and 0.860 for electric rail, indicating that higher education increases the likelihood of choosing buses relative to vans and electric rail by 13.4% and 14%, respectively. This suggests that buses may be perceived as more cost-effective and accessible within the study context.

Living alone has a significant negative effect on electric rail choice, with $\text{Exp(B)} = 0.617$, indicating that older adults living alone are approximately 38% more likely to choose buses than electric rail. Shared vehicle use (ShareVeh) shows no significant influence. Departure mode (DepMode) negatively affects electric rail choice, with $\text{Exp(B)} = 0.714$, indicating a 28.6% higher likelihood of choosing buses over electric rail, reinforcing the importance of first-mile connectivity.

Temporal variables further reveal that access time (AccessTime) positively affects van and electric rail choice, particularly vans ($\text{Exp(B)} = 1.042$) and electric rail ($\text{Exp(B)} = 1.038$). A one-minute increase in bus access time increases the probability of switching to vans by 4.2% and to electric rail by 3.8%, indicating that access difficulties serve as a strong push factor. Conversely, waiting time (WaitTime) negatively affects all modes, with Exp(B) values of 0.947 for electric rail and 0.968 for vans, indicating that longer bus waiting times reduce the likelihood of continuing bus use and encourage shifts to other modes. Travel time (TravelTime) positively influences van and electric rail choice, with Exp(B) values of 1.029 and 1.019, respectively, indicating acceptance of longer travel durations for higher-quality modes.

Fare (Fare) demonstrates strong influence across all modes, with Exp(B) values around 1.03–1.04, indicating that a one-unit fare increase raises the likelihood of choosing alternative modes over buses by approximately 3–4%, reinforcing the perception of buses as the most economical option. Distance negatively affects all modes, particularly vans ($\text{Exp(B)} = 0.980$), suggesting that increased distance encourages continued bus use. Group size (GroupSize) positively influences bus and

van choice but negatively affects electric rail choice, indicating that group travel favors modes with shared costs and greater flexibility.

From Table 4.4, gender (Gen) does not influence the choice of buses, large buses, or electric rail. Age (Age) shows a positive association with large bus choice ($p = 0.006$) but does not affect buses or electric rail. Educational attainment (Edu) has a negative and statistically significant effect on bus and large bus choice but does not influence electric rail selection.

Living alone negatively affects bus choice ($p = 0.036$), indicating that older adults living alone tend to prefer vans over buses. Departure mode (DepMode) has a negative and statistically significant coefficient for bus choice ($p < 0.001$), suggesting that initial travel behavior reduces the likelihood of choosing buses relative to vans.

Access time (AccessTime) has a positive and statistically significant coefficient across all alternatives (bus, large bus, electric rail), indicating that longer access times increase the likelihood of choosing these modes over vans. Waiting time (WaitTime) negatively affects all modes ($p < 0.001$ to 0.006), suggesting that prolonged waiting encourages older adults to choose vans instead. Travel time (TravelTime) positively and significantly affects large bus and electric rail choice but does not influence bus choice, indicating greater tolerance for longer travel durations in these modes. Fare (Fare) positively and significantly affects all modes, reflecting perceived value despite higher fares. Distance (Distance) negatively and significantly affects all modes, indicating that longer trips increase the likelihood of choosing vans. Group size (GroupSize) negatively affects bus choice but positively affects large bus and electric rail choice, suggesting that group travel is more suitable for larger-capacity and electric modes.

Multinomial logit estimates using buses and songthaews as the reference category show that gender (Gen) has no statistically significant influence on mode choice, with $\text{Exp}(B)$ values between 0.822 and 0.989. Age significantly affects large bus choice, with $\text{Exp}(B) = 1.033$, indicating a 3.3% increase in choice probability per additional year of age. Education (Edu) has a significant negative effect on bus choice, with $\text{Exp}(B)$ values of 0.860 for buses and 0.886 for large buses, indicating that higher education increases the likelihood of choosing large buses and electric rail over buses

by approximately 11–14%. This reflects the role of service quality perceptions in decision-making.

Living alone shows mode-specific effects, with $\text{Exp}(B) = 0.617$ for buses, indicating that older adults living alone are approximately 38% more likely to choose electric rail over buses. *ShareVeh* does not exhibit significant influence. Departure mode (*DepMode*) negatively affects bus choice ($\text{Exp}(B) = 0.714$), indicating a 28.6% higher likelihood of choosing electric rail over buses, confirming the importance of first-mile connectivity.

In temporal terms, access time (*AccessTime*) positively affects all modes, particularly large buses ($\text{Exp}(B) = 1.042$) and electric rail ($\text{Exp}(B) = 1.038$). A one-minute increase in bus access time increases the likelihood of switching to large buses by 4.2% and to electric rail by 3.8%. Waiting time (*WaitTime*) negatively affects buses ($\text{Exp}(B) = 0.947$) and large buses ($\text{Exp}(B) = 0.968$), indicating that longer waits reduce continued bus use. Travel time (*TravelTime*) positively affects large bus and bus choice, with $\text{Exp}(B)$ values of 1.029 and 1.019, respectively, indicating acceptance of longer travel durations for higher-quality modes.

