A STUDY ON PUBLIC COMMUTERS WILLINGNESS TO ADOPT A MOBILITY-AS-A-SERVICE APPLICATION: EVIDENCE FROM THAILAND

SUCHADA PHONSITTHANGKUN

MASTER OF BUSINESS ADMINISTRATION
IN
INTERNATIONAL LOGISTICS AND
SUPPLY CHAIN MANAGEMENT

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Author: Suchada Phonsitthangkun

Examination Committee:

Sunida Tiwong, Ph. D.	Chairperson
Assistant Professor Tosporn Arreeras, D. Eng.	Member
Samatthachai Yamsa-ard, Ph. D.	Member
Associate Professor Patiwat Littidej, Ph. D.	Member

Advisor:

....Advisor

(Assistant Professor Tosporn Arreeras, D. Eng.)

Dean:

....

(Piyatida Pianluprasidh, Ph. D.)

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Advisor Assistant Professor Tosporn Arreeras, Ph. D.

ABSTRACT

This study examines factors influencing Thai commuters' willingness to adopt Mobility as a Service (MaaS) using an extended Unified Theory of Acceptance and Use of Technology (UTAUT2) model. The model incorporates privacy concerns, perceived risk, and price sensitivity to better reflect adoption behavior in emerging transportation contexts. Data were collected from 418 respondents across Thailand via an online questionnaire and analyzed using Structural Equation Modeling (SEM). Analysis revealed that Performance Expectancy, Hedonic Motivation, Habit, Price Sensitivity, Privacy Concerns, and Perceived Risk positively influence MaaS adoption willingness, while Social Influence showed negative effects. Facilitating Conditions and Habit directly affected Usage Behavior. Effort Expectancy and Price Value had no significant impact. Demographic analysis found rural residents and older users (36+) prioritized Facilitating Conditions, females emphasized Effort Expectancy, and vehicle ownership moderated multiple relationships. These insights advance theoretical understanding of MaaS adoption in emerging markets and offer practical guidance for service providers and policymakers. Prioritizing service quality, rural infrastructure, and transparent privacy policies is crucial to promote adoption and support sustainable urban mobility in Thailand.

Keywords: MaaS, UTAUT2, Technology Adoption, Public Transportation, SEM, Sustainable Mobility, Travel Behavior

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES

ABBREVIATIONS AND SYMBOLS

VT	Vermont
VA	Virginia
WA	Washington
WV	West Virginia
WI	Wisconsin
WY	Wyoming

CHAPTER 1

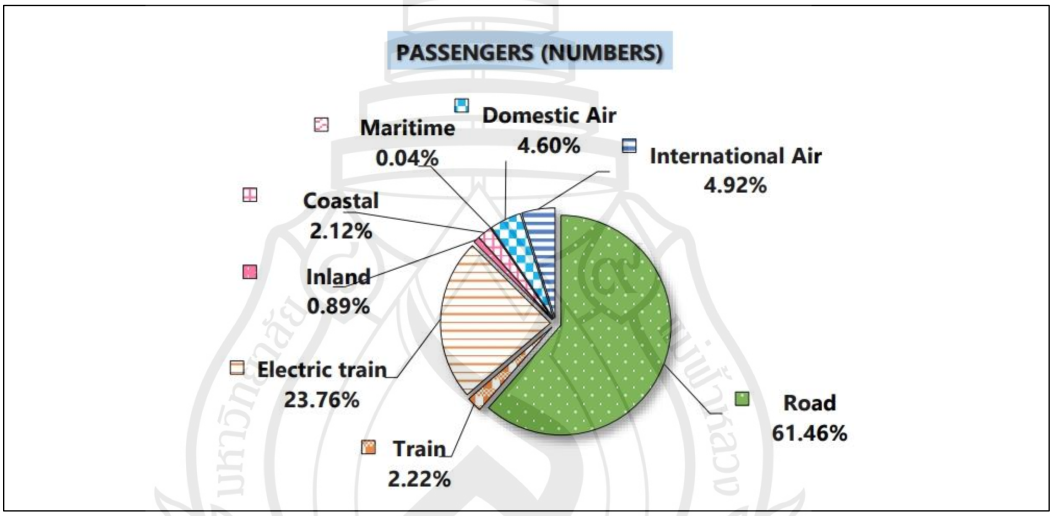
INTRODUCTION

1.1 Background

In recent decades, global transportation systems have faced significant challenges due to increasing urbanization, rising vehicle ownership, and evolving mobility needs. Public transport has struggled to compete with private cars as global car ownership rates increase with rising incomes and greater vehicle affordability. The continued decentralization of suburban areas has created land use and travel patterns that are challenging to service efficiently by mass transit systems (Buehler & Pucher, 2012). Worldwide passenger transport demand is expected to increase to 110 trillion passenger-kilometers by 2060, with most of this growth occurring in developing countries where populations and economies are expanding rapidly. Many cities in both industrial and developing nations suffer from severe traffic congestion due to increased transport demand, leading to significant economic losses, heightened pollution, excessive energy consumption, and extended travel times (Kii et al., 2021).

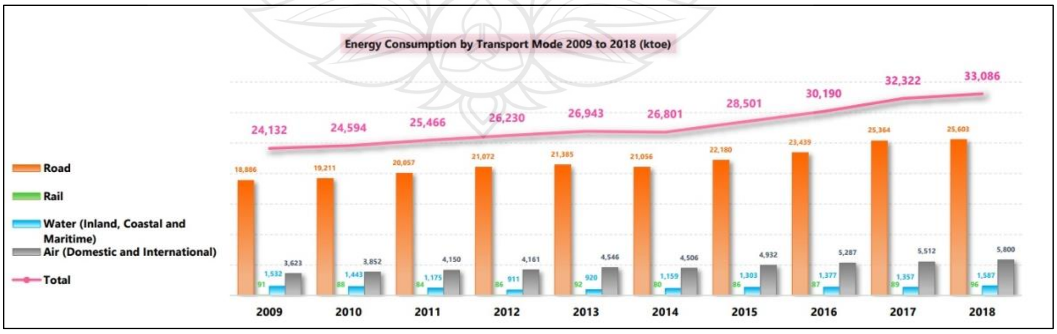
Thailand, as a developing country facing rapid urbanization, presents a clear example of these transportation challenges. Statistical data on registered vehicles in Thailand from 2017-2021 shows a growth rate of 1.90%, approximately 0.95 million additional units annually, with passenger cars showing the most significant increase at 4.27%. During the same period, public motorcycles decreased by 3.62%, while buses, non-buses, and small commercial vehicles declined by 3.60%, 1.37%, and 2.56% respectively (Department of Land Transport, 2021). This trend of rising private vehicle ownership alongside declining public transport availability has created substantial problems including traffic congestion, compromised mental health, air pollution, and noise pollution (Jomnonkwao et al., 2016). The decrease in public transportation options further indicates a concerning shift away from shared mobility solutions toward individual transportation modes.

From a logistics and supply chain management perspective, passenger transportation represents a significant component of the broader mobility ecosystem. Each transport mode forms a critical link in what can be conceptualized as a passenger transportation supply chain, where inefficiencies in one segment affect the entire system. Thailand's primary travel mode remains road-based (61.46% of all journeys), followed by electric trains (23.76%), as shown in Figure 1.1. This modal imbalance results in the highest and steadily increasing energy consumption in road travel from 2009 to 2018, as illustrated in Figure 1.2. Such inefficiencies in the passenger logistics chain directly impact economic productivity, environmental sustainability, and quality of life.



Source Department of Land Transport (2021)

Figure 1.1 Passenger by Transport Mode 2018



Source Department of Land Transport (2021)

Figure 1.2 Energy Consumption by Transport Mode from 2009 to 2018

The concept of Mobility as a Service (MaaS) represents an innovative logistics solution that addresses these transportation challenges through supply chain integration principles. MaaS applies established logistics concepts—such as integration, coordination, and optimization—to passenger transportation rather than freight movement. In essence, MaaS functions as an integrated passenger logistics platform that coordinates multiple transportation providers within a single ecosystem, optimizing the entire mobility supply chain from origin to destination.

MaaS utilizes advanced information communication technology (ICT) and Internet of Things (IoT) capabilities to enhance public transport convenience and efficiency. This comprehensive transportation management system integrates various transport modes to offer customizable mobility packages through a single interface. Whether paying per trip or subscribing to monthly packages, transactions occur through a unified platform similar to mobile phone contracts. Additional services such as trip planning, schedule verification, booking, and information access are consolidated into a single application (Jittrapirom et al., 2017a; Kamargianni et al., 2016). This approach enables users to make optimized travel decisions based on personal preferences, whether prioritizing convenience, speed, or cost-effectiveness. The platform acts as an intermediary connecting both public and private transportation services, creating a seamless mobility supply chain for users.

As consumer expectations evolve across sectors, transportation services must adapt to deliver greater value through integrated "as-a-service" models. Technological advancements and the release of transportation datasets have already enhanced traveler experiences, while shifting consumption patterns suggest increasing adoption of new mobility models that could reduce reliance on private vehicle ownership (Datson, 2016). This trend aligns with the MaaS concept, which originated in Europe and has spread globally. From a user perspective, MaaS is anticipated to play a crucial role in facilitating the transition from private cars to integrated public transportation options (Sakai, 2020), effectively redesigning the passenger logistics chain to optimize resource utilization and minimize inefficiencies.

1.2 Research Inspiration

The severe traffic congestion and increasing transportation challenges in Thailand affect multiple dimensions of urban life, from economic productivity to environmental quality. These issues represent significant inefficiencies in the passenger logistics supply chain that require innovative solutions. The MaaS concept provides a compelling framework for addressing these challenges by applying supply chain management principles to passenger transportation.

From a logistics perspective, MaaS represents a paradigm shift that treats mobility as an integrated service rather than disconnected transport modes. This approach views passenger movement as a continuous supply chain where each transportation mode forms a critical link that must be optimized and coordinated with others. By integrating payment systems, travel information, and booking functions, MaaS creates a more efficient and responsive passenger logistics system.

Previous research on MaaS in Thailand has primarily examined the service provider perspective, with stakeholders expressing agreement with the MaaS concept and anticipating benefits from mass transit system integration for both service providers and users. However, significant concerns remain regarding implementation, as MaaS remains a relatively new concept for Thailand that requires serious cooperation between public and private sectors (Narupiti, 2019). An experimental study in Phuket demonstrated that app-based simulations could influence user travel behavior through data insights, though the application's impact on promoting public transportation usage was limited. The study emphasized that information accuracy is essential for building public trust and encouraging wider participation (Khaimook et al., 2019).

While existing MaaS research in Thailand has provided valuable insights from the supply side of the passenger logistics chain, there remains a significant gap in understanding the demand side—specifically, end-users' willingness to adopt MaaS. As with any supply chain, both supply and demand perspectives must be understood to create an efficient system. Recognizing that the MaaS concept is still emerging in Thailand with limited public awareness, this research aims to explore end-user perspectives to complement existing supply-side research. By understanding both sides of the passenger logistics chain, stakeholders can develop more effective implementation strategies that align service capabilities with user needs and preferences.

1.3 Research Objectives and Questions

This research aims to examine MaaS as an emerging passenger logistics solution and analyze the critical factors influencing user willingness to adopt this technology in Thailand. By applying principles from logistics and supply chain management to passenger transportation, the study seeks to understand how integrated mobility services can transform urban transportation systems. The specific objectives and research questions are formulated as follows

Research Objectives 1: To explore the overall acceptance level among potential Thai commuters toward MaaS as an integrated passenger logistics solution and assess the possibilities for successful implementation in Thailand's transportation ecosystem.

Research Questions1: To what extent are Thai commuters willing to accept MaaS as their primary mobility management system?

Research Objectives 2: To identify and analyze the most significant concerns and requirements influencing potential users' adoption decisions regarding MaaS in Thailand.

Research Questions 2: What factors most strongly influence user willingness to adopt MaaS from a passenger logistics perspective?

Research Objectives 3: To develop user profiles and adoption patterns that can inform stakeholder strategies for effectively implementing MaaS systems within Thailand's transportation network.

Research Questions 3: What traveler characteristics and influence factors should stakeholders prioritize when planning and operating future MaaS deployments in Thailand?

By addressing these objectives and questions, this research will contribute to the understanding of how integrated mobility platforms can enhance passenger logistics efficiency in emerging markets, while providing practical insights for transportation providers, technology developers, and policy makers.

1.4 Scope of Study

This study focuses on analyzing the willingness to adopt MaaS technology among the Thai population through a comprehensive assessment of user perspectives and adoption factors. To ensure broad representation and capture diverse perspectives across Thailand’s varied transportation contexts, the research employs a nationwide random sampling approach that encompasses urban, suburban, and rural areas. This sampling strategy provides insights from multiple geographic regions and demographic segments, enabling a more holistic understanding of MaaS adoption potential throughout the country.

The research methodology begins with a thorough examination of relevant literature to identify potential adoption factors and develop appropriate hypotheses. A Structural Equation Model (SEM) is constructed to analyze the relationships between identified factors, with Exploratory Factor Analysis (EFA) employed to assess reliability based on population data and travel behavior patterns. Confirmatory Factor Analysis (CFA) is then utilized to identify and evaluate the critical factors that influence MaaS adoption.

The study’s analytical scope encompasses both technological adoption perspectives and passenger logistics considerations, examining how the integration of transportation services through MaaS platforms could transform urban mobility management. By analyzing preferences and concerns across diverse user segments within Thailand’s transportation ecosystem, the research provides comprehensive insights that can guide stakeholders in developing effective MaaS implementation strategies aligned with the needs and expectations of Thailand’s heterogeneous commuter population.

1.5 Research Conceptual Framework

This study proposes a conceptual framework based on an extended UTAUT2 model for examining MaaS adoption determinants in Thailand, as illustrated in Figure 1.3. The framework encompasses several integrated components for comprehensive analysis. The UTAUT2 base factors are categorized into three dimensions: technological (Performance Expectancy, Effort Expectancy, Facilitating Conditions), economic (Price Value) and social (Social Influence, Hedonic Motivation, Habit). These established constructions represent fundamental technology acceptance determinants validated in previous research.

The framework incorporates extended factors specific to the MaaS context: an economic extension (Price Sensitivity) and trust dimension (Privacy Concerns, Perceived Risk). Additionally, the passenger logistics perspective emphasizes critical MaaS characteristics—integration of transport modes, optimization of passenger movement, and service provider coordination within the mobility ecosystem. The dependent variables comprise Willingness to Use MaaS and subsequent Usage Behavior. Directional paths indicate hypothesized relationships, with certain factors potentially influencing both adoption intention and actual utilization behavior.

Demographic variables (Age, Gender, Residence, and Vehicle Ownership) are positioned as moderating variables that may affect the relationship strength between constructs, allowing for a nuanced analysis of adoption patterns across different population segments.

The methodological approach employs Structural Equation Modeling (SEM) following a sequential analytical procedure from exploratory analysis through hypothesis testing and multi-group comparisons.

This framework provides a structured approach for examining the complex interrelationships between technological, economic, social, and trust factors in MaaS adoption within Thailand’s transportation context.

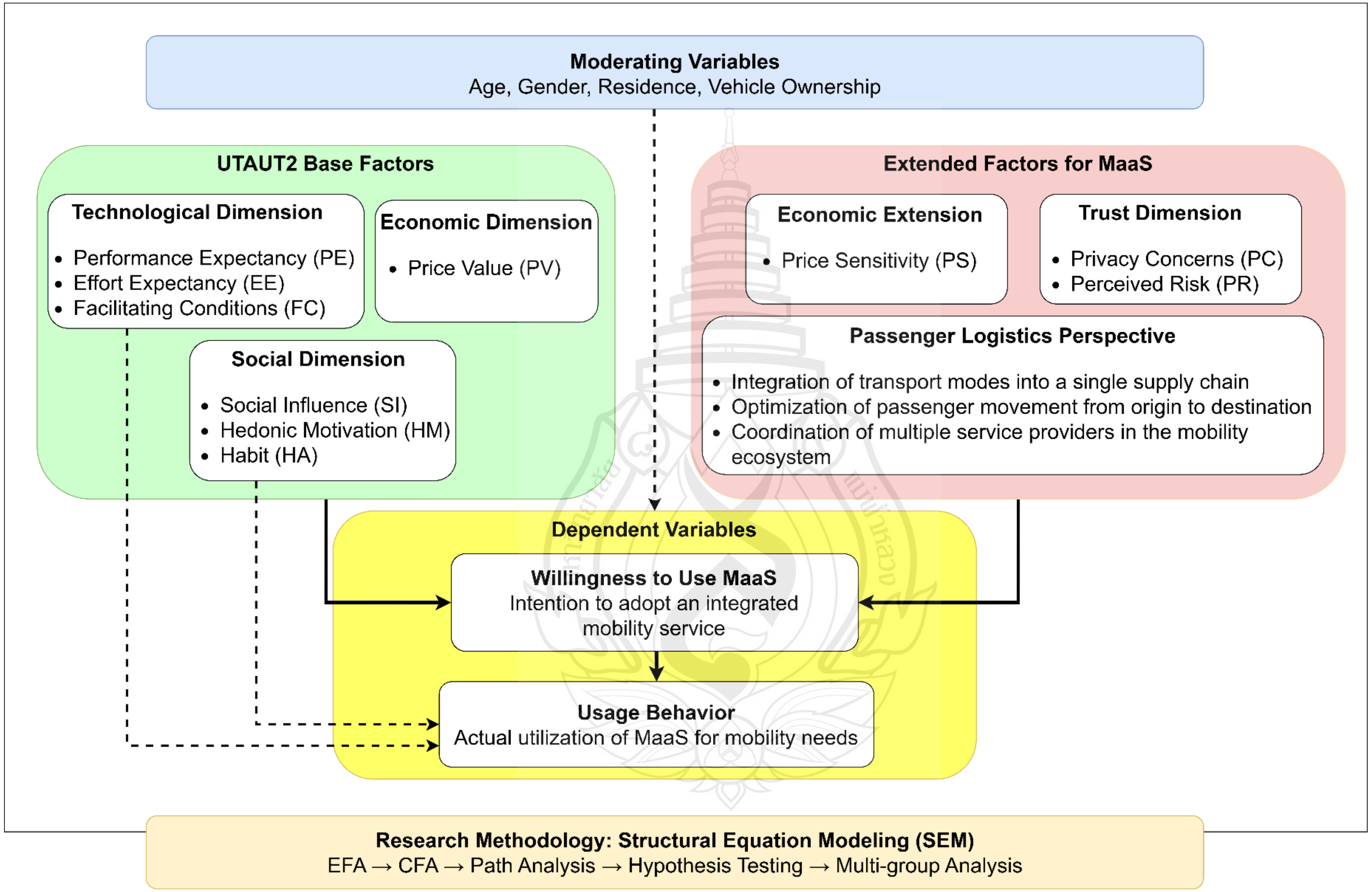


Figure 1.3 Research flow chart

CHAPTER 2

LITERATURE REVIEW

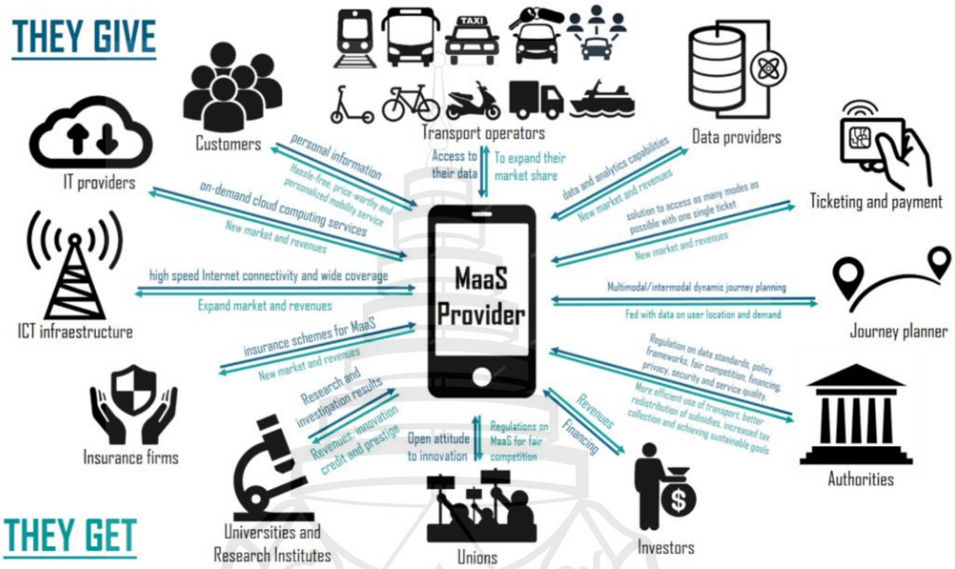
2.1 Mobility as a Service (MaaS)

Mobility as a Service (MaaS) represents an innovative transportation paradigm that integrates various transport systems into a unified service offering. It is a comprehensive system that combines different modes of transport to provide customizable mobility packages. Whether paying for services on a per-trip basis or through monthly subscription packages, all transactions can be executed through a single interface, similar to a monthly mobile phone contract. MaaS also incorporates additional services such as trip planning, schedule checking, booking facilities, and event information within a single application or One-Stop Service, maximizing user convenience (Jittrapirom et al., 2017a; Kamargianni et al., 2016).

Transportation mobility is a ubiquitous global service in both urban and rural areas (Lopez-Carreiro et al., 2020). However, as noted by Kim et al. (2021) and Matyas and Kamargianni (2019), metropolitan areas tend to experience rapid growth and continuous technological development, including innovative mobile applications designed to serve various transportation needs (Ye et al., 2020; Tsouros et al., 2021). MaaS has emerged as a crucial solution for shifting transportation demand away from private vehicles (Kamargianni et al., 2016), encompassing traditional modes such as cars and bicycles that are prevalent across Europe (Jain et al., 2020; Schikofsky et al., 2020), including cities like Madrid, Spain (Lopez-Carreiro, Monzon, & Lopez-Lambas, 2021), West Midland, England (Ho et al., 2018; Lyons et al., 2019), and Randstad, The Netherlands (Lopez-Carreiro, Monzon, & Lopez-Lambas, 2021).

MaaS leverages the latest information communication technology (ICT) and Internet of Things (IoT) to enhance public transport convenience. From a user perspective, MaaS is expected to play a significant role in promoting the transition from passenger cars to public transport (Sakai, 2020). Current applications include Google Map, EMT App, Mi Transporte (Lopez-Carreiro, Monzon, Lois, et al., 2021), UbiGo

(Lyons et al., 2019; Yuen et al., n.d.), Whim (Lyons et al., 2019), Uber, GoGet (Ho et al., 2018), and NaviGoGo (Lyons et al., 2019). The design focus of these platforms centers on creating user-friendly single digital interfaces (Caiati et al., 2020; Lopez-Carreiro et al., 2020).



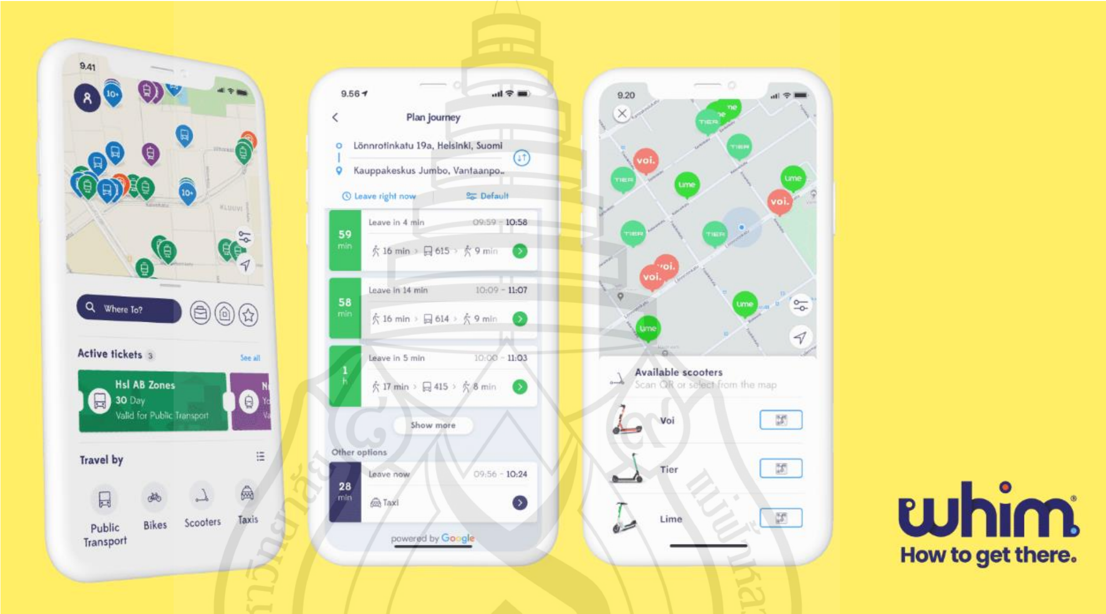
Source Arias-Molinares and García-Palomares (2020)

Figure 2.1 MaaS Provider

As illustrated in Figure 2.1, the MaaS provider acts as an intermediary connecting various public and private transportation services. Ye et al. (2020) emphasize that information is available as a real-time service, covering reservation, ticketing, and flexible travel information. Passengers can access real-time information with desired services from origin to destination through a single app (Mehdizadeh Dastjerdi et al., 2019). Lopez-Carreiro, Monzon, and Lopez-Lambas (2021) and Monzon et al. (2013) further highlight additional features such as integrated payment systems (Jittrapirom et al., 2017b), multi-modal travel routes (Li & Voege, 2017), and frequency optimization to meet user needs.

The Whim application, as shown in Figure 2.2, exemplifies a successful implementation of MaaS principles. According to Lyons et al. (2019), Whim benefits travelers seeking the most efficient way to reach their destinations by integrating multiple public transportation modes, including buses, trains, and taxis. Users can plan their journeys based on timing requirements and budget constraints, making travel more accessible and convenient.

MaaS implementation involves multiple dimensions, including privacy concerns (Hewitt et al., 2019; Kun et al., n.d.), control needs, environmental consciousness (Andersson et al., 2018), and integrated service expectations (Hensher, 2020). Understanding these dimensions is essential for developing effective MaaS solutions that meet diverse user needs and preferences.



Source Lyons et al. (2019)

Figure 2.2 Whim Application

2.2 Level of MaaS Integration

The concept of MaaS encompasses varying degrees of integration, which researchers have systematically categorized to facilitate discourse, compare services, assess potential impacts, and incorporate societal objectives. Sochor et al. (2018) developed a comprehensive typology of MaaS that spans from Level 0 to Level 4, each representing different form of integration involving information dissemination, booking services, payment systems, service offerings, and alignment with broader societal goals.

Building upon this foundation, Lyons et al. (2019) introduced a more refined taxonomy known as "Levels of MaaS Integration (LMI)," which expands the spectrum into five distinct levels:

Level 0 (No Integration): Represents traditional separate transportation services with no integration.

Level 1 (Basic Integration): Focuses on foundational integration, primarily involving information sharing across transport modes.

Level 2 (Intermediate Integration): Incorporates booking and payment functions across multiple transportation services.

Level 3 (Partial Integration): Introduces bundled mobility packages and subscription options.

Level 4 (Full Integration under Specific Conditions): Provides comprehensive integration of planning, booking, payment, and service delivery under defined parameters.

Level 5 (Complete Integration): Represents the ultimate goal of MaaS—seamless integration across all conditions and contexts, offering a mobility solution comparable in convenience to private vehicle ownership.

Understanding these integration levels is crucial for identifying barriers and facilitators at each stage of MaaS development. Such insights enable the creation of targeted strategies aligned with specific MaaS levels and societal objectives, thereby advancing the evolution of MaaS services to effectively address diverse societal needs (Sochor et al., 2018; Lyons et al., 2019). The progression through these levels represents the trajectory toward achieving a fully integrated operational system that delivers substantial benefits for both users and society at large (Kamargianni et al., 2016; Jittrapirom et al., 2017b).

The LMI framework emphasizes that the primary objective of MaaS is to enhance user convenience through seamless, door-to-door journeys (Ho et al., 2018; Lopez-Carreiro, Monzon, & Lopez-Lambas, 2021). Achieving Level 5 integration would provide a mobility solution matching the convenience of private vehicle ownership in fulfilling users' transportation requirements (Hensher, 2020; Lyons et al., 2019). This systematic approach to categorizing MaaS integration levels provides a valuable framework for researchers, policymakers, and service providers to assess and advance MaaS implementations in various contexts, including Thailand's emerging MaaS ecosystem (Narupiti, 2019; Khaimook et al., 2019).

2.3 Willingness to Accept MaaS

The acceptance and expectations of users regarding MaaS within public transportation settings are intricate to demographic, socioeconomic, and travel-related factors (Alonso-González et al., 2020; Schikofsky et al., 2020). First, demographic factors, such as age, gender, and education level, could provide insights into travelers' behavioral patterns (Hensher, 2020; Lyons et al., 2019). Socioeconomic factors encompass various dimensions, for example gender, income, occupation, household structure, and residence, and could considerably shape user attitudes and preferences by compiling with age and education structures (Kim et al., 2021; Lopez-Carreiro et al., 2020). Lastly, travel-related factors, such as party size, destination familiarity, and preferred modes of travel, are significantly influenced by user acceptance (Le-Klähn et al., 2015; Ye et al., 2020). From previous studies by Lyons et al. (2019) and Zijlstra et al. (2020), they revealed that initiatives like NaviGoGo in Scotland influenced behavioral changes among public transportation users, particularly emphasizing tailored service provision for passengers aged 16-25, based on demand for booking accounts. Similar trends in the Netherlands indicate that teenagers generally demonstrate a better understanding and higher acceptance of travel application innovations.(Tsouros et al., 2021).

The preferred mode of transportation for users varies based on individual needs and circumstances. For example, taxis continue to be popular for single-occupancy trips. Whereas other modes, such as trains and bikes, are favored for group travel accommodating multiple occupants (Bagozzi, 2007; Jain et al., 2020; Lopez-Carreiro, Monzon, & Lopez-Lambas, 2021). Travel-related factors information is considered to impact the transportation modes since individuals have different attitudes and intentions for their journey (Chansuk et al., 2022; Lyons, 2006, 2008). Service providers are consistently striving to enhance user experiences by catering to individualized travel needs, including timing preferences and route options (Chorus et al., 2006). Similarly, operational challenges persist in cities such as Copenhagen, Denmark, highlighting the ongoing efforts required for the seamless integration of new travel applications (Dastjerdi et al., 2019). Safety concerns regarding the security of personal information and potential distractions during technology utilization underscore the importance of ensuring user trust and confidence in MaaS platforms (Alhassan et al., 2022; Stiegemeier et al., 2022). These factors collectively influence user acceptance and serve as critical determinants of the success or failure of MaaS initiatives (Le-Klähn et al., 2015).

A variety of studies utilizing different analytical methodologies provided valuable insights into an individual's willingness to embrace MaaS across diverse contexts, emphasizing the multifaceted nature of user acceptance (Alonso-González et al., 2020; Ho et al., 2018; Tsouros et al., 2021). From latent class cluster analysis to unified theory models, this study delves into the complex interplay of attitudes, preferences, and behaviors driving MaaS adoption (Altay & Okumuş, 2022). For the past decades, various studies related to individual willingness and MaaS adoption have been published, thus we summarized in Table 2.1 to highlight the diversity of research methodologies and case studies employed in this field of study.

Table 2.1 Individuals' willingness to adopt MaaS

Reference / Study Area	**Objective**	**Analysis Method**
Ho et al. (2018) / Sydney, Australia	- Determine the inclinations and adoption of MaaS. - Assess the willingness-to-pay for different MaaS products.	Stated Preference (SP) method, Multinominal logistic model (MNL)

Table 2.1 (continued)

Reference / Study Area	Objective	Analysis Method
Alonso-González et al. (2020) / the Netherlands	- Identify factors influencing MaaS adoption based on survey data. - Propose policy implications for future MaaS adoption.	Latent Class Cluster Analysis Model (LCCA), Exploratory Factor Analysis (EFA)
Zijlstra et al. (2020) / the Netherlands	- Develop a Latent Demand for MaaS Index (LDMI) to identify early adopters of MaaS. - Provide insights into the potential uptake of MaaS and its impact on travel behavior and users.	Confirmatory Factor Analysis (CFA)
Ye et al. (2020) / Shanghai, China	- Analyze general user acceptability of MaaS. - Investigate the viability of implementing the MaaS platform. - Identify key user requests to assist MaaS operators in creating successful marketing campaigns. - Analyze driving factors and group differences in MaaS adoption.	Unified Theory of Acceptance and Use Technology Model (UTAUT)
Schikofsky et al. (2020) / Germany	- Identify motivational determinants for MaaS adoption intention. - Investigate the structural interrelations of motivational mechanisms.	Technology Acceptance Model (TAM), Partial Least-Square (PLS)

Table 2.1 (continued)

Reference / Study Area	Objective	Analysis Method
Lopez-Carreiro, Monzon, Lois, et al. (2021) / Madrid, Spain	- Enhance understanding of MaaS adoption by exploring motivational drivers among travelers. - Integrate attitudinal and personality factors into MaaS research. - Identify user clusters in the Madrid metropolitan area based on current mobility behaviors and inclinations towards MaaS. - Provide tailored recommendations for promoting MaaS adoption among different traveler profiles.	TAM, EFA, CFA, Structural Equation Modeling (SEM), Cluster Analysis (CLA)
Lopez-Carreiro, Monzon, and Lopez-Lambas (2021) / Madrid, Spain, and Randstad, the Netherlands	- Discover factors influencing people's readiness to embrace MaaS, focusing on demographic, socioeconomic, and travel-related variables. - Determine which population segments are more likely to adopt MaaS. - Develop customized policy recommendations to enhance MaaS acceptability. - Provide insightful information to policymakers on implementing sustainable mobility plans.	Generalized ordered logit (Gologit) model

Table 2.1 (continued)

Reference / Study Area	**Objective**	**Analysis Method**
Tsouros et al. (2021) / Manchester, the United Kingdom	- Address gaps from existing research by investigating user preferences for MaaS. - Assess the popularity of different MaaS plans. - Evaluate willingness-to-pay (WTP) for MaaS plans using survey and experimental data.	MNL
Altay and Okumuş (2022) / Turkey	- Explore motivations for adopting multimodal trip-planning applications. - Identify variables influencing attitudes and intended behaviors towards application adoption. - Propose a TAM-based model integrating perceived mobility and social influence to explain adoption of integrated mobility technologies.	TAM
Toyama (2022) / Japan	- Apply the UTAUT2 model to identify factors influencing consumers' intention to use MaaS. - Focus on price value, hedonic incentive, social influence, and performance expectancy. - Investigate the impact of age on these factors and interactions. - Provide theoretical and practical insights to enhance MaaS adoption and acceptance among customers.	Extending the Unified Theory of Acceptance and Use of Technology (UTAUT2)

Table 2.1 (continued)

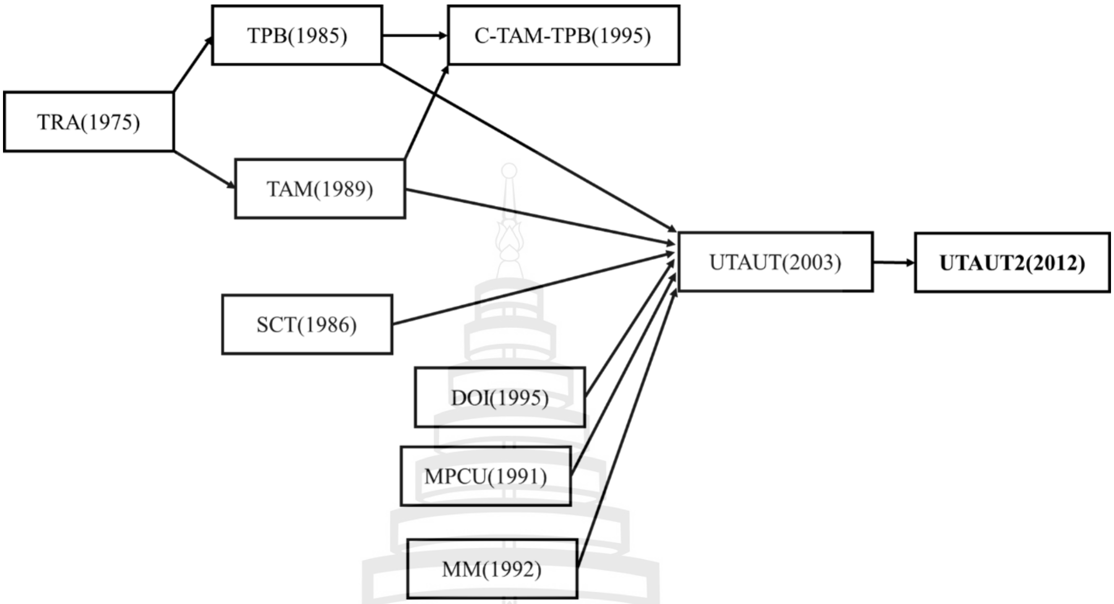
Reference / Study Area	Objective	Analysis Method
This study / Thailand	- Investigate factors influencing the adoption of MaaS among public commuters in Thailand. - Apply technology acceptance theory to understand commuter willingness towards MaaS. - Utilize the UTAUT2 model and integrate extended factors including privacy concerns (PC), perceived risk (PR), and price sensitivity (PS). - Enhance understanding of how these factors affect MaaS adoption in the Thai context.	UTAUT2

2.4 Use of Technology Acceptance Models

The Unified Theory of Acceptance and Use of Technology (UTAUT) is the original model to summarize the core variables to study travelers' behavior and attitudes when technology is applied daily (Stiegemeier et al., 2022) regarding acceptance rate. On the other hand, UTAUT also adds up with the corresponding latent variable, based on the research of (Ye et al., 2020).

Alkhwaldi and Kamala (2017) explained that to determine acceptance in terms of behavior and decision-making, information, psychology, and sociology (Venkatesh et al., 2003) must be considered and applied to complete the design model and hypothesis. The role model that inspired this research is from eight models together (Alkhwaldi & Kamala, 2017; Venkatesh et al., 2003), including; The MaaS, often implied with the Theory of Reasoned Action (TRA), Social Cognitive Theory (SCT), Technology Acceptance Models (TAM), Theory of Planned Behavior (TPB), Model of PC Utilization (MPCU), Diffusion of Innovation (DOI), and Motivational Model (MM). After analyzing the combination, the result shows the Unified Theory of

Acceptance and Use of Technology (UTAUT) developed to extend the Unified Theory of Acceptance and Use of Technology (UTAUT2) model.



Source Alkhwaldi and Kamala (2017)

Figure 2.3 Development of Unified Theory of Acceptance and Use of Technology Model

Figure 2.3 illustrates the evolutionary pathway of technology acceptance models culminating in UTAUT. It demonstrates how eight fundamental theories and models (TRA, TPB, TAM, MM, MPCU, IDT, SCT, and C-TAM-TPB) contributed to the development of UTAUT, highlighting the theoretical integration process that enhances the model's explanatory power for technology acceptance and use behavior.

UTAUT and UTAUT2 models are particularly well-suited for studying MaaS adoption for several compelling reasons. First, MaaS represents a technology-dependent, user-centric transportation solution that integrates multiple dimensions of user acceptance, aligning perfectly with UTAUT's multifactorial approach (Toyama, 2022). The model's comprehensive coverage of performance expectancy, effort expectancy, social influence, and facilitating conditions provides a robust framework for understanding the complex interplay of factors affecting travelers' willingness to adopt such innovative mobility solutions (Lopez-Carreiro et al., 2021).

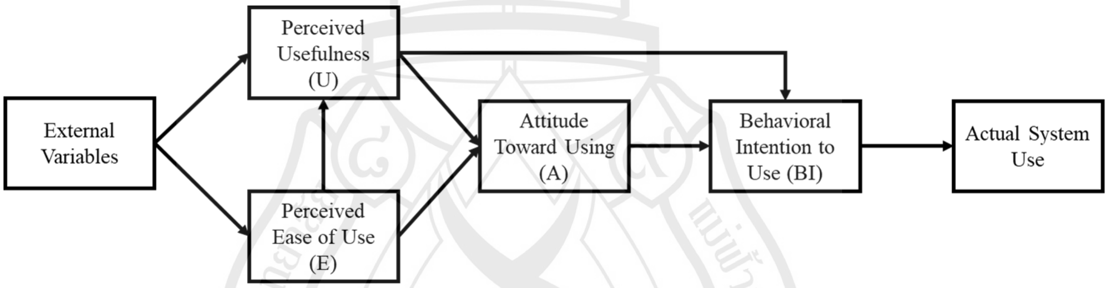
Furthermore, UTAUT2's extended constructs—hedonic motivation, price value, and habit—address the consumer-oriented nature of MaaS, capturing the experiential aspects of mobility services that traditional transportation models often overlook (Ye et al., 2020). This alignment is particularly relevant for Thailand's emerging MaaS landscape, where user experience, cost considerations, and established travel behaviors significantly influence adoption decisions (Narupiti, 2019). The UTAUT2 framework allows researchers to systematically evaluate these critical factors while accommodating contextual variables such as age, gender, and regional differences that characterize Thailand's diverse transportation user base (Khaimook et al., 2019).

Nevertheless, this research adopted the model from Alkhwaldi and Kamala, then developed to self-model that focuses only on the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Extending of the Unified Theory of Acceptance and Use of Technology (UTAUT2) which related with the User Acceptance of Technology. In this study, the research will focus on behavior and travel application technology.

Table 2.2 presents a comprehensive overview of studies applying UTAUT2 in various technology adoption contexts. The table identifies key attitudinal factors examined across diverse domains, including mobile banking, autonomous vehicles, exergaming, and public transport systems. As illustrated, performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC) form the foundation of most UTAUT2 applications, while factors such as hedonic motivation (HM), price value (PV), and habit (HB) are frequently incorporated to enhance model explanatory power. Additionally, domain-specific constructs like trust (TR), service quality (SQ), and sustainability (ST) have been introduced to address particular technological contexts. This synthesis of studies demonstrates the versatility and adaptability of the UTAUT2 framework across different technological innovations and geographical settings, providing valuable methodological guidance for the current investigation into MaaS adoption in Thailand.

Technology Acceptance Model (TAM) was first used to study occupations predicting information technology acceptance (Davis et al., 1989; Li et al., 2021; Stiegemeier et al., 2022). Today, TAM has been applied across countries to understand diverse human users with innovative technology (Terborg, 1981). TAM has been used in multiple dimensions in terms of tools such as Blockchain (Li et al., 2021), Prediction of Human Behavior (Lopez-Carreiro et al., 2021), and Technology Acceptance (Stiegemeier et al., 2022). In the TAM model, the method is together with the usefulness, users' attitude, behavior, and feedback when the existing system is present.

This model Figure 2.4 illustrates the core relationships between external variables, perceived usefulness, perceived ease of use, attitude toward using, behavioral intention to use, and actual system use. TAM emphasizes that users' technology adoption is primarily determined by perceived usefulness and perceived ease of use, which directly influence attitude and behavioral intention, ultimately leading to actual system usage.