Fare exerts the strongest influence, with $\text{Exp}(B)$ values around 1.033–1.037 across all modes, indicating that fare increases of one unit raise the likelihood of choosing alternative modes over buses by approximately 3–4%, reinforcing the perception of buses as the most economical option. Distance negatively affects all modes, particularly large buses ($\text{Exp}(B) = 0.980$), indicating that increased distance encourages continued bus use. Finally, group size (*GroupSize*) positively affects large bus and electric rail choice, with $\text{Exp}(B)$ values of 1.292 and 1.403, respectively, indicating that group travel increases the likelihood of selecting these modes by 29–40% relative to buses.

From Table 4.5, the analysis indicates that gender (*Gen*) and age (*Age*) do not exert clear influences on the choice of buses, large buses, or vans relative to electric rail, except for a positive association between age and van choice ($p = 0.006$). Educational attainment (*Edu*) negatively affects bus and van choice, indicating that older adults with higher education levels are more likely to select electric rail.

Living alone negatively affects bus choice ($p = 0.036$), indicating that older adults living alone tend to prefer electric rail over buses. Departure mode (DepMode) negatively affects bus choice ($p < 0.001$), indicating that initial travel behavior reduces the likelihood of bus use relative to electric rail.

Access time (AccessTime) positively affects bus, large bus, and van choice relative to electric rail ($p < 0.01$), whereas waiting time (WaitTime) negatively and significantly affects all modes, indicating that longer waiting times encourage shifts toward electric rail. Travel time (TravelTime) positively affects large bus and van choice, suggesting that older adults are willing to accept longer travel durations in these modes compared with electric rail.

Fare (Fare) positively influences all alternative modes relative to electric rail, indicating high price sensitivity to electric rail fares. Distance negatively affects all modes relative to electric rail, reflecting the suitability of electric rail for longer-distance travel. Group size (GroupSize) negatively affects bus choice but positively affects large bus and van choice, indicating that group travel is more compatible with these modes than with electric rail.

Model fit evaluation indicates satisfactory performance, with McFadden's pseudo- $R^2 = 0.3505$, Nagelkerke $R^2 = 0.415$, and McFadden $R^2 = 0.328$. These values suggest that the multinomial logit model adequately explains variation in travel mode choice behavior among older adults and is suitable for policy and practical interpretation.

Overall, the multinomial logit analysis with buses and songthaews as the reference category confirms that gender (Gen) does not significantly influence mode choice, while age (Age) primarily affects van selection. Education (Edu) negatively affects bus choice, indicating a preference for higher-quality modes among more educated older adults. Living alone (Alone), departure mode (DepMode), access time (AccessTime), waiting time (WaitTime), travel time (TravelTime), fare (Fare), distance (Distance), and group size (GroupSize) collectively shape mode choice decisions, highlighting the roles of accessibility, service reliability, cost sensitivity, and social context in determining travel behavior among older adults.

4.6 Results and Discussion

The analysis indicates that the gender variable does not exert a statistically significant influence on travel mode choice across all baseline specifications, suggesting that being male or female is not a primary determinant of decision-making among older persons. In contrast, respondents' age shows an influence on van choice, whereby older individuals exhibit a greater propensity to select vans over buses or other public transport modes. This finding suggests that older persons tend to favor modes that offer convenience and ease of access. However, age does not demonstrate a clear influence on the choice of large buses or electric rail transit. These results are consistent with the concept of *aging in place*, which posits that as age increases, older persons adapt their travel behavior to accommodate changing physical capabilities by selecting modes that require less physical effort and provide greater comfort (Stjernborg et al., 2015). In addition, prior studies indicate that older individuals increasingly avoid public transport options that involve extensive walking or prolonged waiting times (Rosenbloom, 2001).

Educational attainment emerges as a significant determinant of travel mode choice. Older persons with higher levels of education are more likely to select large buses and electric rail transit rather than buses or vans. Higher education is associated with an enhanced ability to comprehend complex transport systems, as well as with more systematic perceptions and evaluations of service quality. Consequently, modes that reflect modernity and higher service standards tend to be preferred. Conversely, higher educational attainment is also associated with reduced use of buses and vans, which are often perceived as offering lower service quality. These findings underscore the role of knowledge capital in shaping the acceptance of advanced technologies and higher-standard public transport systems (Kim & Ulfarsson, 2004; Shrestha, Millonig, Hounsell, & McDonald, 2017).

With respect to living arrangements, older persons who live alone are more likely to choose large buses, vans, and electric rail transit over buses and songthaews. This pattern suggests that individuals without caregivers place greater emphasis on convenience, safety, and punctuality than on modes characterized by higher uncertainty. However, when compared with electric rail transit, those living alone tend

to prefer large buses, possibly due to perceptions of greater stability and reduced travel risk. This behavior can be interpreted through the lens of *transport vulnerability*, which highlights that older persons lacking family support often face heightened mobility risks and thus rely more heavily on dependable transport systems (Böcker, van Amen, & Helbich, 2017). In contrast, sharing vehicles within the household does not show a statistically significant effect on mode choice, indicating that this factor does not play a central role in shaping older persons' travel behavior.

Departure mode at the trip origin (DepMode) is identified as a salient influencing factor. Older persons who leave home using motorcycles or private cars are more inclined to select vans and large buses than buses. However, relative to large buses, departing with these modes is associated with a reduced likelihood of choosing electric rail transit. This finding highlights the interdependence of mode choices across successive trip stages and can be explained by the concept of *multimodal trip chaining*, which suggests that mode choice at the initial stage directly influences the selection of the main mode in subsequent stages (Scheiner, 2006).