Source Davis et al. (1989)

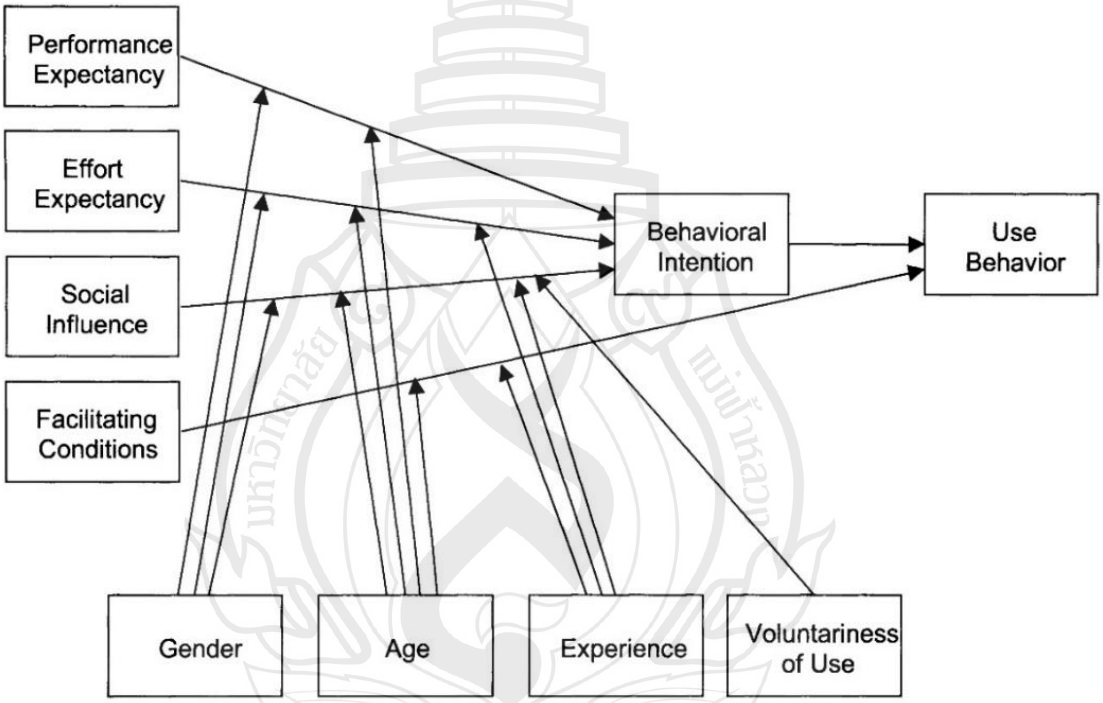
Figure 2.4 Technology Acceptance Model (TAM)

Unfortunately, Stiegemeier mentions that TAM has yet to achieve its objection to interacting with people with technology. However, (Venkatesh et al., 2003) found that TAM does not include the attitude construct to underline the intention parsimoniously. Thus, the new model has been inferred as UTAUT (Figure 2.5).

Additionally, Venkatesh explained that the Unified Theory of Acceptance and Use of Technology (UTAUT) is the model to fortune the human behavioral purpose when implied with technology. Also, with other socioeconomic factors (Yuen et al., n.d.), age, gender, experience, and voluntariness. Since the UTAUT was established, three objects installed UTAUT are the UTAUT integrations that apply with up-to-date technology (Chang et al., 2007). Next, the endogenous theoretical mechanisms outlined in UTAUT (Venkatesh et al., 2012) are tools to enlarge the scope of the focus subject.

Lastly, including exogenous predictors of the UTAUT variable (Neufeld et al., 2007; Yi et al., 2006) helps to understand better when innovative technology is applied within the theoretical boundaries.

This comprehensive model integrates four key determinants of technology acceptance and use: performance expectancy, effort expectancy, social influence, and facilitating conditions. The framework also incorporates four moderating variables (gender, age, experience, and voluntariness of use) that influence these relationships. This model significantly enhances predictive capability for behavioral intention and technology use through its multifaceted approach.



Source Venkatesh et al. (2003)

Figure 2.5 Unified Theory of Acceptance and Use of Technology (UTAUT)

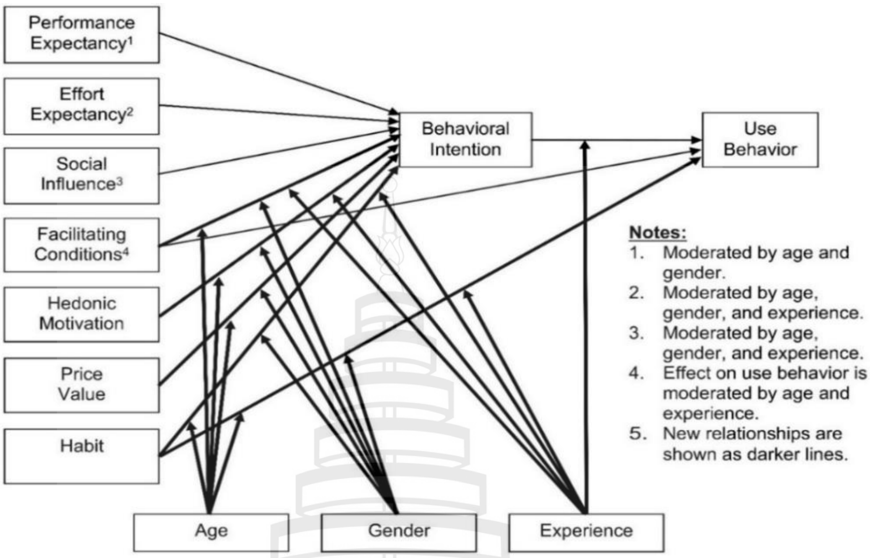
2.5 The Extending of the Unified Theory of Acceptance and Use of Technology (UTAUT2)

The Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) maintains a similar structural foundation to its predecessor UTAUT (Bagozzi, 2007; Venkatesh et al., 2007), with both models evolving from the TAM framework (Alkhwaldi & Kamala, 2017). UTAUT2 represents a significant advancement in explaining variance in behavioral intention and technology usage (Alkhwaldi & Kamala, 2017; Venkatesh et al., 2012). This enhanced model is particularly relevant in contemporary contexts where individuals frequently interact with innovative technologies.

UTAUT2 (Venkatesh et al., 2012) notably excludes voluntariness as a moderating factor, as research findings indicated this variable did not significantly impact outcomes—specifically, no variance was observed when voluntariness was constructed. Conversely, Venkatesh identified three crucial additions to UTAUT2: Hedonic Motivation, Price Value, and Habits. These additions reflect the consumer-oriented nature of many modern technologies and enrich the model's applicability across diverse contexts.

In today's technology landscape, UTAUT2 plays an instrumental role in evaluating acceptance rates for various innovations, including tailored exergames (Yein & Pal, 2021), internet mobile banking (Alalwan et al., 2017, 2018; Khan et al., 2017), and transportation technologies (Dichabeng et al., 2021; Kapser & Abdelrahman, 2020; Korkmaz et al., 2021; Zhou et al., 2021). The model builds upon UTAUT's established relationships while incorporating new dimensions related to user behavior and motivation when engaging with technology (Brown et al., 2005).

UTAUT2 serves as a crucial predictor of technology usage patterns and introduces innovative theoretical constraints (Kim et al., 2007; Kim et al., 2005; Kim & Malhotra, 2005; Venkatesh et al., 2007). Regarding predictive capability, Venkatesh et al. (2003) demonstrated that UTAUT2 explains a higher percentage of variance in both behavioral intention (74 percent) and technology use (52 percent) compared to the original UTAUT model (70 percent and 48 percent, respectively).



Source Venkatesh et al. (2012)

Figure 2.6 Extending of the Unified Theory of Acceptance and Use of Technology

This enhanced predictive power makes UTAUT2 particularly suitable for studying MaaS adoption in Thailand, where understanding individual acceptance of daily travel applications requires a comprehensive analysis of behavioral patterns, psychological factors, and sociological influences (Alkhwaldi & Kamala, 2017; Benbasat & Barki, 2007; Venkatesh et al., 2007, 2012). By incorporating the additional constructs of hedonic motivation, price value, and habit, UTAUT2 provides a more nuanced framework for examining the multifaceted nature of transportation technology adoption in Thai cultural and socioeconomic contexts. Figure 2.6 Extending of the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2012). This expanded model builds upon the original UTAUT by incorporating three additional constructs: hedonic motivation (reflecting the pleasure derived from using technology), price value (representing the cost-benefit assessment), and habit (capturing automatic behaviors developed through prior experience). The model also identifies key moderating variables (age, gender, and experience) that influence the relationships between these constructs and behavioral intention/use behavior. UTAUT2 offers enhanced explanatory power for consumer technology contexts, making it particularly relevant for studying MaaS adoption.

Table 2.2 Individuals' willingness to adopt technology: identifying attitudinal factors of UTAUT2.

Source	Topic and Area	Method	Factor														
			PE	**EE**	**SI**	**FC**	**HM**	**PV**	**HB**	**TR**	**SQ**	**CC**	**ST**	**PI**	**HL**	**SIP**	**EA**
(Alalwan et al., 2017)	Intention and adoption of Mobile banking by customers. Jordanian, Amman and Al-Balqa	Questionnaires, CFA, SEM	✓	✓	✓	✓	✓	✓		✓							
(Khan et al., 2017)	Adoption in a Developing Online Banking, Pakistan	Questionnaires, CFA, SEM	✓	✓	✓	✓	✓	✓	✓	✓							
(Alalwan et al., 2018)	Intentions and adoption of internet banking. Jordanian, Amman and Al-Balqa	Questionnaires	✓	✓	✓	✓	✓	✓	✓	✓							
(Kapser & Abdelrahman, 2020)	Acceptance of autonomous delivery vehicles. Germany	Questionnaires, SEM	✓	✓	✓	✓	✓	✓		✓							

Table 2.2 (continued)

Source	Topic and Area	Method	Factor														
			PE	EE	SI	FC	HM	PV	HB	TR	SQ	CC	ST	PI	HL	SIP	EA
(Dichabeng et al., 2021)	Acceptance of future shared automated vehicles. United Kingdom	Focus group	✓	✓	✓	✓	✓	✓	✓	✓	✓						
(Yein & Pal, 2021)	Analysis of the user acceptance of exergaming. fall-preventive measure, India	Questionnaires	✓	✓	✓	✓	✓	✓	✓								
(Gansser & Reich, 2021)	Acceptance model on behavioral intention and use behavior for products containing AI. Germany	Questionnaires, PLS	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓		
(Zhou et al., 2021)	The motivational mechanism behind taxi driver's adoption of electric vehicles for a living. China	Questionnaires, CFA	✓	✓	✓	✓	✓	✓	✓							✓	

Table 2.2 (continued)

Source	Topic and Area	Method	Factor														
			PE	EE	SI	FC	HM	PV	HB	TR	SQ	CC	ST	PI	HL	SIP	EA
(Korkmaz et al., 2021)	User acceptance of autonomous public transport systems. Turkey, İstanbul	Questionnaires, EFA, SEM	✓	✓	✓	✓	✓	✓	✓	✓							
(Öztaş Karlı et al., 2022)	Willing to acceptance of shared e-scooters. Turkey	Questionnaires, SEM	✓	✓	✓	✓	✓	✓									✓

PE (Performance Expectancy) is the degree to which an individual believes that using the system will help achieve gains in task performance; it reflects perceived effectiveness and benefits derived from innovative applications.

EE (Effort Expectancy) The degree of ease associated with the use of the system; refers to users' perception of application or system utilization ease.

SI (Social Influence) The extent to which individuals perceive that important others believe they should use the new system; implies individuals' perceptions of the importance of views from family, friends, and peers.

FC (Facilitating Conditions) The degree to which an individual believes that organizational and technical infrastructure exists to support use of the system; encompasses technological infrastructure, equipment complexity, and connectivity.

HM (Hedonic Motivation) The pleasure or enjoyment derived from using technology; characterized by the fun and satisfaction individuals experience when utilizing a system.

PV (Price Value) The consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost; examines the balance between benefits and costs associated with technology utilization.

HA (Habit) The extent to which people tend to perform behaviors automatically because of learning; reflects automatic behaviors developed through prior experience and repetitive actions.

TR (Trust/Perceived Risk/Security/safety) The belief that the specific technology will perform as expected, securely and safely, mitigating various risks including privacy, performance, and financial concerns.

SQ (Service Quality) The overall excellence or superiority of the service as perceived by users; encompasses reliability, responsiveness, and assurance of the technology service.

CC (Convenience Comfort) The ease, comfort, and convenience experienced when using the technology; related to accessibility and user-friendliness.

ST (Sustainability) The perception of how environmentally friendly or sustainable the technology or service is; it reflects environmental consciousness.

PI (Personal Innovativeness) An individual's willingness to try out new technologies represents openness to technological innovations.

HL (Health) The perceived impact of the technology on physical or mental wellbeing; particularly relevant for health-related applications.

SIP (Satisfaction with Incentive Policies) The degree to which users are satisfied with policies designed to encourage technology adoption; includes rewards, discounts, or other incentives.

EA (Environmental Awareness) The awareness and concern for environmental issues that may influence technology adoption decisions; related to ecological consciousness.

2.6 Hypotheses Development

2.6.1 User's Performance Expectancy

Performance Expectancy (PE) is defined as perceived effectiveness and benefits derived from innovative applications. It encompasses various factors such as time and effort savings, improved efficiency, accessibility, convenience, and customized services (Venkatesh et al., 2003). Previous research has consistently emphasized Performance Expectancy as a significant determinant of behavioral intention to adopt new systems and technologies. Customers are generally more motivated to adopt and accept new technology when they perceive its advantages and value in daily life. Mobile banking, for instance, is widely recognized as a convenient platform providing customers with flexibility in accessing a wide range of services (Alalwan et al., 2016; Alalwan, Rana et al., 2015; Davis, 1993; Gu et al., 2009; Riquelme & Rios, 2010; Venkatesh et al., 2003). The Performance Expectancy reflects individuals' perception of the specific benefits and enhanced effectiveness which is offered by various technologies. This indicates that technological advancements can lead to more productive activities. Consequently, the utilization of technology, whether mapping application, bike-sharing systems, mobile banking, etc., could support behavioral intentions (Alalwan et al., 2018; Öztaş Karlı et al., 2022). Given its critical role in influencing Behavior, the Performance Expectancy was a pivotal in this study (García de Blanes Sebastián et al., 2024)

2.6.2 User's Effort Expectancy

Effort Expectancy (EE) means users perceived of an application or system utilization. This factor plays a crucial role in influencing an individual's motivation and performance across different tasks (Ayuning Budi et al., 2021). It encompasses the user's perception of utility, ease of use, attitude towards use, and controlling behavior (Alyoussef, 2022). Users positively influence intentional Behavior when using technology. Typically, users prefer technology that require less effort and offers greater convenience (Merhi et al., 2019). The Effort Expectancy significantly influences users' behavioral intentions, as the anticipated level of effort directly impacts user behavior (de Blanes Sebastián et al., 2023).

2.6.3 User's Facilitating Condition

Facilitating Conditions (FC) are defined as the extent to which individuals perceive the availability of resources and support in adopting a particular behavior. It encompasses organizational and technical factors (Ayanwale & Ndlovu, 2024; Venkatesh et al., 2003). The Facilitating Conditions include technological infrastructure, equipment complexity, and internet connectivity. All of which influences the feasibility and ease of new technologies utilization (Bhattacherjee, 2000; Rodríguez-Espíndola et al., 2022). Numerous studies proved that Facilitating Conditions significantly influence intentional Behavior (Nikolopoulou et al., 2021). Especially, the level of technical support provided to users within the UTAUT2 framework directly impacts behavioral intention (Venkatesh et al., 2003). For instance, the availability of technical infrastructure and support services is crucial for encouraging the adoption of online banking channels (Khan et al., 2023; Zhou et al., 2010).

2.6.4 User's Social Influence

Social Influence (SI) refers to individuals' perceptions of the importance of opinions and beliefs from others, i.e., family and friends, in adopting a specific technology (Venkatesh et al., 2003). There was evidence supporting the significant impact of Social Influence on individuals' behavioral intentions when adopting new technologies. For instance, societal expectations play a crucial role in shaping consumer behavior, which is often influenced by the opinions of others (Dwivedi et al., 2021). In the context of mobile banking, Social Influence is evident through the impact of reference groups, family, opinion leaders, friends, and colleagues on customers' intention to adopt the technology (De Leon, 2019). From previous studies, it is clearly indicated that the Social Influence is pivotal in promoting such Behavior (Bhukya & Paul, 2023).

2.6.5 User's Hedonic Motivation

Hedonic Motivation (HM) stands as a crucial determinant of user acceptance and adoption. It is characterized by the pleasure and enjoyment individuals derive from utilizing technology (Venkatesh et al., 2012). By incorporating an affective component into the predominantly cognitive-based UTAUT2 model, Hedonic Motivation broadens the scope to explore intrinsic motivation in consumer technologies (Alalwan et al., 2018; Baabdullah et al., 2019; Venkatesh et al., 2012). These studies proposed a direct link between Hedonic Motivation and customer intention to use technology. Intrinsic utilities like joy and playfulness, along with extrinsic utilities such as efficiency and usefulness, drive Hedonic Motivation and accelerate the intention to adopt emerging systems (Van Der Heijden, 2004). Substantial evidence supports the role of Hedonic Motivation in shaping customers' decisions to adopt technology, as demonstrated in studies on telebanking adoption by Jordanian customers (Alalwan, Dwivedi et al., 2015).

2.6.6 User's Habit

Habit (HA) is defined as prior conduct performed spontaneously without self-instruction. It plays a significant role in shaping individuals' behavioral intention and Usage Behavior. Moreover, Habit is able to reflect the degree to which an individual believes Behavior is automatic due to learning (Venkatesh et al., 2012). Previous studies showed that Habit favors behavioral intention as evidenced by its significant role in people's propensity to use systems such as the public bike system in Taipei. (Pai & Pai, 2015). The influence of Habit on behavioral intention is recognized in UTAUT2, which is considered intentionally as a critical factor in explaining Behavior (Das & Datta, 2024). Habit is viewed in the context of use rather than acceptance. It could predict the use of technology based on automatic behaviors developed through learning and experience. Repetitive Behavior leads to the establishment of settings and intentions that can be activated by triggers, which result in automatic Behavior without conscious mental activity. A more vigorous Habit leads to a stored intention, which influences actual Behavior (Limayem et al., 2007).

2.6.7 User's Price Value

Price Value (PV), an addition to UTAUT2, examines the balance between benefits and monetary costs associated with technology utilization (Venkatesh et al., 2012). Unlike workplace technologies, where costs are typically covered by the organization, private users must personally incur these expenses. This factor encompasses both financial costs and non-monetary costs, such as the time and effort required to utilize the technology (Huang & Kao, 2015). According to Venkatesh et al. (2012), the concept of Price Value complements Effort Expectancy by emphasizing the investment of time and effort in the acceptance and use of new technologies, thereby providing a more comprehensive understanding of the consumer context. A favorable Price Value is assumed when the advantages of using a product outweigh its monetary costs.

2.6.8 User's Price Sensitivity

Price Sensitivity (PS), in the context of MaaS, refers to the extent to which purchasing decisions for MaaS offerings are influenced by price fluctuations. According to previous research, it highlighted the crucial role of Price Sensitivity in consumer behavior across various industries, influenced by factors, e.g., enduring product involvement, consumer innovativeness, perceived brand parity, and attitudinal brand loyalty (Han et al., 2001; Öztaş Karlı et al., 2022). Price Sensitivity has been linked to consumer satisfaction, since price information significantly impacting purchasing decisions and consumer loyalty (Low et al., 2013). Moreover, Price Sensitivity refers to the degree of consumers responding to cost and its fluctuations (Goldsmith, 2009). Kapser and Abdelrahman (2020) introduced Price Sensitivity to the model as a modified version of Price Value, considering its applicability to new technological contexts. For further information, Price Sensitivity has been utilized to predict users' intentions in various areas, including broadband internet, autonomous delivery cars, and mobile shopping applications (Natarajan et al., 2017; Tsai & LaRose, 2015).

2.6.9 User's Privacy Concerns

Privacy Concerns (PC) are pivotal factors influencing MaaS adoption. Although users may not always express overt concern about privacy, they recognize it as an issue. This underscores the significance of trust in MaaS service providers (Kong et al., 2021). However, the role of regulations such as the General Data Protection Regulation (GDPR) in shaping privacy considerations for MaaS is reassuring. These regulations emphasize principles like Privacy by Design and Consent (S. Huang, 2022). In contexts such as Software as a Service (SaaS), privacy emerges as a major inhibitor to its adoption, with users weighing Privacy Concerns against the benefits of the service (Rowe, 2016). Likewise, sharing driving data raises issues about identity and location privacy, which is necessitating secure data handling mechanisms like blockchain (Belletti & Bayen, 2017). Privacy Concerns encompass travelers' ability to control marketers' collection and subsequent use of their personal information. These concerns are barriers to the acceptability and use of technological innovations such as MaaS, which involve compiling, processing, and storing user data as part of their regular operations (Polydoropoulou et al., 2020; Ye et al., 2020). The critical aspect is not the mere disclosure of information but rather the degree of control consumers exercises over their data (Alonso-González et al., 2020; Lopez-Carreiro, Monzon, Lois, et al., 2021).

2.6.10 User's Perceived Risk

Perceived Risk (PR) refers to the negative outcome that is expected to occur in the process of the consumer's use of the service, along with the psychological expectation of the seriousness of the consequences if they occur (Ye et al., 2020). Perceived Risk associated with the activity targeted by a service, such as the nature of health promotion activities or mobile money transactions, influences adoption (Cocosila & Turel, 2022). Factors like privacy risks and overall Perceived Risk have a negative impact on the behavioral intention to use MaaS (Huang, 2022; Korkmaz et al., 2021). Furthermore, the impact of Perceived Risks alongside other factors like social efficacy, influence of significant others, and attitude on the adoption of mobile government services has been highlighted (Saxena, 2018). These findings underscore the importance of addressing Perceived Risks to enhance the acceptability and adoption of innovative mobility solutions like MaaS.