The analysis further demonstrates that access time plays a critical role in older persons' travel mode choice. Longer access times reduce the likelihood of selecting large buses and electric rail transit but increase the probability of choosing buses or vans. This pattern reflects older persons' preference for convenience and easy access, as physical constraints discourage complex travel arrangements or lengthy walks to boarding points (Ravensbergen, Van Liefferinge, Isabella, Merrina, & El-Geneidy, 2022; Y. Zhang, Liang, Yao, & Gu, 2024).

Waiting time also exerts a consistent influence. When older persons experience prolonged waiting times for buses or songthaews, they tend to switch to large buses, vans, or electric rail transit. Conversely, when compared with large buses, extended waiting times reinforce continued selection of buses, indicating that sensitivity to arrival-time uncertainty directly affects mode choice decisions. Punctuality thus represents a key determinant of travel confidence among older persons (Dilian, Beckers, Davidovitch, & Martens, 2024; Fields et al., 2021).

Travel time exhibits heterogeneous effects across modes. Older persons tend to avoid modes associated with long travel times, such as large buses and electric rail

transit, as reflected by negative effects, yet they are willing to tolerate longer travel durations when using vans, as indicated by positive effects. Vans may be perceived as offering greater comfort, punctuality, and flexibility than buses, leading older persons to accept longer travel times in exchange for improved travel quality (Dou, Jian, Guo, & Cao, 2023; Ravensbergen et al., 2022).

Regarding fares, the analysis indicates that older persons perceive large buses as offering good value for money, even when prices increase, such that higher fares do not constitute a major barrier. In contrast, higher fares for electric rail transit act as a direct deterrent, reducing the likelihood of selection. This finding suggests heightened price sensitivity for modes perceived as relatively costly and indicates that fare decisions are evaluated alongside considerations of quality, convenience, and overall value rather than price alone (Li, Zhang, Ruan, Guerra, & Burnette, 2020).

Longer travel distances reduce the likelihood of choosing buses and vans while increasing the probability of selecting electric rail transit. This result demonstrates that older persons recognize the advantages of electric rail systems for medium- to long-distance travel, where continuity, convenience, and reduced physical fatigue are valued relative to traditional modes that are more suitable for short- to medium-distance trips (Yang Zhang et al., 2024).

Group size has a positive effect on the choice of large buses and vans but a negative effect on electric rail transit. This pattern indicates that group travel is better accommodated by modes with greater passenger capacity, such as buses and vans, whereas electric rail transit may be perceived by older persons as less comfortable for group travel (R. C. P. Wong et al., 2018; N. Zhang & Yang, 2024).

Synthesizing these findings, buses/songthaews tend to be selected in contexts where access to boarding points is convenient and travel distances are short to medium. Effective management of waiting time is particularly critical, as prolonged waiting readily induces mode switching among older persons. Furthermore, when travelers move in groups or live alone, they tend to favor modes perceived as more reliable, thereby diminishing the attractiveness of buses in such situations.

Large buses are well suited to older persons who prioritize service standards, value for money, and reliability, especially for group travel, which further enhances

the appeal of this mode. From a temporal perspective, users are sensitive to lengthy access and travel times; therefore, reducing walking distances and streamlining access procedures is essential. Nevertheless, when buses entail long waiting times, travelers often shift toward large buses, underscoring the role of this mode as a viable substitute under conditions of service uncertainty in basic transport options.

Vans are characterized by flexibility, punctuality, and convenient connectivity, making them suitable for short- to medium-distance travel and for older individuals of more advanced age. Users are also willing to accept longer travel times when using vans, reflecting favorable perceptions of comfort. Moreover, small- to medium-sized group travel further enhances the attractiveness of this mode.

Electric rail transit is most appropriate for medium- to long-distance travel under two key conditions: (1) station access must be straightforward and not excessively time-consuming, and (2) fare levels must remain acceptable for older persons. Users exhibit greater sensitivity to access time and price than to speed alone. In terms of passenger characteristics, individuals who value service standards and modernity are more likely to select electric rail transit. However, for larger group travel, large buses tend to better accommodate comfort and passenger capacity requirements.

4.7 Conclusions and Policy Recommendations

4.7.1 Conclusions

This study aims to analyze the factors determining travel mode choice among older persons by applying the multinomial logit model to a sample of older individuals with a mean age of 68 years. The statistical analysis reveals complex interrelationships among temporal factors, socioeconomic factors, and cost and distance factors, which jointly shape older persons' travel mode choice behavior.

With respect to socioeconomic factors, educational attainment emerges as a key determinant influencing the direction of mode choice. Older persons with higher levels of education are more likely to select large buses and electric rail transit rather than buses or vans, reflecting the association between knowledge capital and access to transport modes characterized by higher service standards and more

advanced technologies. At the same time, older persons who live alone tend to prefer modes that offer greater convenience and reliability, such as large buses and electric rail transit. The absence of family support increases reliance on stable transport systems that reduce travel-related risks.

Regarding temporal factors, these are found to exert the strongest influence on travel mode choice. In particular, access time has a negative effect on the selection of large buses and electric rail transit, while exerting a positive effect on the choice of buses and vans. In other words, when older persons are required to spend excessive time walking to stations or boarding points, they tend to avoid buses and electric rail systems and instead choose modes that are more easily accessible, such as buses or vans, which are typically located closer to residential areas or community centers. Meanwhile, waiting time plays a pronounced role across all baseline specifications. As waiting time increases, older persons are more likely to avoid buses and songthaews and switch to modes that offer greater reliability and punctuality, such as vans, large buses, or electric rail transit. This finding highlights the critical importance of service punctuality and reduced uncertainty in fostering travel confidence among older persons.

In terms of cost and distance factors, the results indicate that older persons are sensitive to fare levels, particularly for electric rail transit, which is perceived as relatively costly. Increases in fares discourage older persons from selecting this mode. By contrast, although large buses may involve slightly higher fares, older persons continue to choose them due to perceptions of better value for money and higher service quality. In addition, distance is a significant determinant of mode choice. Electric rail transit is more suitable for medium- to long-distance travel that requires speed and continuity, whereas buses and vans remain primary options for short- to medium-distance trips.

When considering usage patterns by mode, buses and songthaews are convenient for short-distance travel but require improvements in service frequency and reductions in waiting time to retain users. Large buses are well suited to older persons who prioritize service standards, value for money, and group travel. Vans demonstrate strengths in flexibility, punctuality, and suitability for older individuals of

more advanced age, particularly for medium-distance travel. Electric rail transit is appropriate for medium- to long-distance journeys; however, it continues to face constraints related to station accessibility and high fare sensitivity.

4.7.2 Policy Recommendations

4.7.2.1 Integrated Transport Policy

Development of a Hub-and-Spoke System for Older Persons

- 1) Establish transfer hubs specifically designed for older persons, equipped with facilities such as seating areas, restrooms, and shelters for protection from sun and rain.
- 2) Develop feeder services using vans or small vehicles to connect residential communities to primary transport hubs.
- 3) Apply real-time information technologies to reduce uncertainty associated with waiting times.

Age-Friendly Route Design

- 1) Analyze and improve walking distances from residences to boarding points, ensuring that they do not exceed 300 meters.
- 2) Locate bus stops in areas that provide shade and adequate ventilation.
- 3) Develop pedestrian pathways that are safe and non-slip, equipped with handrails and sufficient lighting.

4.7.2.2 Pricing and Fare Structure Policy

Progressive Fare System for Older Persons

- 1) Implement a distance-based, tiered fare structure, particularly for electric rail transit, to reduce cost barriers.
- 2) Consider means-tested subsidies for older persons with low income.
- 3) Develop integrated ticketing systems that can be used across all modes within a unified transport network.

Promotion of Public Transport Use through Pricing Mechanisms

- 1) Introduce special fares for travel during off-peak periods.
- 2) Establish fare discount programs for trips involving multiple transfers across modes.

4.7.2.3 Service Quality Enhancement Policy

Improvement of Bus and Songthaew Service Standards

- 1) Set service frequency standards to ensure regular and reliable operations, particularly on routes heavily used by older persons.
- 2) Develop real-time vehicle tracking systems to provide accurate arrival time information.
- 3) Upgrade vehicle quality by ensuring adequate seating for older passengers and sufficient air-conditioning systems.

Upgrading Electric Rail Transit Services

- 1) Improve station accessibility through simplified access systems, such as sufficient elevators and safe escalators.
- 2) Provide on-site assistance staff during periods of high usage by older persons.
- 3) Enhance signage and announcement systems to ensure clarity and ease of understanding for older users.

4.7.2.4 Infrastructure and Environmental Development Policy

Improvement of the Travel Environment

- 1) Upgrade walking surfaces to ensure smoothness and non-slip conditions.
- 2) Provide resting seats along pedestrian routes, particularly on longer walking distances.
- 3) Improve lighting systems to enhance safety during evening travel.

Design of Stations and Bus Stops

- 1) Apply Universal Design principles in the design of stations and bus stops.
- 2) Provide covered waiting areas with appropriate ventilation systems.
- 3) Install clear audio announcement systems and well-designed informational signage.

4.7.2.5 Targeted Support Policy

Support for Older Persons Living Alone

- 1) Establish companion travel programs for older persons traveling to hospitals or healthcare facilities.
- 2) Develop door-to-door services for older persons with mobility limitations.
- 3) Create community-based volunteer networks to assist with travel needs.

Promotion of Group Travel

- 1) Develop group booking systems that offer fare discounts for group travel.
- 2) Organize social trip programs that integrate travel with health-oriented tourism activities.

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CHAPTER V

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusions

The current use of public transport systems in Thailand continues to involve both limitations and risks for older persons, who constitute a population group with heightened physical vulnerability and increasing age-related constraints. These include, for example, visual impairments, reduced mobility, and an elevated risk of sudden accidents. Such issues span multiple dimensions, ranging from infrastructure conditions to service quality. Accordingly, this thesis undertakes an in-depth investigation to generate empirical evidence aimed at identifying key factors associated with older persons' intention to use public transport and at developing a service quality measurement model specific to this population group. The ultimate objective is to prepare Thailand's public transport system to attain sufficient capacity and efficiency to accommodate future demographic changes, while ensuring that the mobility needs of older persons are met in a manner that is safe, convenient, and equitable. The findings are intended to provide practical insights and guidance for relevant stakeholders in improving and developing public transport systems, thereby promoting public transport use among both existing users and potential new users. The research outcomes are summarized in accordance with the study objectives as follows.