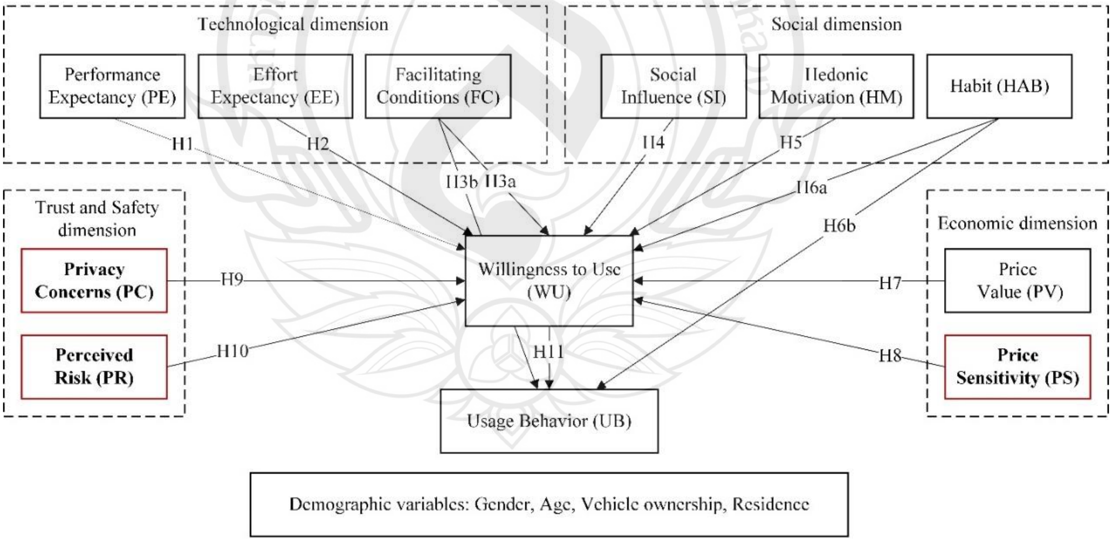
2.6.11 User's Willingness to Use

The individual's perception of their Willingness to Use (WU) is a significant factor in technology usage prediction. Willingness to Use (i.e., the likelihood of a person using a system) is a key determinant of whether a system is utilized. According to the available data, Willingness to Use directly influences the actual usage of a system. The primary objective of UTAUT2 is to forecast the acceptance and use of technology, reflecting the impact of the applicable theory of technological acceptance. Conceptual Behavior, a dependent variable, is determined by the aim of the Behavior to improve circumstances and Habits. The relationship between Willingness to Use and the Usage Behavior is pivotal in predicting technology use. Willingness to Use has been extensively studied in previous studies and has been verified to play a significant role in shaping the actual adoption and use of new systems (Hasbullah et al., 2016; Venkatesh et al., 2003, 2012). The influence of subjective normative perception on behavioral control is profound. It has a positive impact on purchase and/or Usage Behavior (Burhan & Sihite, 2023).

CHAPTER 3

RESEARCH METHODOLOGY

This research employed a quantitative design, utilizing questionnaires and statistical analysis to investigate public commuters' willingness to adopt Mobility as a Service (MaaS) in Thailand. The analysis utilized IBM SPSS version 26 and AMOS version 23 software to evaluate structural relationships and analyze sampling data. The statistical analysis drew upon the UTAUT2 model, which was identified as the most appropriate framework compared to alternative models like TAM or UTAUT for fundamental analysis and establishing conclusive results. The original UTAUT2 structure encompasses: Performance Expectancy, Effort Expectancy, Facilitating Condition, Social Influence, Hedonic Motivation, Habit, Price Value, Behavioral Intention, and Use Behavior. For this study, the behavioral intention factor was modified to 'Willingness to Use' and three additional factors were incorporated: Privacy Concerns, Perceived Risk, and Price Sensitivity (Figure 3.1).



Source Adapted from Venkatesh et al. (2012)

Figure 3.1 Extended UTAUT2 model for MaaS adoption research framework

3.1 Research Model

This research adopts and extends the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) model, which has been widely used in transportation and technology adoption studies. The original UTAUT2 framework includes seven core constructs: Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Facilitating Conditions (FC), Hedonic Motivation (HM), Price Value (PV), and Habit (HA).

To better capture the specific factors relevant to MaaS adoption in Thailand, three additional constructs were integrated into the model:

1. Privacy Concerns (PC): addressing users' concerns about data protection and personal information sharing

2. Perceived Risk (PR): capturing users' perceptions of potential risks associated with MaaS adoption

3. Price Sensitivity (PS): measuring users' price consciousness and response to cost variations

The dependent variables in the model are Willingness to Use (WU) MaaS and Usage Behavior (UB). The research framework illustrates the hypothesized relationships between these constructs, with demographic factors (residence, age, gender, and vehicle ownership) serving as moderating variables.

The research model proposes that the ten independent variables (PE, EE, SI, FC, HM, PV, HA, PC, PR, PS) influence Willingness to Use MaaS, while FC, HA, and WU directly impact Usage Behavior (UB). This comprehensive model provides a robust foundation for examining the multifaceted nature of MaaS adoption in Thailand.

Based on the extended UTAUT2 framework, thirteen hypotheses were formulated to test the relationships between constructs:

H1: Performance Expectancy for MaaS has a path impact on Willingness to Use.

H2: Effort Expectancy for MaaS has a path impact on Willingness to Use.

H3a: Facilitating Conditions for MaaS have a path impact on Willingness to Use.

H3b: Facilitating Conditions for MaaS has a path impact on Usage Behavior.

H4: Social Influence for MaaS has a path impact on Willingness to Use.

H5: Hedonic Motivation for MaaS has a path impact on Willingness to Use.

H6a: Habit for MaaS has a path impact on Willingness to Use.

H6b: Habit for MaaS has a path impact on Usage Behavior.

H7: Perceived Price Value for MaaS has a path impact on Willingness to Use.

H8: Price Sensitivity for MaaS has a path impact on Willingness to Use.

H9: Privacy Concerns for MaaS have a path impact on Willingness to Use.

H10: Perceived Risk for MaaS has a path impact on Willingness to Use.

H11: Willingness to Use MaaS has a path impact on Usage Behavior.

These hypotheses are grounded in established theoretical frameworks and supported by empirical evidence from transportation and technology adoption literature. To operationalize these theoretical constructs, Table 3.1 presents a comprehensive set of measurement items carefully adapted from seminal works by researchers such as Venkatesh et al. (2012), Ye et al. (2020), and others. The table delineates specific survey items for each construct, providing a systematic approach to measuring performance expectancy, Effort Expectancy, social influence, and other key factors influencing Mobility as a Service (MaaS) adoption. By utilizing multiple measurement items per construct, the research ensures a robust and nuanced understanding of the complex factors driving technology acceptance in the transportation domain.

Table 3.1 Measurement Items and Sources for MaaS Adoption Factors in Thailand

Construct	Variable	Measurement Statement
Performance Expectancy (PE)	PE1	Using MaaS for travel saves time.
Venkatesh et al. (2012),	PE2	Using MaaS makes travel easier.
Ye et al. (2020)	PE3	Using MaaS allows me to check transportation services in real-time.
	PE4	I expect MaaS will fit with the local lifestyle.
	PE5	I expect MaaS will be practical in my daily life.
Effort Expectancy (EE)	EE1	Learning to use MaaS will be easy for me.
Tian & Wang (2022),	EE2	Using MaaS will be easy for me.
Venkatesh et al. (2012)	EE3	Using MaaS will not require much effort.
	EE4	I feel confident in my ability to use MaaS.

Table 3.1 (continued)

Construct	Variable	Measurement Statement
Social Influence (SI)	SI1	I would use MaaS if many others were using it.
Gansser & Reich (2021),	SI2	I would use MaaS if people important to me support it.
Venkatesh et al. (2012),	SI3	I will use MaaS if it receives positive media reviews.
Ye et al. (2020)		
Facilitating Conditions (FC)	FC1	I am familiar with mobile payment systems.
Venkatesh et al. (2012),	FC2	My mobile network connection is reliable when
Ye et al. (2020)		traveling.
	FC3	I am familiar with smartphone use and regularly carry
		my phone.
Hedonic Motivation (HM)	HM1	Using MaaS would be enjoyable due to increased
Venkatesh et al. (2012),		travel flexibility.
Ye et al. (2020)	HM2	Using MaaS would be exciting.
	HM3	Using MaaS would give me satisfaction.
	HM4	Using MaaS would enhance my travel enjoyment.
Price Value (PV)	PV1	I expect MaaS services to be reasonably priced.
Venkatesh et al. (2012),	PV2	The benefits of MaaS would justify its cost.
	PV3	Government subsidies would make MaaS more
		attractive.
Price Sensitivity (PS)	PS1	I am willing to pay extra to try MaaS as a new travel
Öztaş Karlı et al. (2022)		option.
	PS2	I am willing to spend significantly on MaaS.
	PS3	I'm not interested in using it if the new MaaS costs
		more than the old travel system.
Habit (HA)	HA1	Using smartphone apps is part of my daily routine.
Korkmaz et al. (2021),	HA2	I am familiar with similar transportation technologies.
Venkatesh et al. (2012),	HA3	I believe I need MaaS even if I'm not yet familiar with
Yein & Pal (2021)		it.
	HA4	Using MaaS could become routine for me.

Table 3.1 (continued)

Construct	Variable	Measurement Statement
Privacy Concerns (PC) Lopez-Carreiro et al. (2021), Ye et al. (2020)	PC1	I am concern about the privacy of my personal information when using the new system (MaaS).
	PC2	I am concern in sharing personal information with the third parties while using new mode (MaaS)
	PC3	I am comfortable sharing my profile and opinions with other MaaS users
	PC4	I am willing to share necessary personal data with relevant MaaS companies.
Perceived Risk (PR) Lopez-Carreiro et al. (2021), Ye et al. (2020)	PR1	I am concerned about privacy risks with MaaS.
	PR2	I am concerned that MaaS might be cumbersome to use.
	PR3	I am concerned about the reliability of the MaaS system.
Willingness to Use (WU) Venkatesh et al. (2012)	WU1	I will choose MaaS as my everyday travel option when available.
	WU2	I plan to use MaaS frequently once it's available.
	WU3	I will use MaaS when I need to travel.
Usage Behavior (UB) Venkatesh et al. (2012)	UB1	Using MaaS will be a pleasant experience.
	UB2	MaaS will be my first choice when available.
	UB3	I will recommend MaaS to my friends once it's available.

Note The survey was conducted in Thailand from December 2022 to February 2023 with 418 valid responses from diverse demographic backgrounds. Items were measured using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree)

3.2 Data Collection

3.2.1 Survey Design and Administration

The survey instrument was designed based on the extended UTAUT2 framework, with measurement items adapted from previous studies. The questionnaire was translated into Thai to ensure clarity for participants and consisted of four main sections:

1. Demographic information: gender, age, education, income, occupation, vehicle ownership, and area of residence

2. Travel behavior: frequency of using public transport, purpose of latest trip, average travel time, and travel expenses

3. Awareness and expectations regarding MaaS services

4. Factors influencing MaaS adoption: items measuring the extended UTAUT2 constructs

Each construct was measured using multiple scale items with responses on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The concept of MaaS was explained at the beginning of the questionnaire to ensure participant understanding.

Data was collected from December 2022 to February 2023 through an online questionnaire administered via Google Forms. The survey was distributed through emails and social media channels including Facebook, Line, and Instagram to reach Thai public commuters.

3.2.2 Population and Sample Size

The target population comprised public transport users in Thailand of various genders, ages, and educational backgrounds. A convenience sampling method was employed to collect data from Thai commuters nationwide, utilizing online distribution through social media platforms to reach diverse demographic groups across urban, suburban, and rural areas. While convenience sampling is a non-probability sampling technique that may limit generalizability, it is commonly used in technology acceptance research due to its practicality and cost-effectiveness in reaching target populations (Etikan et al., 2016).

Following the Maximum Likelihood (ML) estimation method for confirmatory factor analysis, the sample size was determined to be at least five times the number of free parameters in the model. With 42 observed variables in the questionnaire, a minimum sample size of 210 was required.

For ML estimation techniques in confirmatory factor analysis, the sample size should be at least five times the number of independent variables, including error conditions (Bentler & Chou, 1987). In cases of heavy kurtosis data, the minimum sample size should be increased to ten times the number of independent variables

(Hoogland & Boomsma, 1998). The formula for calculating adequate sample size for SEM can be represented as:

$$n \geq 5k \tag{1}$$

Where:

n = required sample size

k = number of observed variables or indicators

For this study with 42 observed variables, the minimum sample size would be:

$$N = \frac{Z^2pq}{e^2} \tag{2}$$

Where:

N = sample size

Z = critical value of desired confidence level (1.96 for 95% confidence)

p = estimated proportion of an attribute in the population (0.5 when unknown)

q = 1-p (0.5)

e = desired level of precision (0.05 for ±5%)

$$N= \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = \frac{3.8416\times0.25}{0.0025} =384.16 \approx 384 \tag{3}$$

The questionnaires were distributed to 500 participants, and after excluding invalid responses, 418 valid samples were obtained for analysis, exceeding both calculated minimum requirements and providing a robust dataset for statistical analysis.

3.2.3 Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and received approval from the Institutional Review Board of Mae Fah Luang University Ethics Committee on Human Research under protocol number EC 23220-12, dated November 24, 2023. Participants were informed about the purpose of the study and assured of data confidentiality and anonymity.

3.3 Data Analysis

Statistical analysis was conducted using IBM SPSS version 26 and IBM AMOS version 23. AMOS was utilized to draw path diagrams and estimate regression equations in the path model (Byrne, 2010). The analysis followed a systematic approach:

3.3.1 Step 1 : Descriptive Statistics and Sample Characteristics

Demographic data and travel behavior patterns were analyzed using descriptive statistics to provide an overview of the sample characteristics. The analysis included examination of participants' sociodemographic characteristics, travel behaviors, and familiarity with MaaS concepts to establish the context for subsequent statistical modeling.

3.3.2 Step 2 : Data Preparation and Preliminary Assessment

After data collection, preliminary data screening was conducted to check for outliers, missing values, and normality. The questionnaires were distributed to 500 participants, and after excluding invalid responses, 418 valid samples were obtained for analysis. The data cleaning process involved removing incomplete responses, inconsistent answer patterns, and responses that failed attention checks, resulting in the exclusion of 82 invalid samples.

Following data cleaning, no missing values remained in the final dataset of 418 participants due to the systematic removal of incomplete responses during the screening process. Outlier analysis using Mahalanobis distance was conducted on the cleaned dataset and revealed no significant multivariate outliers that could distort the results. Skewness and kurtosis values for all variables remained within the acceptable range of ±2, indicating no severe violations of normality assumptions for the final valid sample.

3.3.3 Step 3 : Item Purification and Initial Factor Assessment

Prior to conducting the full measurement model analysis, individual Confirmatory Factor Analysis (CFA) was performed for each construct to assess factor loadings and identify items requiring deletion. Items with standardized factor loadings below 0.60 were systematically removed to ensure adequate measurement quality.

3.3.4 Step 4 : Reliability and Validity Testing

Following item deletion, the final measurement model was evaluated using multiple reliability and validity measures:

1. Internal Consistency Reliability

Cronbach's alpha was calculated using:

$$\alpha = \frac{k\bar{r}}{1 + \bar{r}(k-1)} \quad (4)$$

k = items,

$\bar{r}$ = mean correlation between the items

Composite reliability (CR) was calculated to assess overall reliability:

$$CR = \frac{\Sigma_{i=1}^{n} \lambda_i^2}{\Sigma_{i=1}^{n} \lambda_i^2 + \Sigma_{i=1}^{n} \varepsilon} \quad (5)$$

Where:

λ_i = standardized factor loading of item i

ε_i = error variance of item i

n = number of items

2. Convergent Validity

Average Variance Extracted (AVE) was calculated to assess convergent validity:

$$AVE = \frac{\Sigma_{i=1}^{n} \lambda_i^2}{n} \quad (6)$$

The recommended thresholds were standardized factor loading > 0.6, composite reliability > 0.7, Cronbach's alpha > 0.7, and AVE > 0.5 (Fornell & Larcker, 1981; McDonald & Ho, 2002). The recommended thresholds are presented in Table 3.2.

3. Discriminant Validity

Heterotrait-Monotrait ratio (HTMT) was used to assess discriminant validity, with values below 0.90 indicating acceptable discriminant validity.

Table 3.2 Reliability and exploratory factor analysis criteria

Criteria	Description	Acceptable Threshold
Standardized Factor Loading (Hair et al., 2012)	Measures the correlation between observed variables and latent factors	≥ 0.60
Cronbach's Alpha (α) (Hair et al., 2012)	Measures internal consistency of a set of scale items	≥ 0.70
Composite Reliability (CR) (Fornell & Larcker, 1981)	Assesses the overall reliability of a collection of heterogeneous but similar items	≥ 0.70
Average Variance Extracted (AVE) (Fornell & Larcker, 1981)	Measures the amount of variance captured by a construct in relation to variance due to measurement error	≥ 0.50
Kaiser-Meyer-Olkin (KMO) (Kaiser & Rice, 1974)	Measures sampling adequacy for factor analysis	≥ 0.80 (excellent)
Bartlett's Test of Sphericity (Byrne, 2010) (Hair et al., 2012)	Tests the hypothesis that variables are uncorrelated	$p < 0.05$

3.3.5 Step 5 : Overall Measurement Model Assessment and Model Fit Evaluation

After individual construct validation and reliability testing, the overall measurement model was assessed to examine the fit between the hypothesized model and the observed data. Several indicators were used to test the overall fitness of the measurement model: chi-square to degrees of freedom ratio (χ^2/df), Comparative Fit

Index (CFI), Standardized Root Mean Square Residual (SRMR), Root Mean Square Error Of Approximation (RMSEA), p-value, Normed Fit Index (NFI), Tucker-Lewis index (TLI), and Goodness-Of-Fit Index (GFI). The specific criteria for each indicator are detailed in Table 3.3.

3.3.6 Step 6 : Structural Equation Modeling (SEM) and Hypothesis Testing

Structural Equation Modeling (SEM) was employed to test the proposed hypotheses through factor analysis and path coefficients. Path coefficients and t-statistics were analyzed to identify significant relationships between variables, with a threshold of 1.96 at the 0.05 significance level (Hair et al., 2012; MacKinnon et al., 2004). The structural model testing examined the relationships between constructs while controlling for measurement error.

3.3.7 Step 7 : Moderating Effects Analysis

The moderating effects of control variables (residence, age, gender, and vehicle ownership) were tested using z-score, given the categorical nature of these variables. Multi-group analysis was conducted to examine how demographic characteristics influence the relationships between constructs. Pairwise comparisons of significant categories were indicated using letters in the pairwise column to identify specific group differences.

3.3.8 Step 8 : Mediation Analysis and Bootstrap Validation

Mediation effects were analyzed to examine both direct and indirect relationships between constructs. Bootstrap validation was performed with 1,000 iterations at a significant level of 0.05 ($p < 0.05$) to validate the results and assess the robustness of the findings. Bootstrapping, as a non-parametric resampling technique, provides a more accurate estimation of standard errors and confidence intervals by generating multiple subsamples from the original dataset (Hayes, 2013).

The bootstrap analysis generated empirical approximations of the sampling distributions for the direct, indirect, and total effects. Bias-corrected 95% confidence intervals were calculated, with Lower Limit Confidence Interval (LLCI) and Upper Limit Confidence Interval (ULCI) values. Non-overlapping confidence intervals with zero provide strong statistical support for significant relationships.

3.3.9 Step 9 : Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated to assess the suitability of the data for factor analysis. A KMO value ≥ 0.80 indicates excellent suitability for factor analysis (Kaiser & Rice, 1974). Bartlett's test of sphericity was performed to test whether the correlation matrix significantly differs from an identity matrix, confirming the appropriateness of the data for factor analysis ($p < 0.001$).

This comprehensive analytical approach ensures the reliability and validity of the findings, providing robust insights into the factors influencing MaaS adoption in Thailand. The systematic progression from descriptive analysis through advanced structural modeling techniques enables thorough examination of the research hypotheses while maintaining methodological rigor.

Table 3.3 Standard values of CFA

Fit Index	Description	Acceptable Threshold
Chi-square/df (χ^2/df) (Byrne, 2010)	Ratio of chi-square to degrees of freedom	Between 1 and 3
Comparative Fit Index (CFI) (Hair et al., 2012)	Assesses the model fit by examining the discrepancy between the data and the hypothesized model	≥ 0.90
Normed Fit Index (NFI) (Byrne, 2010)(Hair et al., 2012)	Assesses the model by comparing the χ^2 value of the model to the χ^2 of the null model	≥ 0.90
Incremental Fit Index (IFI) (Bollen, 1989)	Addresses issues of parsimony and sample size of NFI	≥ 0.90

Table 3.3 (continued)

Fit Index	Description	Acceptable Threshold
Goodness-of-Fit Index (GFI) Jöreskog, K. G., & Sörbom, D. (1982)	Measures the fit between the hypothesized model and the observed covariance matrix	≥ 0.90
Tucker-Lewis Index (TLI) (Tucker & Lewis, 1973)	Compares the χ^2 value of the model to that of the null model	≥ 0.90
Standardized Root Mean Square Residual (SRMR) Bollen (1989)	Square root of the difference between residuals of the sample covariance matrix and hypothesized model	≤ 0.08
Root Mean Square Error of Approximation (RMSEA) (Browne & Cudeck, 1992)	Measures how well the model would fit the population covariance matrix	≤ 0.05 (excellent fit) ≤ 0.08 (good fit)

3.4 Analysis Framework

Input	Process	Output
Survey Design • UTAUT2 • Extended Factors • Translation Population and Sampling • Thai commuters • N= 418 Questionnaire Development • Demographics • Travel Behavior • MaaS Factors	• Data Collection and Preparation • Reliability and Validity Testing (CFA, Cronbach's alpha, CR, AVE) • Model Fit Evaluation • SEM Analysis • Moderating Effects Analysis • Bootstrap Validation	• Descriptive Statistics • Measurement Model Results • Structural Model Results • Hypothesis Testing Results • Moderating Effects Results • Bootstrap Validation

Figure 3.2 Analysis Framework Diagram

The analysis framework adopts an Input-Process-Output (IPO) approach to systematically examine the factors influencing MaaS adoption in Thailand. This structured framework ensures a comprehensive analysis of the data, testing the reliability and validity of the measurement model, and rigorously validating the hypotheses and relationships between variables. The IPO framework is illustrated in the diagram above.

The inputs to the framework include the survey design based on the UTAUT2 model, the population and sampling approach, and the questionnaire development. The process component encompasses data collection and preparation, reliability and validity testing, model fit evaluation, hypothesis testing through SEM analysis, moderating effects analysis, and bootstrap validation. The outputs include descriptive statistics of respondents, reliability and validity results, model fit indices, hypothesis testing results, moderating effects insights, and validated results through bootstrapping.

This structured approach provides a robust foundation for analyzing MaaS adoption factors in Thailand, offering valuable insights for policymakers, service providers, and researchers in developing effective strategies for implementing MaaS in Thailand.

CHAPTER 4

RESEARCH RESULTS

4.1 Descriptive Statistics

The initial phase of the study involved data collection through a structured questionnaire distributed from December 2022 to February 2023. The online survey was administered via Google Forms and distributed through various social media platforms to reach a diverse range of Thai commuters. From the 500 questionnaires distributed, 418 valid responses (83.6% response rate) were obtained after excluding incomplete or erroneous submissions. This sample size exceeds the minimum threshold required for Structural Equation Modeling, which recommends at least five to ten respondents per observed variable.

Before the primary analysis, preliminary data screening was conducted to check for outliers, missing values, and normality. No missing values were identified in the dataset due to the online questionnaire's mandatory response format. Outlier analysis using Mahalanobis distance revealed no significant multivariate outliers that could distort the results. Skewness and kurtosis values for all variables remained within the acceptable range of ±2, indicating no severe violations of normality assumptions.

Reliability analysis was performed to ensure the internal consistency of the measurement scales. The results were satisfactory, with factor loadings exceeding 0.6, Cronbach's alpha and Composite Reliability (CR) values above 0.7, and Average Variance Extracted (AVE) exceeding 0.5 for all constructs. These metrics indicate robust reliability and convergent validity of the measurement. Additionally, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy yielded a value of 0.959, indicating excellent suitability of the data for factor analysis, and Bartlett's test of sphericity was significant ($p < 0.001$), confirming the appropriateness of the correlation matrix for factor analysis.

The descriptive statistical analysis provided insights into the demographic and socioeconomic characteristics of the sample, travel behaviors, and attitudes toward MaaS adoption. The following sections detail these findings, beginning with the respondents' demographic profiles.

4.1.1 Respondents' Profile

The respondents' profiles were summarized in Table 4.1, which provided the sample's detailed demographic and socioeconomic characteristics. Analyzing these characteristics is crucial for understanding the context in which MaaS adoption decisions are made and identifying potential demographic influences on technology acceptance patterns.

Table 4.1 Descriptive Statistics of participant demographic and travel behavior (N=418)

Variable	Description	Frequency
Gender	Male	161
	Female	257
Age	≤ 21 years	54
	21-35 years	240
	≥ 36 years	124
Education Level	Under bachelor's degree	75
	Bachelor's degree	272
	Higher bachelor's degrees	71
Monthly Income (THB)	≤ 15,000	168
	15,001-25,000	109
	25,001-35,000	64
	35,001-45,000	33
	> 45,000	44

Table 4.1 (continued)

Variable	Description	Frequency
Occupation	Public employee	72
	Private sector employee	107
	Self-employed	50
	Retired	24
	Housewife/Househusband	2
	Student	153
	Unemployed	10
Vehicle Ownership	Yes	287
	No	131
Household size	1 person	38
	2 persons	63
	3 persons	114
	4 persons or more	203
Residence	Urban area	146
	Suburban area	149
	Rural area	123
The primary purpose of the latest trip	Work	206
	Study	104
	Travel	60
	Go home	25
	Business	23
Average time spent on the latest trip	< 15 minutes.	68
	15-30 minutes	102
	30-45 minutes	85
	45-60 minutes	84
	> 60 minutes.	47
	1 day	13
	> 1 day	19

Table 4.1 (continued)

Variable	Description	Frequency
Average travel expenses (THB)	≤ 50	111
	51-100	109
	101-150	60
	151-200	42
	201-250	18

Figure 4.1 shows that Gender distribution revealed a notable predominance of female participants, constituting 61.5% of the sample compared to 38.5% of male respondents. This gender imbalance, while not representing the exact gender distribution in the Thai population (approximately 51% female, according to the National Statistical Office of Thailand), provides an opportunity to examine potential gender-specific considerations in MaaS adoption. Previous transportation studies have identified gender as a significant factor influencing travel preferences and technology adoption patterns.

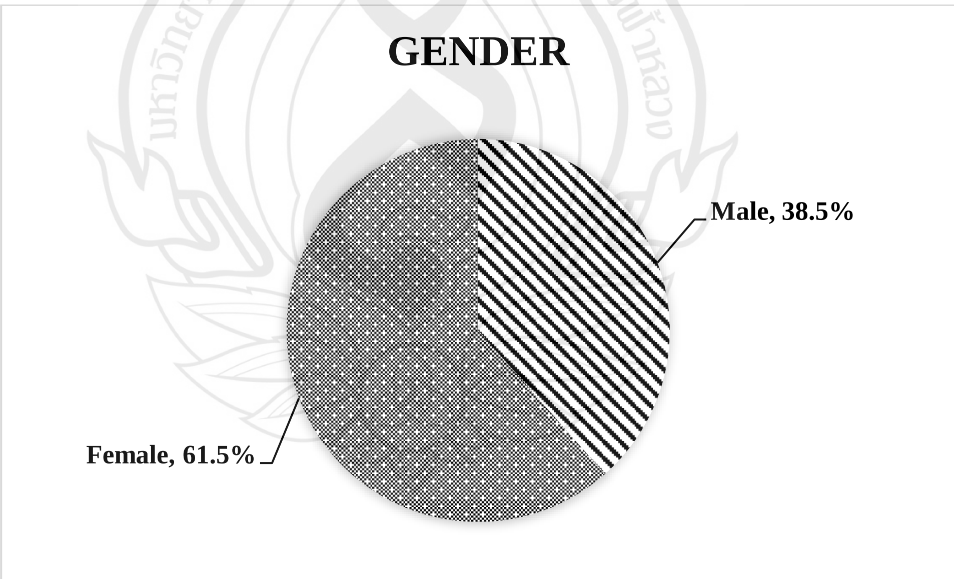


Figure 4.1 Gender Distribution of Survey Respondents

Figure 4.2 shows that the age categorization of respondents in this study was structured into three distinct groups: youth (under 21 years), early-career adults (21-35 years), and experienced working adults (36 years and above). This classification is grounded in established theoretical frameworks and methodologies widely accepted in transportation technology adoption research, which align with Thailand's context of age-differentiated population structures and travel behaviors.

This three-group age segmentation demonstrates statistical appropriateness for Structural Equation Modeling (SEM) analysis, as excessive group fragmentation could result in insufficient sample sizes per group, compromising analytical reliability (Hair et al., 2021). As shown in Figure 4.2, the sample distribution is well-balanced across these three meaningful age segments (12.9%, 57.4%, and 29.7%, respectively), enabling robust statistical analysis.

Furthermore, this grouping corresponds with Thailand's societal age-stage delineations, which exhibit distinct differences in travel behaviors, technology acceptance, and public transportation utilization patterns. The under-21 group typically comprises students, the 21-35 age group represents early-career professionals, and the 36+ age group demonstrates more established career paths and decision-making processes. The impact of these age differences on MaaS adoption factors is further examined in the moderating effects analysis presented in Table 7, where significant variations in relationships between constructs across these age groups are identified and discussed.

Figure 4.2 Age Distribution of Survey Respondents

Figure 4.3 shows that educational attainment was notably high among respondents, with 65.1% holding a bachelor's degree and an additional 17.0% possessing postgraduate qualifications. Only 17.9% reported educational levels below a bachelor's degree. This educational profile indicates a sample with substantial formal education, potentially influencing technological literacy and openness to innovation. The high educational level of the sample might positively bias attitudes toward technological solutions like MaaS, as education has been positively correlated with technology acceptance in previous studies.

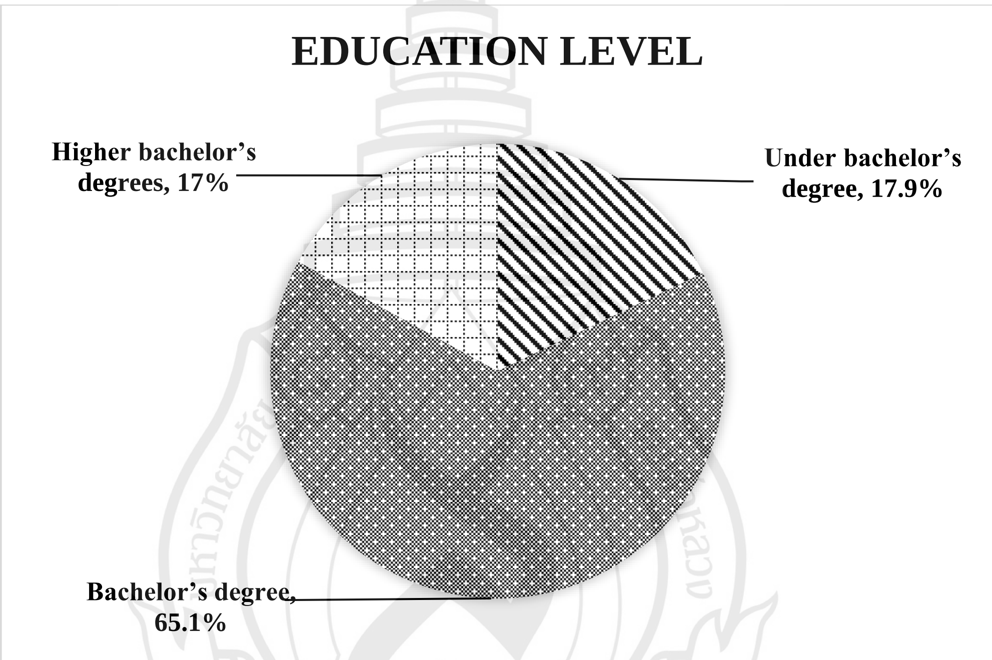


Figure 4.3 Educational Level of Survey Respondents

Figure 4.4 shows that Income distribution revealed that a substantial proportion of respondents (40.2%) reported monthly earnings of ≤15,000 Thai baht, which is below Thailand's average monthly income of approximately 27,000 baht (National Statistical Office, 2021). The second largest income group earned between 15,001-25,000 baht (26.1%), followed by those earning 25,001-35,000 baht (15.3%). Higher-income brackets (35,001-45,000 and >45,000 baht) represented 7.9% and 10.5% of respondents, respectively. This income distribution suggests that the sample includes substantial representation from lower and middle-income groups, which is valuable for understanding potential Price Sensitivity in MaaS adoption decisions.

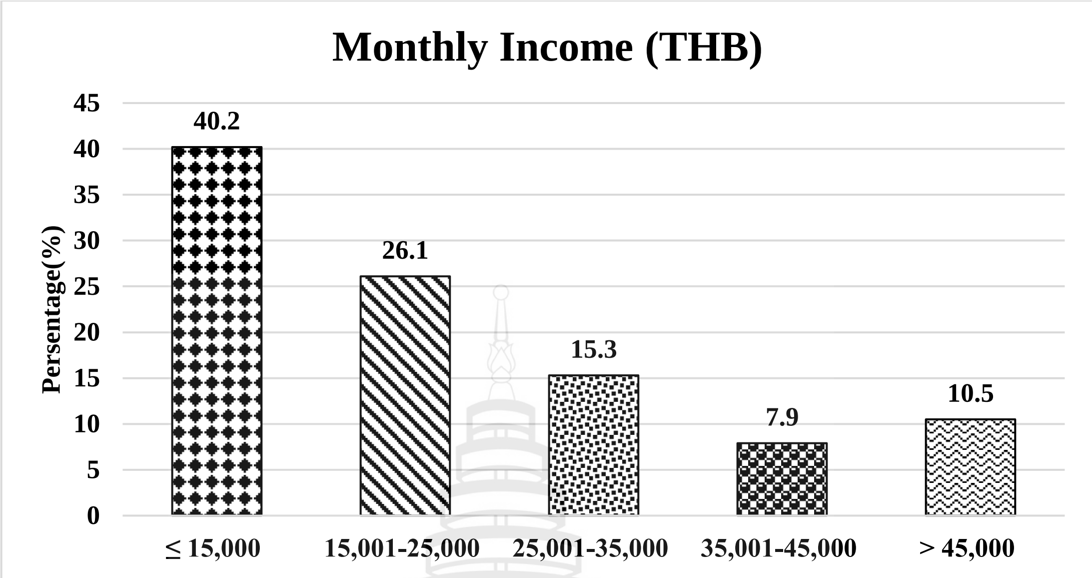


Figure 4.4 Monthly Income Distribution of Survey Respondents

Figure 4.5 shows that Occupational analysis revealed a diverse professional background, with students forming the largest group (36.6%), followed by private sector employees (25.6%) and public employees (17.2%). The substantial representation of students aligns with the age distribution and offers insights into a demographic that often relies heavily on public transportation due to budget constraints and lifestyle factors. Self-employed individuals constituted 12.0% of respondents, while retired persons represented 5.7%. The low representation of housewives/househusbands (0.5%) and unemployed individuals (2.4%) should be noted when interpreting findings related to these specific groups.

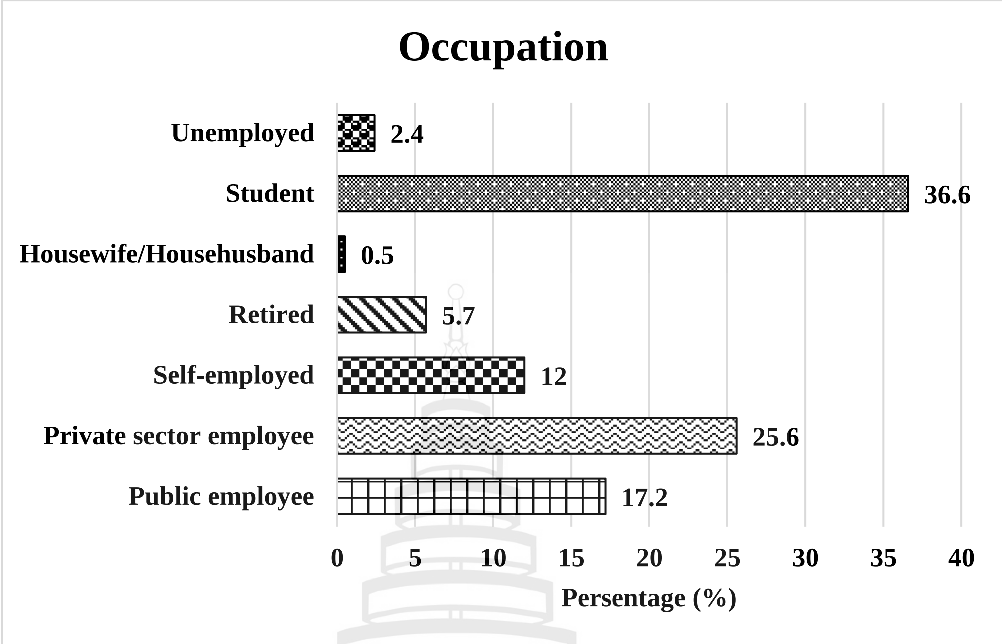


Figure 4.5 Occupational Distribution of Survey Respondents

Figure 4.6 shows that Vehicle ownership data revealed that a significant majority (68.7%) of respondents owned personal vehicles, while 31.3% did not. This ownership pattern is particularly relevant for MaaS adoption research, as vehicle owners may evaluate MaaS differently from non-owners, weighing the opportunity costs against their existing transportation solutions. Previous research by Alonso-González et al. (2020) and Ho et al. (2018) has identified vehicle ownership as a significant moderating factor in MaaS adoption intentions.

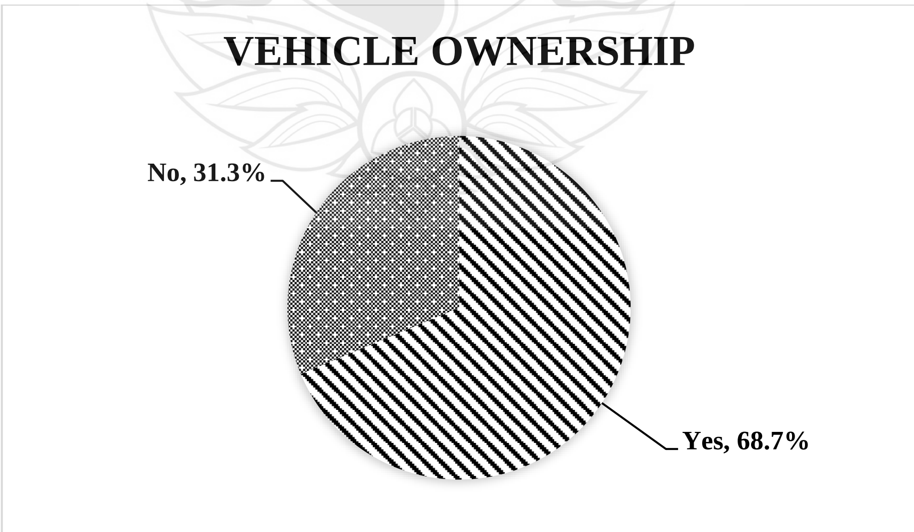


Figure 4.6 Vehicle Ownership Among Survey Respondents

Figure 4.7 shows that Household composition analysis showed that nearly half of the respondents (48.6%) lived in households with four or more members, followed by three-person households (27.3%), two-person households (15.1%), and single-person households (9.1%). This household size distribution reflects Thailand's family-oriented culture and may influence transportation decision-making, as larger households often have more complex mobility needs and coordination requirements.

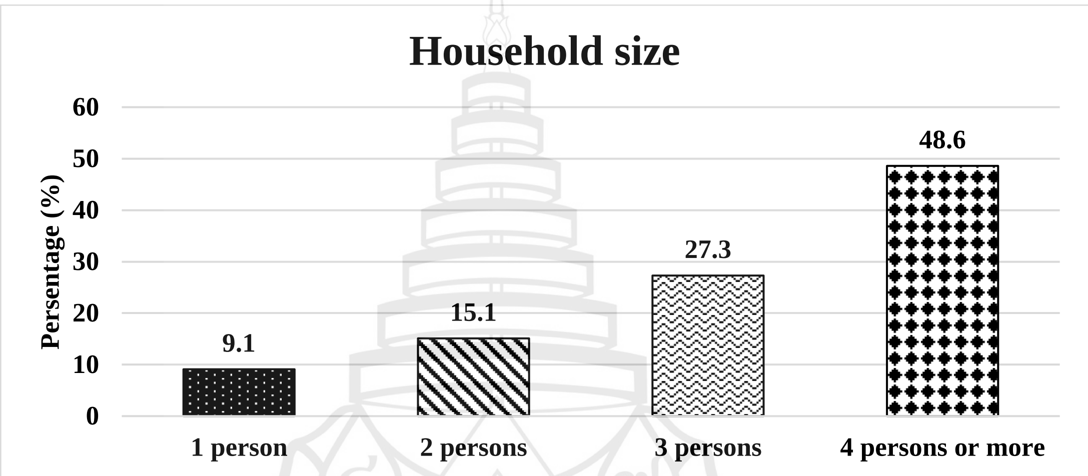


Figure 4.7 Household Size Distribution of Survey Respondents

Figure 4.8 shows that residential location was relatively evenly distributed across urban (34.9%), suburban (35.6%), and rural (29.4%) areas, providing a balanced geographical representation. This distribution enables meaningful comparisons of MaaS perceptions across different residential contexts, which is valuable given that transportation infrastructure and service availability often vary significantly between urban and rural settings.

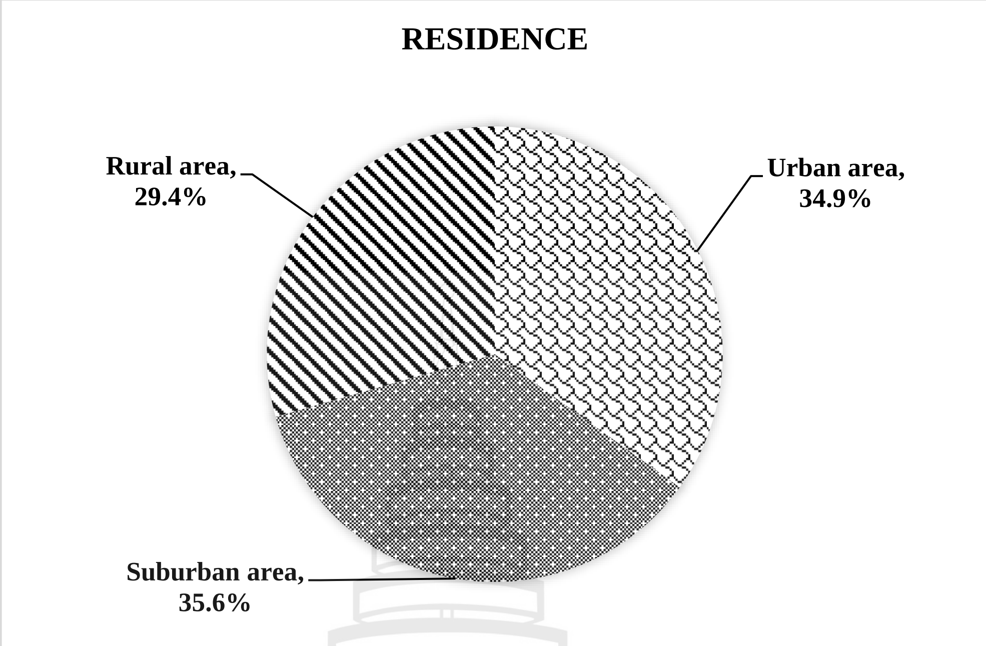


Figure 4.8 Residential Area Distribution of Survey Respondents

Figure 4.9 shows that the analysis of travel behavior revealed that work commuting was the predominant purpose of respondents' latest trips (49.3%), followed by educational travel (24.9%) and leisure travel (14.4%). These trip purposes align with the demographic composition of the sample, which featured substantial proportions of working professionals and students. Trip duration was predominantly in the range of 15-60 minutes, with 24.4% reporting trips of 15-30 minutes, 20.3% reporting trips of 30-45 minutes, and 20.1% reporting trips of 45-60 minutes. This duration profile suggests that most respondents engage in medium-length journeys that could benefit from integrated mobility solutions.