5.1.1 Analyzing the Travel Intention of Elderly Passengers in Thailand's Public Transportation System: A Structural Equation Modeling Approach

Study 1 aims to apply Structural Equation Modeling (SEM) to validate empirical evidence regarding the factor structure influencing older passengers' intention to use public transport. Data were collected through a questionnaire survey grounded in the Theory of Planned Behavior (TPB) and the SERVQUAL conceptual framework. The sample comprised 2,250 older persons aged 60 years and above from

five regions across Thailand. The questionnaire covered demographic characteristics, travel experiences, and perceptions of service quality.

The results indicate that passenger satisfaction is a strong determinant of intention to use public transport. This positive attitude exerts both direct and indirect effects—mediated through satisfaction—on older persons’ behavioral intention. In contrast, habitual reliance on private car use has a negative influence on the intention to use public transport. This finding underscores the need to create supportive environments that facilitate the formation of new travel habits, thereby encouraging older persons to shift from private car use to public transport. The outcomes of this study provide a foundation for government agencies and relevant stakeholders to better understand older persons’ perspectives and needs with respect to public transport systems in Thailand, which in turn can contribute to social equity and long-term societal stability.

In summary, this research reinforces the central role of satisfaction as a robust factor in analyzing older persons’ travel behavior. Moreover, a positive attitude toward public transport is shown to enhance the intention to use such systems, whereas habitual dependence on private travel modes exerts an opposing effect.

5.1.2 Research on Older Persons’ Satisfaction with Public Transport Systems in Thailand Using Multiple Importance–Performance Analysis (IPA) Approaches

Study 2 aims to examine the level of satisfaction among older persons who use public transport services and to compare the analytical outcomes of expectations and satisfaction derived from three different approaches. This comparison highlights theoretical strengths and differences that lead to varied interpretations, which in turn inform policy recommendations and development guidelines tailored to an aging society. Accordingly, this study applies Importance–Performance Analysis (IPA) using multiple methodological approaches, as follows.

Traditional IPA, which offers straightforward and transparent interpretation and can be readily replicated, making it suitable for guiding policy implementation.

The Gap 1 approach has a limitation in that it does not explicitly identify the priority order of factors requiring development or improvement.

IPA using the Gap 2 approach, which is similar in structure to traditional IPA but serves a different objective, namely the comparison of service performance with competitors. In this study, the Gap 2 approach is integrated into the analysis to reflect disparities within Thailand's public transport service system.

As a result, the findings provide valuable guidance for stakeholders, such as transport operators and government agencies, in implementing policy changes to encourage older persons to use public transport. Public transport is considered a safer travel option than private driving for this population group. To achieve sustainable development, improvements should prioritize issues that are particularly important to older persons, especially safety-related aspects, in order to enhance travel efficiency and safety. Moreover, services and facilities designed for older persons—such as stairways, elevators, handrails, resting areas, and wheelchairs—remain limited, which restricts accessibility and usability. This limitation is especially critical given that older persons face higher risks of accidents and crime compared with other population groups.

Accordingly, this research addresses a significant knowledge gap in the study of satisfaction among older public transport users in Thailand by systematically comparing multiple IPA approaches. The resulting comprehensive insights are expected to support policy formulation and the development of public transport systems that align with the needs of an aging society in a sustainable manner.

5.1.3 An Analysis of Determinants of Travel Mode Choice Among Older Persons Using a Multinomial Logit Model

Study 3 aims to examine the factors influencing older persons' decisions regarding travel mode choice within four types of public transport systems: buses or songthaews, large buses, vans, and electric rail transit.

The results of the multinomial logit model analysis indicate that socioeconomic factors play a significant role in determining travel mode choice among older persons, particularly educational attainment and living arrangement. Older

persons with higher levels of education are more likely to select large buses and electric rail transit rather than buses or songthaews. This pattern reflects greater awareness of service information, familiarity with modern transport systems, and a higher capacity to adapt to technological applications. In addition, older persons who live alone tend to prefer travel modes that offer higher levels of comfort and temporal reliability, such as large buses, vans, and electric rail transit, rather than conventional bus services. By contrast, gender and shared vehicle use within the household do not exhibit statistically significant effects on travel mode choice.

With respect to service-related and temporal factors, waiting time and access time to the transport system emerge as key determinants of older persons' mode selection. Long waiting times or extended access times, such as the need to walk long distances, exert negative effects on the choice of buses, large buses, and electric rail transit. At the same time, older persons demonstrate greater flexibility toward in-vehicle travel time when choosing vans, as these are perceived to provide higher levels of comfort and punctuality compared with other modes.

Findings related to cost and distance indicate that older persons are most sensitive to the fare levels of electric rail transit. High fares significantly reduce the likelihood of selecting this mode. In contrast, large buses are perceived as offering good value for money when both fare levels and service quality are considered. For long-distance travel, electric rail transit is the most frequently chosen mode among older persons, owing to its speed, comfort, and suitability for longer trips.

Furthermore, other travel behavior factors, such as group size and departure mode from the origin, also influence travel mode choice. Traveling in groups increases the likelihood of selecting large buses, vans, and electric rail transit. In addition, the use of private vehicles to access the main transport system affects overall mode choice decisions.

In summary, the findings indicate that the development of public transport systems for older persons should prioritize punctuality, reductions in waiting time, and the design of access facilities that are convenient and safe. Appropriate fare structures—particularly for electric rail transit—are also essential to ensure equitable access for older persons. The results of this study provide policy-relevant evidence to

support the development of age-friendly public transport systems. Moreover, improvements in public transport for older persons should integrate both service quality enhancement and policy-oriented design that reflects actual travel behavior in order to promote equitable access and the long-term sustainability of transport systems in an aging society.

5.2 Recommendations

5.2.1 Analyzing the Travel Intention of Elderly Passengers in Thailand's Public Transportation System: A Structural Equation Modeling Approach

Based on the research findings identifying factors that influence older passengers' intention to use public transport, the following recommendations are proposed.

- 1) Implementation Stages
 - a. Short-term: Improve basic service quality, including cleanliness, safety, user-friendly travel information, clear signage, and fare reduction measures.
 - b. Medium-term: Develop age-friendly infrastructure, such as elevators, ramps, and designated seating for older persons.
 - c. Long-term: Promote a culture of sustainable mobility through public campaigns, education initiatives, and integration with social welfare systems.
- 2) Resource Requirements
 - a. Budgetary support from central and local governments.
 - b. Personnel trained specifically in providing services to older persons.
 - c. Accessible technologies, such as applications with large fonts, audio narration, and simplified language.
- 3) Evaluation Metrics
 - a. Proportion of older persons shifting toward public transport use.
 - b. Levels of satisfaction and frequency of service usage.
 - c. Outcomes related to social equity.
- 4) Barriers and Mitigation Strategies

- a. Barriers: Habitual reliance on private vehicles, limited budgets, and unequal access.
- b. Strategies: Economic incentives, active participation of older persons through co-creation processes, trial-use and fare discount programs, volunteer assistance initiatives (Buddy System), technology training, and integration of transport policies with urban development and health planning.

5.2.2 Research on Older Persons' Satisfaction with Public Transport Systems in Thailand Using Multiple Importance–Performance Analysis (IPA) Approaches

Based on the findings from the analysis of older persons' satisfaction with public transport in Thailand using multiple Importance–Performance Analysis (IPA) approaches, relevant agencies should prioritize improvements in factors that are rated as highly important by older persons but demonstrate low performance. These factors include accessibility, safety, and punctuality. Reducing waiting times, increasing service frequency, and designing age-friendly infrastructure can enhance satisfaction and confidence in public transport use. In addition, travel information systems should be made clear and easy to understand, and service standards should be maintained consistently. The combined application of multiple IPA approaches supports more precise policy decision-making and contributes to the development of public transport systems that are well aligned with the needs of Thailand's aging society.

5.2.3 An Analysis of Determinants of Travel Mode Choice Among Older Persons Using a Multinomial Logit Model

Based on the study of factors influencing older persons' travel mode choice in Thailand, the following policy recommendations are proposed.

5.2.3.1 Integrated Transport Policy

- 1) Hub-and-Spoke System for Older Persons
 - a. Establish age-friendly transfer hubs equipped with essential facilities.
 - b. Develop feeder services connecting communities to primary hubs.

c. Implement real-time information systems to reduce waiting times.

2) Age-Friendly Route Design

a. Reduce walking distances to boarding points to no more than 300 meters.

b. Upgrade bus stops to provide shade and adequate ventilation.

c. Develop safe pedestrian pathways with handrails and sufficient lighting.

5.2.3.2 Pricing and Fare Structure Policy

1) Progressive Fare System for Older Persons

a. Implement distance-based tiered fare structures.

b. Provide means-tested fare subsidies for low-income older persons.

c. Develop integrated ticketing systems usable across all transport modes.

2) Promotion of Public Transport Use through Pricing Mechanisms

a. Introduce special fares during off-peak periods.

b. Offer fare reductions for multimodal travel.

5.2.3.3 Service Quality Enhancement Policy

1) Buses and Songthaews

a. Ensure consistent service frequency.

b. Implement real-time vehicle tracking systems.

c. Upgrade vehicles to include designated seating for older persons and adequate air-conditioning.

2) Electric Rail Transit

a. Improve station accessibility through safe elevators and escalators.

b. Provide assistance staff during periods of high older-person usage.

c. Enhance signage and announcements to improve clarity and comprehension.

5.2.3.4 Infrastructure and Environmental Development Policy

1) Travel Environment

a. Improve walking surfaces to ensure smooth and non-slip conditions.

b. Provide resting seats along travel routes.

c. Enhance lighting to improve safety.

2) Stations and Bus Stops

a. Design facilities in accordance with Universal Design principles.

b. Provide covered waiting areas with adequate ventilation.

c. Install clear signage and audio announcement systems.

5.2.3.5 Targeted Support Policy

1) Older Persons Living Alone

a. Implement companion travel programs for hospital visits.

b. Develop door-to-door services for individuals with mobility limitations.

c. Establish community-based volunteer networks.