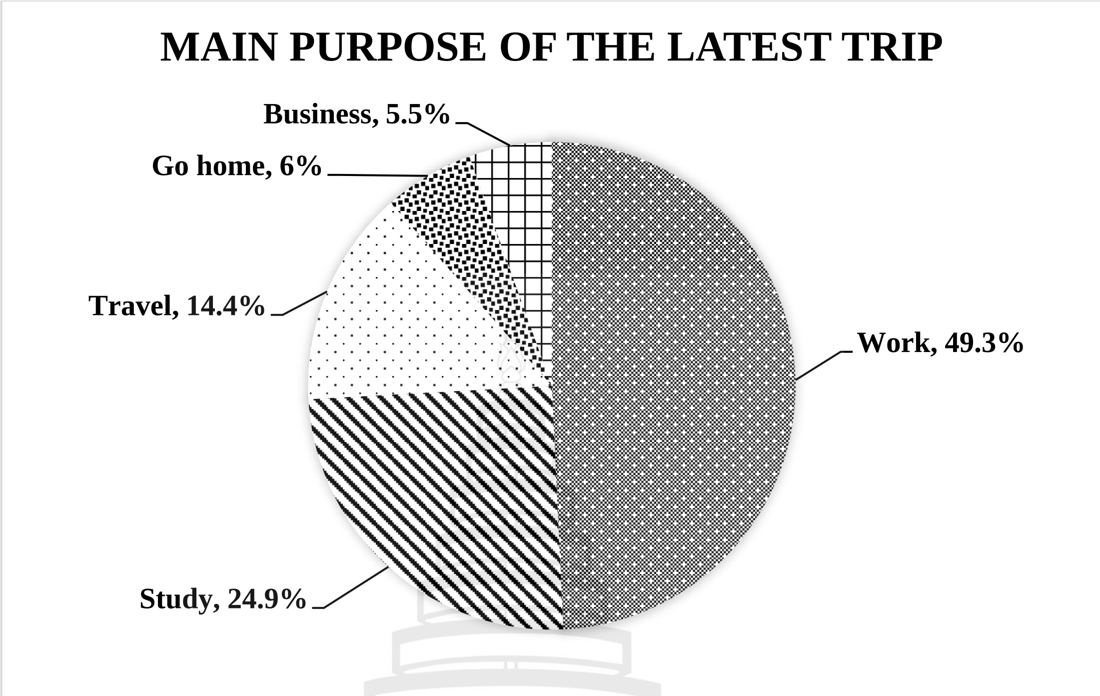


Figure 4.9 Main Purpose of Latest Trip Among Survey Respondents

Figure 4.10 and Figure 4.11 show Travel expenditure patterns indicating that most respondents spent relatively modest amounts on transportation, with 26.6% spending ≤50 baht and 26.1% spending 51-100 baht on their latest trip. This expenditure pattern suggests potential Price Sensitivity influencing MaaS adoption decisions, particularly regarding subscription models and bundled services.

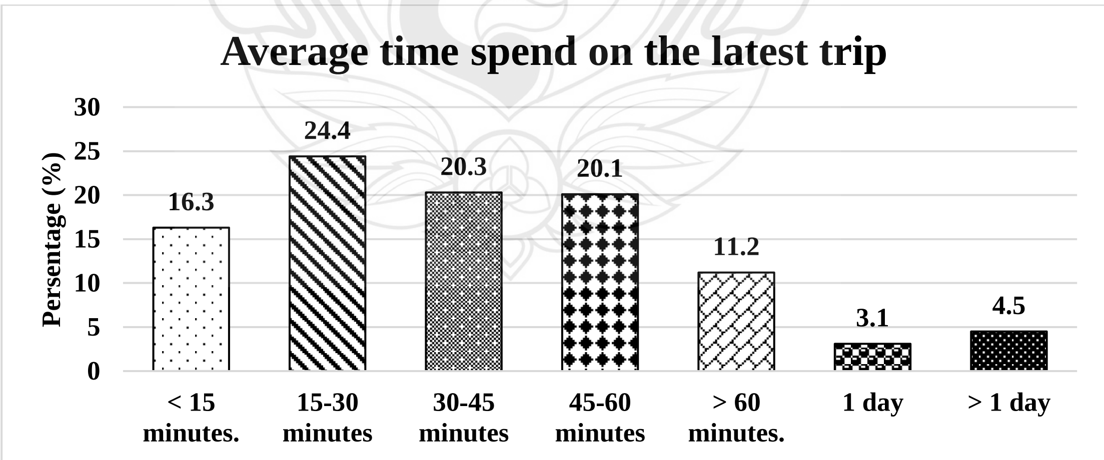


Figure 4.10 Average Travel Time Distribution of Survey Respondents

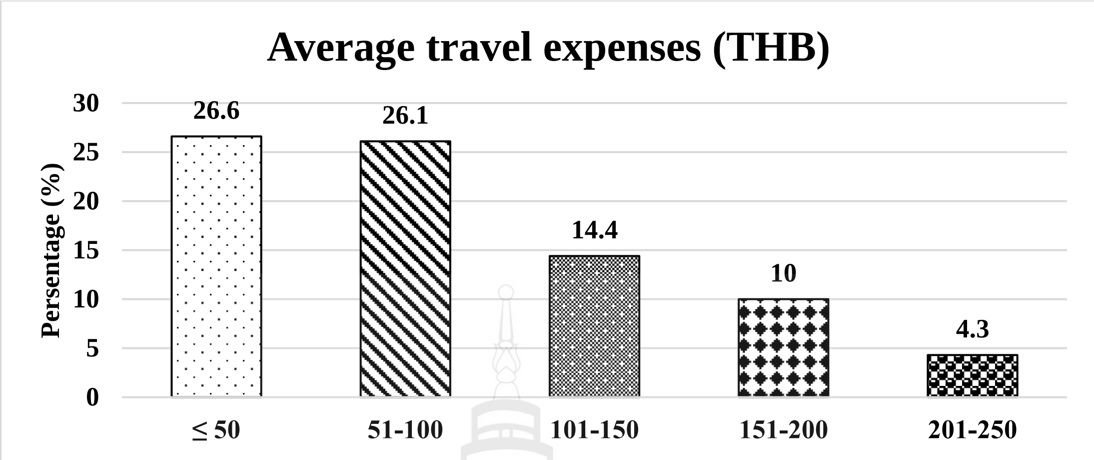


Figure 4.11 Average Travel Expenses Distribution of Survey Respondents

These demographic and socioeconomic characteristics collectively provide a comprehensive profile of the respondents and establish the context for interpreting subsequent findings on MaaS adoption factors. While showing some deviations from Thailand's general population demographics (particularly in education levels), the sample provides diverse representation across key demographic variables relevant to transportation research. These characteristics will be considered when interpreting the relationships between variables and developing targeted recommendations for MaaS implementation strategies in Thailand.

4.1.2 Travel Behavior Characteristics and MaaS Familiarity

The analysis of travel behavior characteristics reveals important patterns in transportation usage among respondents. As illustrated in Figure 4.12, the frequency of weekly transportation usage categorized by transport modes (public transport, e-hailing, and private vehicle) shows distinct usage patterns. The data indicates that most respondents used public transportation at low frequencies, with 82.8% accessing these services fewer than 5 times per week. Similarly, e-hailing services were predominantly used at low frequencies, with 90.2% of respondents using these services fewer than 5 times weekly. Private vehicle usage demonstrated more distributed patterns, where 40.2% used them less than 5 times weekly, while 26.6% utilized them 11-15 times weekly, indicating a higher reliance on personal vehicles for daily transportation needs.

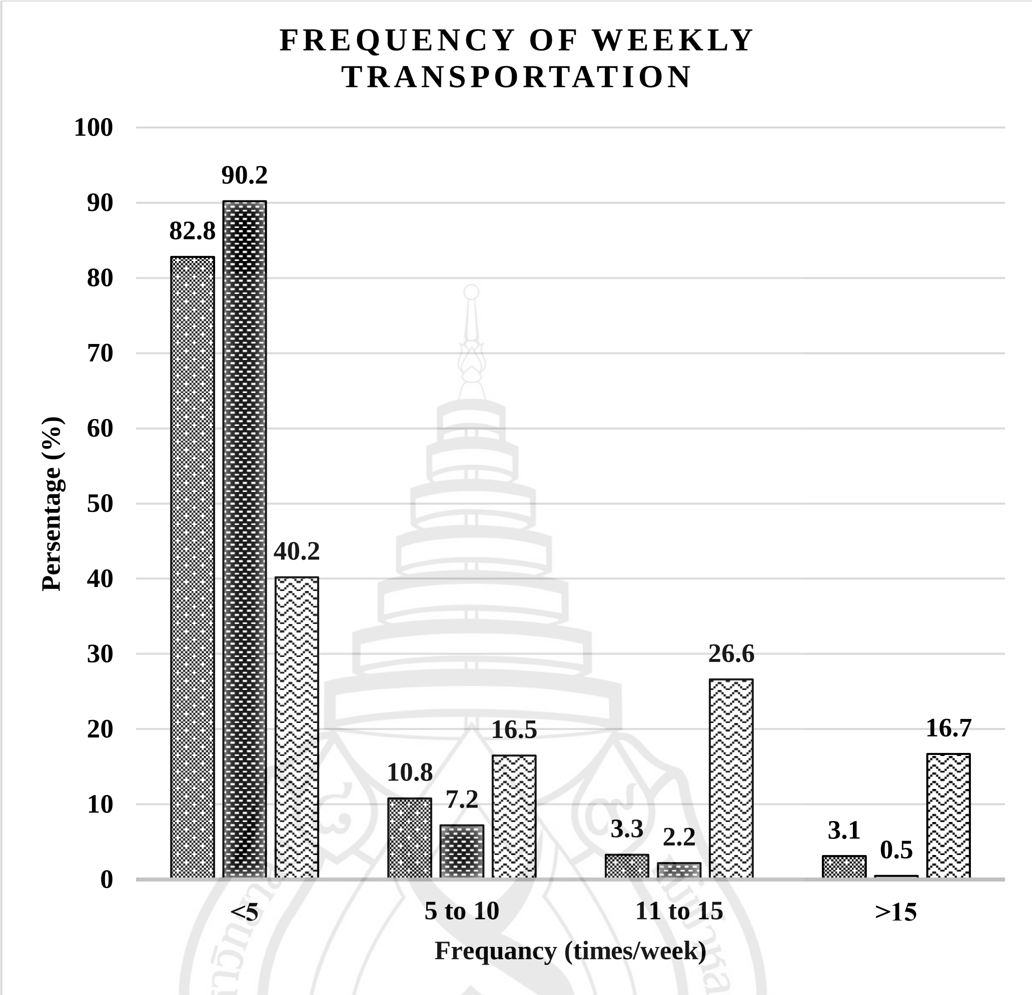


Figure 4.12 Frequency of weekly transportation by transport modes

Regarding trip characteristics, the primary purpose of the latest trip for 49.3% of respondents was traveling to work, followed by 24.9% traveling for study purposes. The average travel duration was between 15 to 30 minutes for 24.4% of respondents and 30-45 minutes for 20.3%. Regarding expenses, 26.6% of respondents spent less than or equal to 50 Thai baht on their latest trip, while 26.1% spent between 51-100 Thai baht, suggesting that cost-effective transportation options are important for a significant portion of the sample.

The relationship between transport mode usage and key travel characteristics was further explored through ANOVA testing. The results revealed significant associations between travel time and both public transport ($p < 0.05$) and private vehicle usage ($p < 0.01$), indicating that journey duration meaningfully influences mode choice decisions. Travel costs demonstrated a strong relationship with private vehicle usage ($p < 0.01$), suggesting that financial considerations play a crucial role in private transportation decisions. Mode transfer exhibited highly significant associations with public transport and e-hailing services ($p < 0.001$), suggesting that the need to transfer between modes significantly influences travelers' choices regarding these services. Interestingly, trip purpose was not found to have statistically significant relationships with any of the three transport modes examined.

Regarding familiarity with the MaaS concept, the survey revealed moderate awareness among respondents. As shown in Figure 4.13, most respondents (52.6%) reported a moderate familiarity with MaaS. Most participants learned about MaaS primarily through the questionnaire (37.9%) and social media platforms (25.0%), indicating limited prior exposure to the concept. When asked about preferred integration in a potential MaaS system, respondents favored the integration of public transportation (38.4%) and service applications (28.2%).

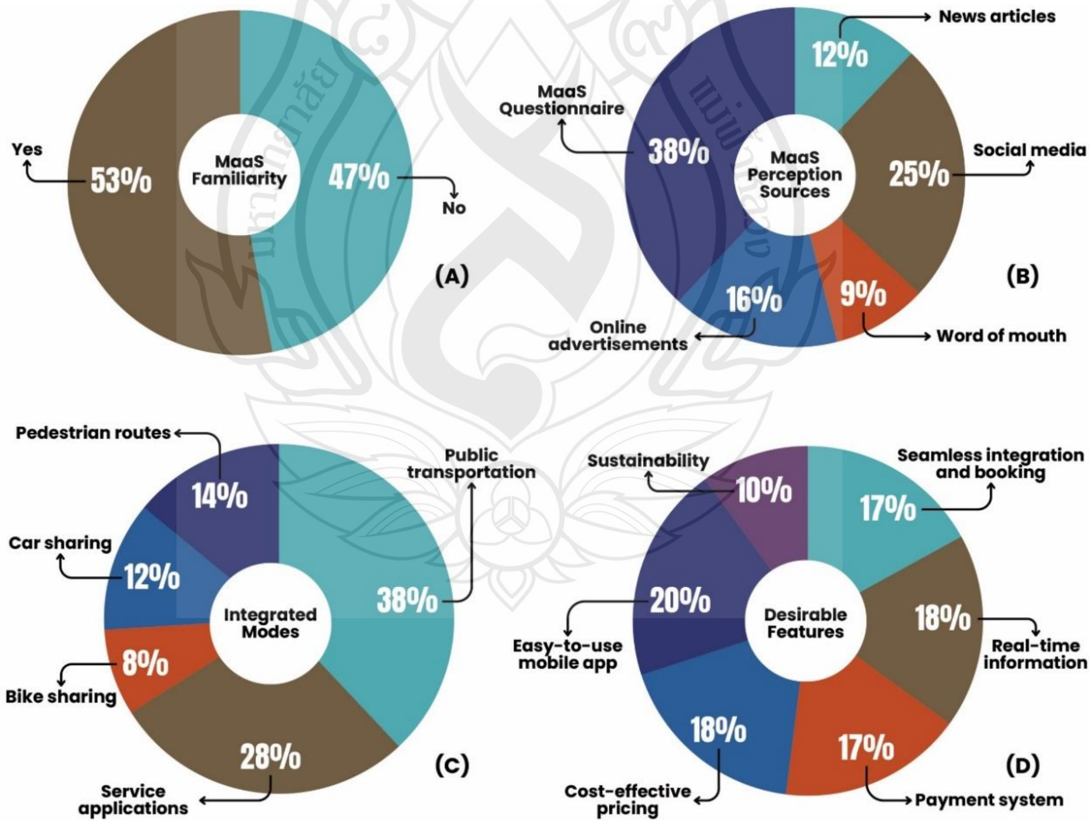


Figure 4.13 Familiarity with the concept of MaaS: familiarity (A), perception sources (B), integrated modes (C), and desirable features (D)

Respondents most valued ease of use in mobile applications and access to real-time information in a potential MaaS system. Specifically, respondents emphasized the importance of several key features: seamless integration and booking capabilities, real-time information availability, efficient payment systems, cost-effective pricing structures, and user-friendly mobile applications. More than half of the respondents considered all these elements critical. Sustainability was also deemed an important feature, though to a slightly lesser extent than the other functional aspects.

These findings highlight the need for a comprehensive, user-friendly, and integrated MaaS system that addresses the diverse needs of potential users, with particular emphasis on real-time information, seamless integration, and cost-effectiveness. The moderate familiarity with MaaS among respondents also suggests the importance of information dissemination initiatives and educational initiatives to promote understanding and adoption of MaaS concepts in Thailand.

4.2 Confirmatory Factor Analysis (CFA): Reliability and Validity Results

The reliability and validity of the measurement model were thoroughly assessed using multiple statistical techniques to ensure the robustness of the constructs before hypothesis testing. Prior to conducting the full measurement model analysis, individual CFA was performed for each construct to evaluate factor loadings and identify items requiring deletion.

4.2.1 Item Purification Process

Table 4.2 presents the factor loadings for all measurement items before model refinement. During the initial CFA assessment, three items were identified with factor loadings below the acceptable threshold of 0.60: PC1 (0.190), PC2 (0.216), and PS3 (0.422). These items were systematically removed from the measurement model to improve overall model fit and ensure adequate convergent validity. The deletion of these poorly performing items enhanced the psychometric properties of their respective constructs while maintaining theoretical integrity.

Table 4.2 Factor loadings of measurement items before model refinement

Construct	Variable	Measurement Statement	Factors Loading
Performance Expectancy (PE)	PE1	Using MaaS for travel saves time.	0.718
	PE2	Using MaaS makes travel easier.	0.816
	PE3	Using MaaS allows me to check transportation services in real-time.	0.833
	PE4	I expect MaaS will fit with the local lifestyle.	0.747
	PE5	I expect MaaS will be practical in my daily life.	0.741
Effort Expectancy (EE)	EE1	Learning to use MaaS will be easy for me.	0.858
	EE2	Using MaaS will be easy for me.	0.887
	EE3	Using MaaS will not require much effort.	0.766
	EE4	I feel confident in my ability to use MaaS.	0.688
Social Influence (SI)	SI1	I would use MaaS if many others were using it.	0.816
	SI2	I would use MaaS if people important to me support it.	0.892
	SI3	I will use MaaS if it receives positive media reviews.	0.784
Facilitating Conditions (FC)	FC1	I am familiar with mobile payment systems.	0.949
	FC2	My mobile network connection is reliable when traveling.	0.703
	FC3	I am familiar with smartphone use and regularly carry my phone.	0.804
Hedonic Motivation (HM)	HM1	Using MaaS would be enjoyable due to increased travel flexibility.	0.718
	HM2	Using MaaS would be exciting.	0.786
	HM3	Using MaaS would give me satisfaction.	0.900
	HM4	Using MaaS would enhance my travel enjoyment.	0.715
Price Value (PV)	PV1	I expect MaaS services to be reasonably priced.	0.855
	PV2	The benefits of MaaS would justify its cost.	0.814
	PV3	Government subsidies would make MaaS more attractive.	0.677

Table 4.2 (continued)

Construct	Variable	Measurement Statement	Factors Loading
Price Sensitivity (PS)	PS1	I am willing to pay extra to try MaaS as a new travel option.	0.877
	PS2	I am willing to spend significantly on MaaS.	0.722
	PS3	I'm not interested in using it if the new MaaS costs more than the old travel system.	**0.422**
Habit (HA)	HA1	Using smartphone apps is part of my daily routine.	0.735
	HA2	I am familiar with similar transportation technologies.	0.758
	HA3	I believe I need MaaS even if I'm not yet familiar with it.	0.790
	HA4	Using MaaS could become routine for me.	0.763
Privacy Concerns (PC)	**PC1**	I am concern about the privacy of my personal information when using the new system (MaaS).	**0.190**
	PC2	I am concern in sharing personal information with the third parties while using new mode (MaaS)	**0.216**
	PC3	I am comfortable sharing my profile and opinions with other MaaS users	0.979
	PC4	I am willing to share necessary personal data with relevant MaaS companies.	0.668
Perceived Risk (PR)	PR1	I am concerned about privacy risks with MaaS.	0.716
	PR2	I am concerned that MaaS might be cumbersome to use.	0.745
	PR3	I am concerned about the reliability of the MaaS system.	0.879
Willingness to Use (WU)	WU1	I will choose MaaS as my everyday travel option when available.	0.705
	WU2	I plan to use MaaS frequently once it's available.	0.780
	WU3	I will use MaaS when I need to travel.	0.663
Usage Behavior (UB)	UB1	Using MaaS will be a pleasant experience.	0.682
	UB2	MaaS will be my first choice when available.	0.826
	UB3	I will recommend MaaS to my friends once it's available.	0.774

4.2.2 Final Measurement Model Assessment

Table 4.3 presents the comprehensive results of the refined measurement model, including factor loadings, Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) for each construct after item deletion.

Internal consistency reliability was evaluated using Cronbach's alpha and Composite Reliability measures. Cronbach's alpha values ranged from 0.771 (Price Sensitivity) to 0.880 (Performance Expectancy), all exceeding the recommended threshold of 0.70 (Hair et al., 2012). This indicates strong internal consistency among the items measuring each construct. Similarly, Composite Reliability values ranged from 0.773 (Privacy Concerns) to 0.892 (Usage Behavior), further confirming the reliability of the measurement scales. While Cronbach's alpha assumes that all indicators are equally reliable, Composite Reliability allows for varying indicator loadings, providing a more robust assessment of internal consistency (Fornell & Larcker, 1981). The strong results from both measures provide compelling evidence for the reliability of the constructs.

Convergent validity, which assesses whether items that should theoretically be related to each other demonstrate actual correlations, was examined through standardized factor loadings and AVE values. All retained items demonstrated standardized factor loadings greater than 0.60, with most exceeding 0.70, indicating strong associations between the indicators and their respective latent constructs. The AVE values for all constructs exceeded the minimum threshold of 0.50, ranging from 0.566 (Performance Expectancy) to 0.733 (Usage Behavior). These values indicate that more than 50% of the variance in the indicators is explained by their respective latent constructs rather than measurement error, providing strong evidence for convergent validity (Fornell & Larcker, 1981). Particularly robust convergent validity was observed for Usage Behavior (AVE = 0.733) and Willingness to Use (AVE = 0.682), suggesting that these outcome variables were measured with high precision.