2) Group Travel

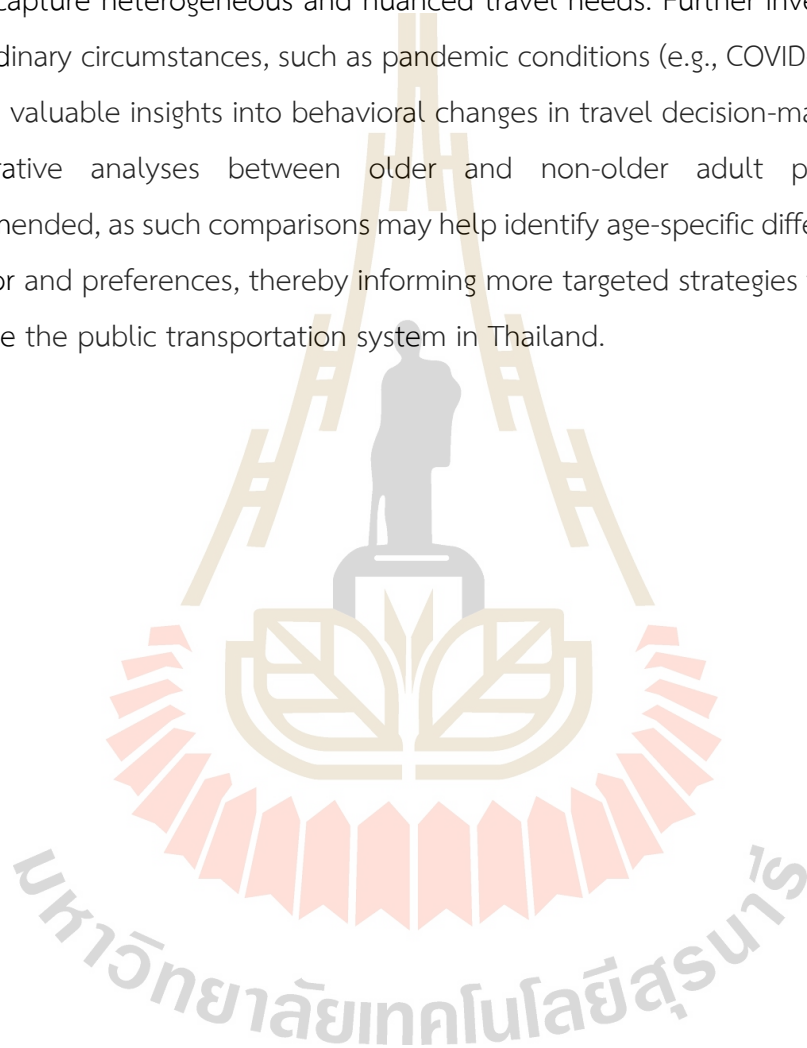
a. Develop group booking systems with fare discounts.

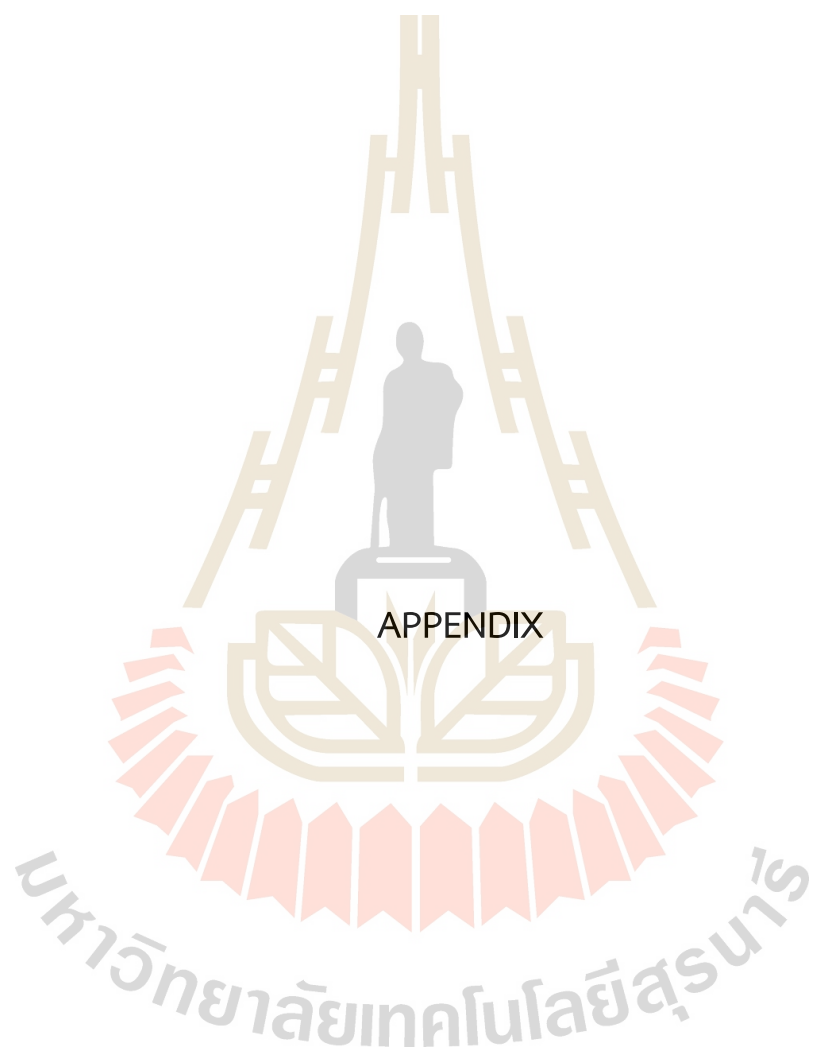
b. Organize group travel activities combined with health-oriented tourism.