Table 4.3 Confirmatory Factor Analysis (CFA): Reliability and Convergent Validity Assessment

Factors	Variable	Loadings	Alpha	CR	AVE
Performance Expectancy (PE)	PE1	0.657	0.880	0.866	0.566
	PE2	0.771			
	PE3	0.776			
	PE4	0.769			
	PE5	0.780			
Effort Expectancy (EE)	EE1	0.861	0.877	0.889	0.669
	EE2	0.871			
	EE3	0.670			
	EE4	0.853			
Social Influence (SI)	SI1	0.757	0.869	0.848	0.651
	SI2	0.819			
	SI3	0.842			
Facilitating Conditions (FC)	FC1	0.917	0.854	0.860	0.673
	FC2	0.722			
	FC3	0.811			
Hedonic Motivation (HM)	HM1	0.753	0.859	0.878	0.643
	HM2	0.815			
	HM3	0.854			
	HM4	0.781			
Price Value (PV)	PV1	0.844	0.821	0.830	0.620
	PV2	0.801			
	PV3	0.712			
Price Sensitivity (PS)	PS1	0.841	0.771	0.784	0.645
	PS2	0.764			
Habit (HAB)	HA1	0.846	0.847	0.867	0.621
	HA2	0.713			
	HA3	0.785			
	HA4	0.803			

Table 4.3 (continued)

Factors	Variable	Loadings	Alpha	CR	AVE
Privacy Concerns (PC)	PC3	0.783	0.790	0.773	0.631
	PC4	0.805			
Perceived Risk (PR)	PR1	0.748	0.818	0.827	0.615
	PR2	0.743			
	PR3	0.857			
Willingness to Use (WU)	WU1	0.819	0.855	0.865	0.682
	WU2	0.864			
	WU3	0.793			
Usage Behavior (UB)	UB1	0.818	0.870	0.892	0.733
	UB2	0.870			
	UB3	0.879			

Discriminate validity, which ensures that constructs that should be unrelated are indeed not highly correlated, was assessed using the Heterotrait-Monotrait (HTMT) ratio of correlations method. As shown in Table 4.4, all HTMT values were below the conservative threshold of 0.90 (Henseler et al., 2015), with most values considerably lower. This confirms that each construct in the model captures unique phenomena not represented by other constructs. The highest HTMT ratio was observed between Willingness to Use and Usage Behavior (0.857), which, while still below the threshold, reflects the theoretical proximity of these constructs as sequential stages in the technology adoption process.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy yielded a value of 0.959, well above the recommended threshold of 0.80, indicating the excellent suitability of the data for factor analysis (Kaiser & Rice, 1974). Furthermore, Bartlett's test of sphericity was significant ($p < 0.001$), confirming that the correlation matrix is significantly different from an identity matrix, thus making the data appropriate for factor analysis. Overall, these comprehensive assessments of reliability and validity provide strong statistical evidence for the psychometric quality of the measurement model. The systematic item purification process, followed by rigorous reliability and validity testing, establishes a solid foundation for the subsequent structural model analysis and hypothesis testing, enhancing confidence in the interpretability and generalizability of the findings.

Table 4.4 Heterotrait-Monotrait ratio of correlations

	PR	PC	HA	PS	PV	HM	FC	SI	EE	PE	WU	UB
PR	**1.000**											
PC	0.145	**1.000**										
HA	0.233	0.479	**1.000**									
PS	0.059	0.657	0.518	**1.000**								
PV	0.498	0.324	0.608	0.406	**1.000**							
HM	0.268	0.470	0.643	0.537	0.688	**1.000**						
FC	0.487	0.324	0.699	0.341	0.788	0.621	**1.000**					
SI	0.366	0.437	0.755	0.435	0.696	0.774	0.755	**1.000**				
EE	0.237	0.317	0.696	0.372	0.595	0.698	0.652	0.808	**1.000**			
PE	0.332	0.350	0.618	0.367	0.732	0.680	0.767	0.842	0.798	**1.000**		
WU	0.316	0.568	0.671	0.593	0.612	0.665	0.604	0.617	0.572	0.631	**1.000**	
UB	0.310	0.505	0.720	0.531	0.614	0.636	0.653	0.643	0.590	0.626	0.857	**1.000**

4.3 Model Fit Indices

Model fit indices were examined to assess how well the proposed structural model fits the observed data. These indices are critical for determining the validity of the structural equation model before interpreting the relationships between constructs. Table 4.5 presents the overall fitness indicators for the measurement model and their recommended values.

Table 4.5 Indicators and measurement

Indicator	Model value	Recommended value	Decision
CMIN/DF = χ^2/df	1.967	$1 < \chi^2/\text{df} < 3$	Accepted
CFI	0.962	> 0.90	Accepted
NFI	0.928	> 0.90	Accepted
IFI	0.963	> 0.90	Accepted
GFI	0.906	> 0.90	Accepted
SRMR	0.046	< 0.08	Accepted
RMSEA	0.044	< 0.05 Excellent fit	Accepted

Table 4.5 (continued)

Indicator	Model value	Recommended value	Decision
TLI	0.937	0 >TLI< 1	Accepted

Note χ^2/df = ratio of chi-square to degrees of freedom, CFI= comparative of fit index, SRMR= standardized root mean square residual, RMREA= root mean square error of approximation, NFI= normed fit index, IFI= incremental fit index, TLI= trucker lewis index, GFI= goodness-of-fit index.

The Structural Equation Modeling (SEM) diagrams, Figures 4.14 and 4.15, provide a comprehensive visual representation of Mobility as a Service (MaaS) adoption model, revealing the intricate relationships between various technological acceptance constructs. Figure 4.14 illustrates the unstandardized estimates, displaying raw path coefficients connecting latent variables in their original measurement units. In contrast, Figure 4.15 presents standardized estimates, normalizing the path coefficients to a common scale that allows for direct comparisons across different constructs.

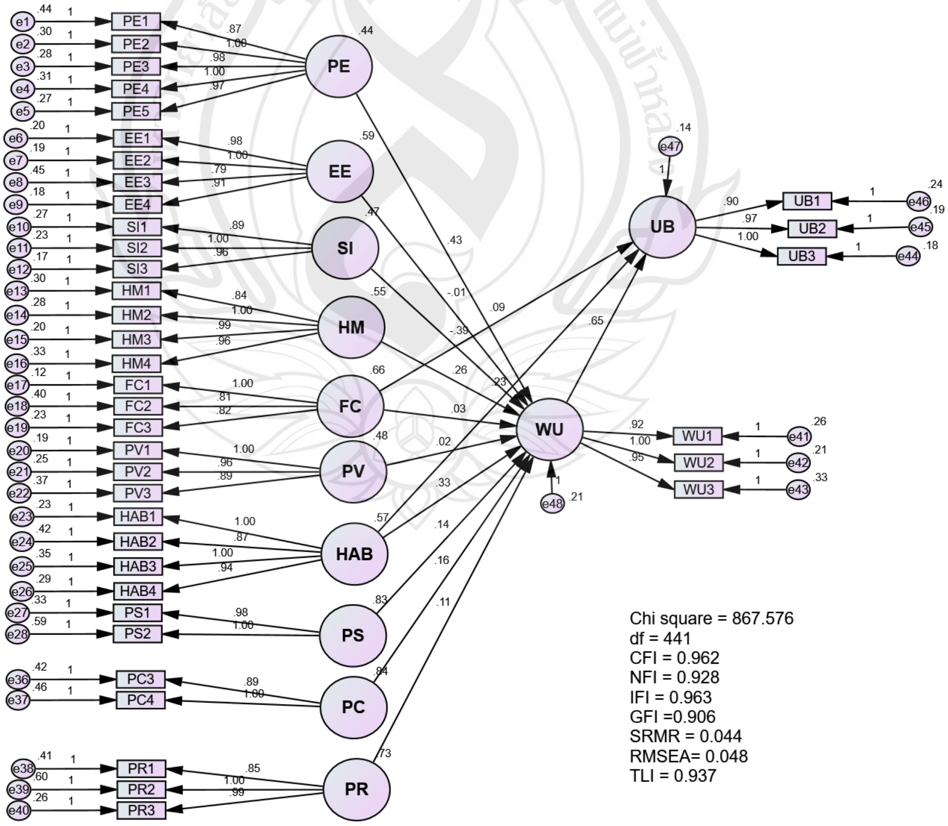


Figure 4.14 Diagrammatically model with an unstandardized estimate

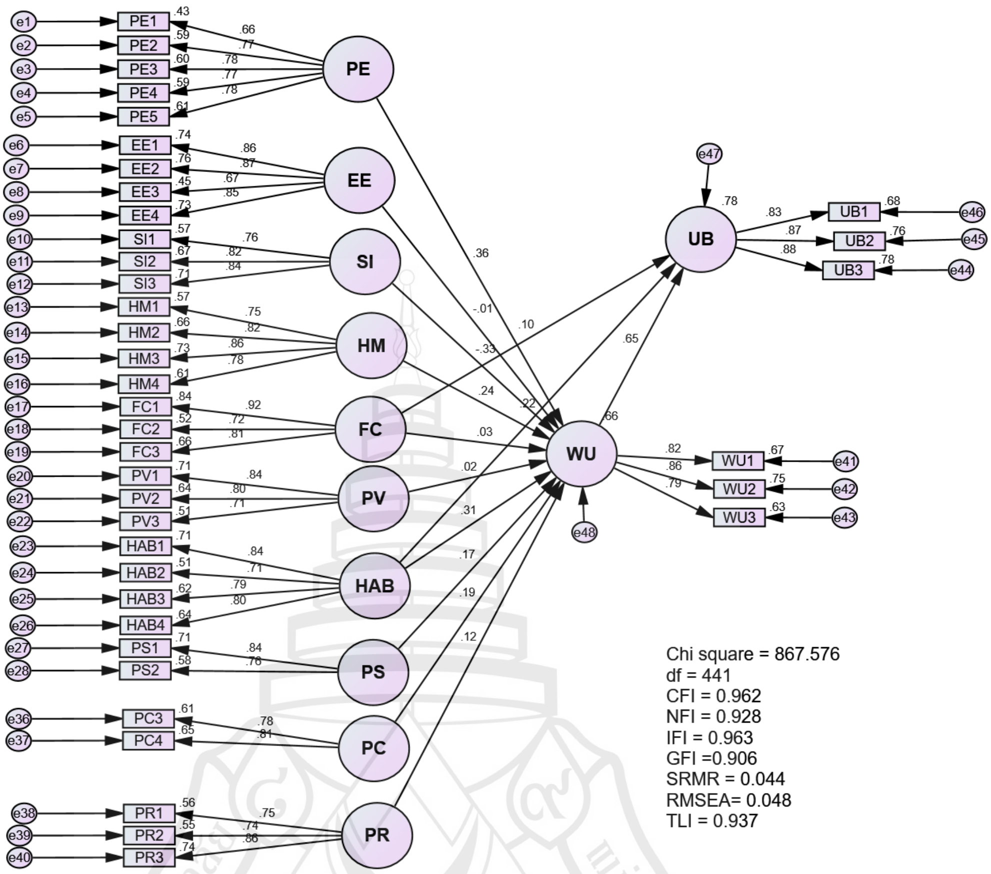


Figure 4.15 Diagrammatically model with a standardized estimate

The chi-square to degrees of freedom ratio (χ^2/df) was 1.967, which falls well within the recommended range of 1 to 3, indicating an acceptable model fit. This ratio suggests that the proposed model adequately represents the observed covariance among the measured variables. The diagrams visually confirm this statistical robustness, presenting a complex network of constructs including Performance Expectancy (PE), Effort Expectancy (EE), Social Influence (SI), Hedonic Motivation (HM), Facilitating Conditions (FC), and Usage Behavior (UB).

The Comparative Fit Index (CFI) value of 0.962 exceeded the recommended threshold of 0.90, suggesting excellent comparative fit between the hypothesized and null models. Similarly, the Normed Fit Index (NFI) of 0.928 and the Incremental Fit Index (IFI) of 0.963 surpassed the 0.90 threshold, further supporting the model's goodness of fit. These statistical indicators are reflected in the detailed structural relationships depicted in the SEM diagrams, which showcase the nuanced interactions between various technological adoption factors.

The Goodness-of-Fit Index (GFI) was 0.906, exceeding the recommended value of 0.90, indicating that the model fits the sample data well. The Standardized Root Mean Square Residual (SRMR) value was 0.046, well below the maximum acceptable threshold of 0.08, suggesting minimal differences between the observed correlation matrix and the model-implied correlation matrix. The Root Mean Square Error of Approximation (RMSEA) was 0.044, below 0.05, signifying excellent fit and indicating that the model represents a close approximation to the population.

The Tucker-Lewis Index (TLI) of 0.937 surpassed the recommended value of 0.90, further confirming the model's robustness. The unstandardized and standardized estimate diagrams provide a visual testament to this statistical rigor, displaying a sophisticated web of relationships that go beyond simple linear connections. By presenting both raw and normalized coefficients, these figures offer researchers a comprehensive view of the complex decision-making processes underlying MaaS adoption in the Thai context.

Collectively, these fit indices and visual representations demonstrate that the proposed structural model exhibits excellent fit with the empirical data. All indicators met or exceeded their respective thresholds, providing a strong foundation for the subsequent analysis of path relationships and hypothesis testing. The strong model fit suggests that the extended UTAUT2 framework, incorporating Privacy Concerns, Perceived Risk, and Price Sensitivity, is appropriate for examining the factors influencing MaaS adoption in the Thai context. This robust model fit increases confidence in the validity of the findings and the theoretical relationships being tested.

4.4 Hypothesis Testing

The hypothesized relationships between the constructs were tested using Structural Equation Modeling. Figure 4.16 displays the structural model with path coefficients, while Table 4.6 presents the results of the hypothesis testing. Each hypothesis is discussed in detail below, including theoretical justification and empirical findings.

4.4.1 Performance Expectancy (H1)

H1: Performance expectancy for MaaS has a path impact on Willingness to Use.

The analysis confirmed a significant positive relationship between performance expectancy and Willingness to Use MaaS ($\beta = 0.441$, $p < 0.05$), supporting H1. This indicates that Thai commuters are more likely to adopt MaaS when they perceive it will enhance their travel experience through benefits such as time savings, improved efficiency, and greater convenience. This finding aligns with previous UTAUT2 studies consistently identifying performance expectancy as a key determinant of technology adoption (Venkatesh et al., 2012; Alalwan et al., 2016).

For MaaS implementation in Thailand, this suggests that highlighting functional benefits such as reduced travel time, seamless integration of transportation modes, and real-time service information would significantly enhance adoption intentions. The strong path coefficient ($\beta = 0.441$) indicates that performance expectancy is one of the most influential factors in the model, reinforcing the importance of utilitarian value in transportation technology adoption decisions.

4.4.2 Effort Expectancy (H2)

H2: Effort expectancy for MaaS has a path impact on Willingness to Use.

Contrary to theoretical expectations, effort expectancy did not significantly influence Willingness to Use MaaS ($\beta = -0.024$, $p = 0.817$), leading to the rejection of H2. This result diverges from traditional UTAUT2 findings (Venkatesh et al., 2012), which typically show a positive relationship between ease of use and adoption intentions.

The non-significant relationship might be explained by several factors specific to the Thai context. First, the proliferation of mobile applications and digital services in Thailand has created a population highly familiar with technology interfaces, potentially reducing the salience of effort concerns (Ayuning Budi et al., 2021). Second, the potential benefits of MaaS might outweigh concerns about effort, particularly in urban areas with significant transportation challenges. Third, the sample's demographic profile, with 65.1% holding bachelor's degrees and 57.4% aged 21-35 years, represents a relatively tech-savvy population for whom effort expectancy may be less relevant.

4.4.3 Facilitating Conditions (H3a and H3b)

H3a: Facilitating Conditions for MaaS have a path impact on Willingness to Use.

H3b: Facilitating Conditions for MaaS have a path impact on Usage Behavior.

The results showed that Facilitating Conditions did not significantly influence Willingness to Use MaaS ($\beta = 0.017$, $p = 0.865$), rejecting H3a. However, Facilitating Conditions significantly affected Usage Behavior ($\beta = 0.116$, $p < 0.05$), supporting H3b. This interesting pattern suggests that while Facilitating Conditions (technological infrastructure, support resources, and connectivity) may not directly motivate adoption intentions, they become crucial enablers of actual Usage Behavior.

This finding partially aligns with Venkatesh et al.'s (2012) proposition that Facilitating Conditions directly influence behavioral intention and Usage Behavior in consumer contexts. The significant path from Facilitating Conditions to Usage Behavior highlights the importance of ensuring adequate technological infrastructure, reliable mobile connectivity, and support systems for successful MaaS implementation in Thailand (Bhattacherjee, 2000; Rodríguez-Espíndola et al., 2022). The moderating effects analysis (Table 4.6) further revealed that this relationship is particularly strong in rural areas, emphasizing the need for infrastructure development in less urbanized regions.

4.4.4 Social Influence (H4)

H4: Social Influence for MaaS has a path impact on Willingness to Use.

The analysis revealed a significant but negative relationship between Social Influence and Willingness to Use MaaS ($\beta = -0.395$, $p < 0.05$), partially supporting H4. While the relationship was significant, as hypothesized, the negative direction was contrary to expectations. This unexpected finding suggests that social pressure or opinions from important others in the Thai context might actually discourage MaaS adoption intentions.

Several contextual factors might explain this counterintuitive result. First, transportation choices in Thai culture often serve as status symbols, with private vehicle ownership representing achievement and success (Van & Fujii, 2011). Social Influence may reinforce preferences for private transportation rather than shared mobility solutions. Second, MaaS represents a novel concept in Thailand, and social networks might exhibit conservatism toward unproven transportation innovations. Third, concerns about data privacy and security might be amplified through social networks, creating negative perceptions of digital transportation platforms.

This finding contrasts with previous UTAUT2 studies in transportation contexts that typically report positive Social Influence effects (Dwivedi et al., 2021; De Leon, 2019) and highlights the importance of cultural context in technology adoption research.

4.4.5 Hedonic Motivation (H5)

H5: Hedonic Motivation for MaaS has a path impact on Willingness to Use.

Hedonic Motivation significantly influenced Willingness to Use MaaS ($\beta = 0.265$, $p < 0.01$), supporting H5. This indicates that anticipated enjoyment, pleasure, and satisfaction derived from using MaaS significantly motivate adoption intentions among Thai commuters. This finding aligns with previous UTAUT2 research highlighting the importance of hedonic factors in consumer technology contexts (Alalwan et al., 2018; Baabdullah et al., 2019).

The significant influence of Hedonic Motivation suggests that MaaS providers should emphasize functional benefits and experiential aspects of their services. Features that enhance travel enjoyment, create positive emotions, or add gamification elements could potentially increase adoption rates. The moderating effects analysis (Table 4.7) revealed that Hedonic Motivation is particularly influential among those aged over 36 years ($\beta = 0.444$, $p < 0.001$) and female users ($\beta = 0.307$, $p < 0.001$), providing guidance for targeted marketing strategies.

4.4.6 Habit (H6a and H6b)

H6a: Habit for MaaS has a path impact on Willingness to Use.

H6b: Habit for MaaS has a path impact on Usage Behavior.

The results strongly supported both H6a and H6b, revealing significant positive relationships between Habit and Willingness to Use ($\beta = 0.344$, $p < 0.01$) and between Habit and Usage Behavior ($\beta = 0.212$, $p < 0.001$). These findings indicate that Habitual use of similar technologies (e.g., smartphone apps and digital transportation services) positively influences MaaS adoption intentions and Usage Behavior. The mediation analysis (Table 4.8) further revealed that Habit directly and indirectly affects Usage Behavior, with a substantial total effect ($\beta = 0.437$).

These results align with previous findings highlighting Habit as a powerful predictor of technology use (Limayem et al., 2007; Venkatesh et al., 2012). For MaaS implementation, this suggests the importance of creating seamless user experiences that promote Habitual use, potentially through consistent interfaces, personalized recommendations based on travel history, and integration with commonly used applications. The significant moderating effects for vehicle owners (Table 4.7) indicate that Habit formation may be particularly important for transitioning current drivers to MaaS solutions.

4.4.7 Price Value (H7)

H7: Perceived Price Value for MaaS has a path impact on Willingness to Use.

Contrary to expectations, Price Value did not significantly influence Willingness to Use MaaS ($\beta = 0.015$, $p = 0.902$), leading to the rejection of H7. This finding diverges from the original UTAUT2 model, which identifies Price Value as a significant determinant of behavioral intention in consumer contexts (Venkatesh et al., 2012).

The non-significant relationship might be attributed to several factors. First, without concrete pricing models for MaaS in Thailand, respondents may have had difficulty assessing price-value relationships for a hypothetical service. Second, the high percentage of students (36.6%) and respondents with lower incomes (40.2% earning ≤15,000 THB monthly) in the sample might have focused more on absolute affordability rather than price-value ratios. Third, transportation decisions often involve complex value considerations beyond simple monetary calculations, including time savings, convenience, and environmental impacts.

This finding suggests that price-value perceptions may become more relevant once concrete MaaS offerings are introduced in Thailand with specific pricing structures, allowing for more informed consumer evaluations.

4.4.8 Price Sensitivity (H8)

H8: Price Sensitivity for MaaS has a path impact on Willingness to Use.

Price Sensitivity demonstrated a significant positive relationship with Willingness to Use MaaS ($\beta = 0.151$, $p < 0.05$), supporting H8. This finding indicates that users' awareness of and responsiveness to price variations positively influences their adoption intentions. This interesting result suggests that price-conscious consumers may view MaaS as a potentially cost-effective alternative to existing transportation options, particularly private vehicle ownership with its associated costs of purchase, maintenance, insurance, and fuel.