5.3 Future Research Directions

This study is subject to several limitations that suggest important directions for future research. First, the focus on urban areas may limit the generalizability of the findings, as variations in spatial and contextual characteristics across urban, suburban, and rural settings can lead to distinct travel behavior patterns that are not fully

captured in the present analysis. Future studies should therefore expand the geographical scope to include diverse spatial contexts with varying public transport service conditions, enabling comparative assessments of spatial factors influencing mode choice. In addition, subsequent research should consider broader population groups beyond older adults, including individuals with severe physical limitations, to better capture heterogeneous and nuanced travel needs. Further investigation under extraordinary circumstances, such as pandemic conditions (e.g., COVID-19), would also provide valuable insights into behavioral changes in travel decision-making. Moreover, comparative analyses between older and non-older adult populations are recommended, as such comparisons may help identify age-specific differences in travel behavior and preferences, thereby informing more targeted strategies to enhance and promote the public transportation system in Thailand.

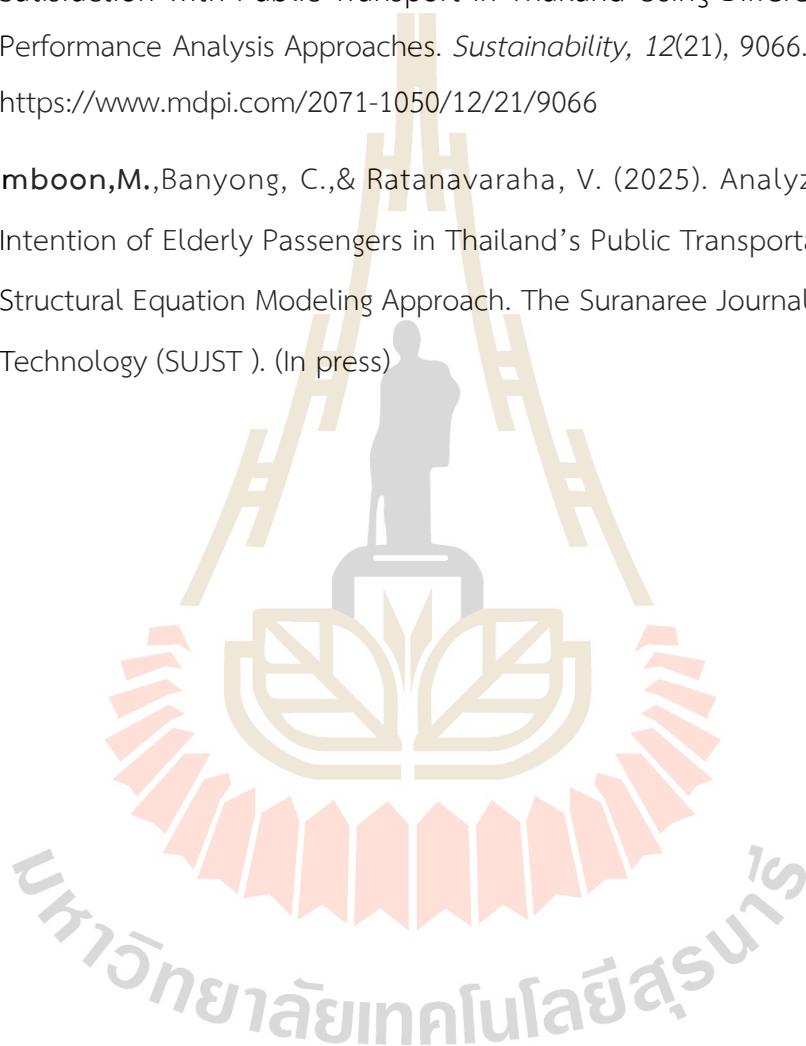




LIST OF PUBLICATIONS

Chaisomboon, M., Jomnonkwao, S., & Ratanavaraha, V. (2020). Elderly Users' Satisfaction with Public Transport in Thailand Using Different Importance Performance Analysis Approaches. *Sustainability*, 12(21), 9066. Retrieved from <https://www.mdpi.com/2071-1050/12/21/9066>

Chaisomboon, M., Banyong, C., & Ratanavaraha, V. (2025). Analyzing the Travel Intention of Elderly Passengers in Thailand's Public Transportation System: A Structural Equation Modeling Approach. *The Suranaree Journal of Science and Technology (SUJST)*. (In press)



BIOGRAPHY

Methawadee Chaisomboon was born on January 16, 1993, in Nakhon Ratchasima, Thailand. She obtained her bachelor's degree in transportation and logistics engineering in 2015 from the School of Transportation Engineering, Suranaree University of Technology (SUT), Nakhon Ratchasima. After graduation, she worked as a logistics engineer at AGC Auto Thailand for two years, where she gained practical experience in logistics operations and transportation systems.

In 2018, she was awarded a scholarship under the Royal Golden Jubilee (RGJ) Ph.D. Program by the Thailand Research Fund, which enabled her to pursue doctoral studies in the Doctor of Philosophy program in Civil, Transportation, and Geo-Resources Engineering. Her doctoral research focuses on travel behavior analysis, public transport systems, and transportation planning for an aging society, with particular emphasis on elderly passengers' travel intentions, satisfaction, and mode choice using advanced quantitative and econometric modeling approaches.

During her doctoral studies, she actively disseminated her research findings through academic conferences and presented her work at *the National RGJ and RRI Conferences 2025: Engineering and Technology*. Her research aims to support evidence-based policy development and contribute to the improvement of public transport systems that promote accessibility, safety, and quality of life for older persons in Thailand.