The finding aligns with previous transportation studies highlighting the importance of Price Sensitivity in mobility decisions (Han et al., 2001; Öztaş Karlı et al., 2022). For MaaS implementation in Thailand, this suggests the value of transparent, flexible pricing structures that allow users to optimize costs based on their needs. The moderating effects analysis revealed stronger relationships for those over 36 years old ($\beta = 0.284$, $p < 0.01$) and female users ($\beta = 0.181$, $p < 0.01$), indicating demographic variations in Price Sensitivity that could inform targeted pricing strategies.

4.4.9 Privacy Concerns (H9)

H9: Privacy Concerns for MaaS have a path impact on Willingness to Use.

The analysis revealed a significant positive relationship between Privacy Concerns and Willingness to Use MaaS ($\beta = 0.152$, $p < 0.05$), supporting H9. This finding is particularly interesting as it indicates that acknowledging and addressing Privacy Concerns positively influences adoption intentions, rather than deterring them as might be expected from a purely negative interpretation of Privacy Concerns.

This result suggests that users value transparency and control regarding their personal data in transportation services. Rather than avoiding services with privacy implications, users appear willing to adopt MaaS when their Privacy Concerns are acknowledged and adequately addressed. This aligns with research by Kong et al.

(2021) and Huang (2022) emphasizing the importance of trust in service providers' data handling practices.

The moderating effects analysis revealed stronger relationships among male users ($\beta = 0.517$, $p < 0.001$) compared to females ($\beta = 0.045$), suggesting gender differences in privacy sensitivity that should be considered in MaaS implementation. For successful MaaS deployment in Thailand, this finding highlights the importance of robust privacy policies, transparent data practices, and user control over personal information.

4.4.10 Perceived Risk (H10)

H10: Perceived Risk for MaaS has a path impact on Willingness to Use.

Perceived Risk demonstrated a significant positive influence on Willingness to Use MaaS ($\beta = 0.117$, $p < 0.05$), supporting H10. Similar to Privacy Concerns, this finding suggests that acknowledging and addressing potential risks positively influences adoption intentions rather than deterring them. Users appear more willing to adopt MaaS when they perceive that risks are being recognized and mitigated.

This result aligns with studies by Cocosila and Turel (2022) highlighting the complex role of risk perception in technology adoption. For MaaS implementation in Thailand, this suggests the importance of proactive risk communication, security measures, and trust-building mechanisms. The positive relationship indicates that transparent discussion of potential risks and their mitigations may actually enhance user confidence rather than create barriers to adoption.

The moderating effects analysis revealed significant relationships for urban residents ($\beta = -0.192$, $p < 0.05$), indicating that risk perception may function differently across residential contexts, with urban dwellers potentially more risk-averse regarding transportation innovations.

4.4.11 Willingness to Use and Usage Behavior (H11)

H11: Willingness to Use MaaS has a path impact on Usage Behavior.

The analysis strongly supported H11, revealing a significant positive relationship between Willingness to Use and Usage Behavior ($\beta = 0.656$, $p < 0.001$). This finding confirms the fundamental theoretical proposition that behavioral intention is a strong predictor of actual behavior (Venkatesh et al., 2012; Hasbullah et al., 2016). The high path coefficient ($\beta = 0.656$) indicates that Willingness to Use explains a substantial portion of the variance in Usage Behavior, reinforcing the validity of the UTAUT2 framework for predicting MaaS adoption.

The significant relationship was consistent across all demographic segments examined in the moderating effects analysis (Table 4.7), indicating the robustness of this core theoretical relationship. This finding provides confidence that initiatives to enhance adoption intentions will likely translate into actual MaaS usage once the service becomes available in Thailand.

4.4.12 Summary of Hypothesis Testing

The structural model testing revealed that 9 out of 13 hypothesized relationships were supported. Performance expectancy, Hedonic Motivation, Habit, Price Sensitivity, Privacy Concerns, and Perceived Risk all significantly influenced Willingness to Use MaaS, while Social Influence had a significant negative impact. Facilitating Conditions and Habit significantly influenced Usage Behavior, as did Willingness to Use. Effort expectancy, Facilitating Conditions (to willingness), and Price Value did not show significant relationships with Willingness to Use.

The model demonstrated strong explanatory power, with R^2 values of 0.661 for Willingness to Use and 0.780 for Usage Behavior, indicating that the extended UTAUT2 framework effectively captures the determinants of MaaS adoption in the Thai context. These findings provide valuable insights for MaaS implementation strategies, highlighting the importance of addressing both utilitarian and hedonic aspects of the service, fostering Habit formation, considering Price Sensitivity, and addressing privacy and risk concerns transparently.

Table 4.6 Hypothesis test

Hypothesis	Path	Beta	S.E.	t-stat	p-value	Decision
H1	PE→WU	0.441	0.195	2.265	0.023*	Accepted
H2	EE→WU	-0.024	0.102	-0.232	0.817	Not Accepted
H3a	FC→WU	0.017	0.101	0.170	0.865	Not Accepted
H3b	FC→UB	0.116	0.046	2.515	0.012*	Accepted
H4	SI→WU	-0.395	0.200	-1.972	0.049*	Accepted
H5	HM→WU	0.265	0.100	2.651	0.008**	Accepted

Table 4.6 (continued)

Hypothesis	Path	Beta	S.E.	t-stat	p-value	Decision
H6a	HA→WU	0.344	0.106	3.254	0.001**	Accepted
H6b	HA→UB	0.212	0.054	3.883	0.000***	Accepted
H7	PV→WU	0.015	0.122	0.124	0.902	Not Accepted
H8	PS→WU	0.151	0.068	2.229	0.026*	Accepted
H9	PC→WU	0.152	0.063	2.414	0.016*	Accepted
H10	PR→WU	0.117	0.055	2.133	0.033*	Accepted
H11	WU→UB	0.656	0.052	12.671	0.000***	Accepted

Note * Significant at 0.050 level, ** Significant at 0.010 level, *** Significant at 0.001 level.

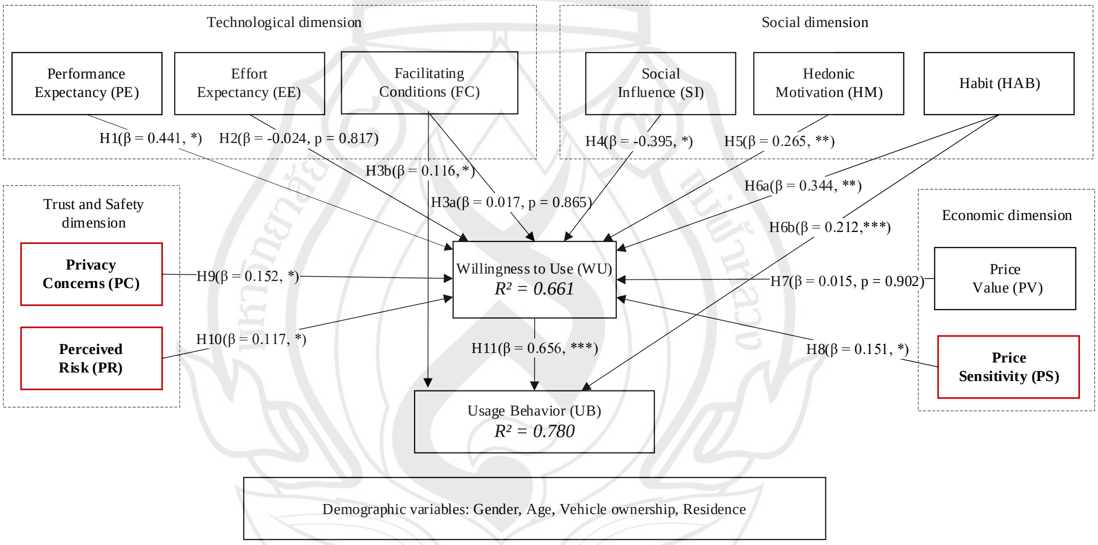


Figure 4.16 Structural model results

4.5 Moderating Effect

Table 4.7 presents the moderating effects of control variables (residence, age, gender, and vehicle ownership) on the relationships between different constructs and the primary outcomes: Willingness to Use (WU) and Usage Behavior (UB). The relationships were depicted through hypothesis paths, highlighting variations across residential areas such as urban, suburban, and rural settings regarding their influence on WU and UB paths.

4.5.1 Residence Effects

The analysis revealed significant differences in how residential location moderates the relationships between constructs. The pairwise comparisons revealed that rural areas have a stronger substantial effect than suburban areas on FC→UB ($\beta = 0.256$ vs. $\beta = 0.203$, $p < 0.001$ vs. $p < 0.05$), and rural areas had a more substantial effect than urban areas on HA→UB ($\beta = 0.264$ vs. $\beta = 0.286$, $p < 0.001$ vs. $p < 0.01$). These findings suggest that Facilitating Conditions play a more crucial role in determining Usage Behavior among rural residents compared to suburban residents, possibly due to infrastructure limitations or accessibility challenges in rural settings. Similarly, Habit appears to have a stronger influence on Usage Behavior in rural contexts compared to urban environments, potentially reflecting the greater reliance on established behavioral patterns in areas with fewer transportation alternatives (Lyons et al., 2019).

Table 4.7 Moderating effects of control variables

		PE→WU	EE→WU	SI→WU	HM→WU	FC→WU	PV→WU	HA→WU	PS→WU	PC→WU	PR→WU	WU→UB	FC→UB	HA→UB
Residence	Urban[a]	-0.044	-0.223	0.074	0.131	0.241	0.207	0.357	0.141	0.194	-0.192*	0.626***	-0.005	0.286**
	Suburb[b]	2.704	-0.454	-2.022	0.921	-0.273	-0.320	0.583	0.756	-0.493	0.001	0.740***	0.203*	0.091
	Rural[c]	1.409	-0.222	-2.186	0.445	-0.316	0.021	0.984	0.139	-0.083	0.700	0.522***	0.256***	0.264***
	airwise	-	-	-	-	-	-	-	-	-	-	-	c***>b*	c***>a**
Age	<21[d]	-0.239	0.473	1.790	0.127	-0.091	-0.967	-0.913	0.735	-0.183	0.597	0.891***	0.069	0.09
	21-36[e]	0.653	-0.187	-0.400	0.152	-0.342*	0.168	0.624**	0.193	0.049	0.174*	0.633***	0.197**	0.209**
	>36[f]	-0.225	0.078	-0.085	0.444***	0.310**	0.217	-0.037	0.284**	0.308***	-0.02	0.783***	-0.108	0.254**
	Pairwise	-	-	-	-	f**>e*	-	-	-	-	-	-	-	-
Gender	Male	0.080	0.391	-0.485	0.121	0.106	0.041	0.343	-0.048	0.517***	0.076	0.701	0.140*	0.167
	Female	0.539**	-0.120	-0.355	0.307***	0.023	0.060	0.292	0.181**	0.045	0.126*	0.654	0.103	0.223**
	z-score	1.169	-2.124**	0.289	0.646	-0.379	0.071	-0.256	1.371	-3.024***	0.423	-0.460	-0.414	0.506
Vehicle Ownership	Yes	0.273	-0.012	-0.183	0.271**	0.038	0.067	0.267**	0.128	0.128*	0.137*	0.644	0.111*	0.242***
	No	1.283	-0.857	-1.331	0.679	-0.226	0.015	1.263	-0.004	0.417	-0.147	0.618***	0.108	0.145
	z-score	0.371	-0.343	-0.392	0.456	-0.225	-0.063	0.731	-0.339	0.940	-1.218	-0.226	-0.030	-0.711

Note * Significant at 0.050 level, ** Significant at 0.010 level, *** Significant at 0.001 level

4.5.2 Age-Related Differences

The difference between age groups identified by pairwise comparison indicated that FC→WU was vital in the age group over 36 ($\beta = 0.310$, $p < 0.01$), compared to the 21 to 36 group ($\beta = -0.342$, $p < 0.05$). This suggests that older users place greater importance on supportive infrastructure and resources when forming adoption intentions, aligning with previous findings that older demographics may require more comprehensive support systems when adopting new. Interestingly, Hedonic Motivation demonstrated significant influence on Willingness to Use among those aged over 36 ($\beta = 0.444$, $p < 0.001$), suggesting that enjoyment factors are particularly important for older users when considering MaaS adoption.

4.5.3 Gender Differences

Gender differences were compared by z-score, indicating significant contrasts between males and females in EE→WU ($z = -2.124$, $p < 0.01$) and PC→WU ($z = -3.024$, $p < 0.001$), with females showing a stronger substantial effect in both paths. The negative z-score values indicate that the relationship strength differs significantly between gender groups, with the direction and magnitude of these differences revealed through the individual path coefficients for each group. This suggests that ease of use is a more critical determinant of adoption willingness for female users compared to males, consistent with previous technology adoption research highlighting gender differences in the importance placed on user-friendliness. Additionally, the stronger relationship between Privacy Concerns and Willingness to Use among male users ($\beta = 0.517$ vs. $\beta = 0.045$) suggests that men may be more sensitive to privacy issues when considering MaaS adoption, with the significant negative z-score ($z = -3.024$) confirming that this gender difference is statistically meaningful rather than due to random variation. This finding adds nuance to our understanding of gender differences in technology acceptance patterns.

The negative z-score values do not indicate negative relationships, but rather significant differences in the strength of relationships between male and female groups. The z-score compares the path coefficients between groups, with negative values indicating that one group shows a stronger effect than the other, as evidenced by the individual beta coefficients presented in Table 4.7.

4.5.4 Vehicle Ownership Influence

Vehicle ownership revealed significant positive effects for HM→WU |($z = 0.271$, $p < 0.01$), HA→WU ($z = 0.267$, $p < 0.01$), PR→WU ($z = 0.137$, $p < 0.05$), FC→UB ($z = 0.111$, $p < 0.05$), and HA→UB ($z = 0.242$, $p < 0.001$). These findings indicate that vehicle owners evaluate MaaS differently than non-owners, with Hedonic Motivation and Habit playing more substantial roles in their adoption intentions. This may reflect the opportunity cost considerations of vehicle owners, who must perceive significant benefits beyond their existing transportation solution to adopt MaaS. Non-ownership positively affected WU→UB ($z = 0.618$, $p < 0.001$), with no significant z-score differences observed between vehicle owners and non-owners for any path. This suggests that the translation of willingness into actual usage might be more straightforward for non-vehicle owners, who may have fewer alternative transportation options.

4.5.5 Implications of Moderating Effects

The moderation analysis reveals the importance of considering demographic and contextual factors when implementing MaaS systems. The significant variations across different user groups suggest that a one-size-fits-all approach to MaaS deployment may be insufficient. For example, rural areas may require stronger support systems and infrastructure development to facilitate adoption, while different age groups may respond to different value propositions (ease of use for younger users, supportive conditions for older users). Similarly, gender-specific considerations should be incorporated into interface design and marketing strategies, with particular attention to ease of use for female users and privacy assurances for male users.

In summary, the impact of FC on UB was significant for rural residents and those aged 21 to 36. HA consistently showed significant positive effects on UB across various demographic groups, indicating its strong influence on Usage Behavior. WU's impact on UB was significant across all residence categories, indicating its crucial role in shaping Usage Behavior. These findings provide valuable insights for tailoring MaaS implementation strategies to different demographic segments, potentially increasing adoption rates and user satisfaction.

4.6 Validated Result

The analysis reported in Table 4.8 revealed significant insights into the relationships between constructs in the model. FC exerted a direct and significant effect on UB, as indicated by the path coefficient (LLCI = 0.011, ULCL = 0.223) (Preacher & Hayes, 2008). However, the impact of FC on UB was not significantly amplified through indirect or total effects mediated by other variables. Interestingly, FC did not directly impact WU, whereas HA demonstrated a significant direct effect on WU.

Table 4.8 Mediation effects

Variable	Estimate	Boot SE	LLCI	ULCI
Direct Effects				
UB←FC	0.116	0.054	0.011	0.223
UB←HA	0.212	0.064	0.090	0.339
Indirect Effect (Mediation)				
UB←FC	0.012	0.095	-0.157	0.181
UB←HA	0.214	0.116	0.058	0.408
Total Effects				
UB←FC	0.128	0.102	-0.045	0.316
UB←HA	0.437	0.120	0.261	0.675

Note LLCI=lower limit confidence interval, ULIC= upper limit confidence interval

In contrast, HA significantly affected UB through direct, indirect, and overall paths. This comprehensive impact underscored the substantial role of HA in influencing both WU and UB within the model. To validate these relationships and ensure the robustness of the findings, a bootstrapping procedure was implemented with 1,000 resamples and a bias-corrected 95% confidence interval. Bootstrapping, as a non-parametric resampling technique, provides a more accurate estimation of standard errors and confidence intervals by generating multiple subsamples from the original dataset (Hayes, 2013). This approach is particularly valuable for testing mediation effects in Structural Equation Modeling as it does not impose assumptions of normality on the sampling distribution of indirect effects and provides higher statistical power compared to traditional methods like the Sobel test (Zhao et al., 2010).

In this study, the bootstrap analysis with 1,000 iterations generated empirical approximations of the sampling distributions for the direct, indirect, and total effects. The results confirmed the significance of HA's direct effect on UB (β = 0.212, Boot SE = 0.064, LLCI = 0.090, ULCI = 0.339) and its indirect effect through WU (β = 0.214, Boot SE = 0.116, LLCI = 0.058, ULCI = 0.408). The total effect of HA on UB was also significant (β = 0.437, Boot SE = 0.120, LLCI = 0.261, ULCI = 0.675), indicating robust evidence for both direct and mediated pathways. The non-overlapping confidence intervals with zero provide strong statistical support for these relationships.

While FC directly impacted UB (β = 0.116, Boot SE = 0.054, LLCI = 0.011, ULCI = 0.223), its overall effect—considering both direct and mediated pathways—was not significant (β = 0.128, Boot SE = 0.102, LLCI = -0.045, ULCI = 0.316) as the confidence interval included zero. The robust direct effect of HA on UB highlighted the strength and significance of this relationship in determining Usage Behavior within the framework, emphasizing the critical role of Habitual behavior in MaaS adoption.

The bootstrapping results enhance the reliability of our findings by accounting for potential sampling variability and providing more accurate estimates of standard errors, which is especially important given the complexity of the model and the non-normal distribution of mediation effects (MacKinnon et al., 2004). This rigorous validation approach strengthens confidence in the structural relationships identified in the model and provides a more nuanced understanding of how Facilitating Conditions and Habits influence MaaS Usage Behavior both directly and through Willingness to Use.

CHAPTER 5

CONCLUSION AND DISCUSSION

5.1 Research Overview and Addressing Research Objectives

This study investigated the determinants influencing public commuters' adoption of Mobility as a Service (MaaS) in Thailand, applying an extended unified theory of acceptance and use of technology (UTAUT2) framework. The research addressed three key objectives through systematic analysis of data collected from 418 participants across Thailand, employing structural equation modeling to examine complex relationships within integrated passenger logistics systems.

5.1.1 Addressing Research Objective 1: Overall Acceptance Level

Research Objective 1: To explore the overall acceptance level among potential Thai commuters toward MaaS as an integrated passenger logistics solution and assess the possibilities for successful implementation in Thailand's transportation ecosystem.

Research Question 1: To what extent are Thai commuters willing to accept MaaS as their primary mobility management system?

Overall Acceptance Assessment: The study findings reveal a moderate to positive acceptance level toward MaaS among Thai commuters. The model demonstrated strong explanatory power with R^2 values of 0.661 for willingness to use and 0.780 for usage behavior, indicating that 66.1% of the variance in adoption intentions and 78% of usage behavior variance can be explained by the identified factors. This substantial explanatory power suggests that Thai commuters' acceptance of MaaS is influenced by multiple, well-defined factors rather than random preferences.

Current Awareness and Familiarity: The demographic analysis showed that 52.6% of respondents reported moderate familiarity with MaaS, primarily learning about the concept through the survey questionnaire (37.9%) and social media (25.0%). This indicates limited prior exposure but suggests openness to learning about innovative mobility solutions.

Implementation Potential: The strong positive relationship between willingness to use and usage behavior ($\beta = 0.656$, $p < 0.001$) demonstrates that once Thai commuters develop positive intentions toward MaaS, they are highly likely to translate these intentions into actual usage, indicating strong potential for successful implementation in Thailand's transportation ecosystem.

5.1.2 Addressing Research Objective 2: Key Adoption Factors

Research Objective 2: To identify and analyze the most significant concerns and requirements influencing potential users' adoption decisions regarding MaaS in Thailand.

Research Question 2: What factors most strongly influence user willingness to adopt MaaS from a passenger logistics perspective?

The analysis identified six significant positive factors and one negative factor influencing MaaS adoption willingness:

Positive Influences: Performance Expectancy ($\beta = 0.441$, $p < 0.05$) emerged as the strongest predictor, indicating that Thai users prioritize functional benefits such as time savings, convenience, and improved travel efficiency. This aligns with passenger logistics principles of optimizing travel experiences. Habit ($\beta = 0.344$, $p < 0.01$) represented the second strongest factor, suggesting that users familiar with smartphone applications and digital transportation services are more likely to adopt MaaS. This factor demonstrates both direct effects on willingness ($\beta = 0.344$) and usage behavior ($\beta = 0.212$), with a substantial total effect ($\beta = 0.437$).

Hedonic Motivation ($\beta = 0.265$, $p < 0.01$) indicates that enjoyment and satisfaction derived from using MaaS significantly influence adoption decisions, highlighting the importance of user experience design. Privacy Concerns ($\beta = 0.152$, $p < 0.05$) showed a counterintuitively positive influence, suggesting that acknowledging and addressing privacy concerns enhances rather than deters adoption intentions. Price Sensitivity ($\beta = 0.151$, $p < 0.05$) indicates that price-conscious users view MaaS as potentially cost-effective compared to existing transportation options. Perceived Risk ($\beta = 0.117$, $p < 0.05$) also demonstrated a counterintuitively positive effect, suggesting that transparent risk communication and mitigation strategies enhance user confidence.

Negative Influence: Social Influence ($\beta = -0.395$, $p < 0.05$) exhibited a significant negative relationship with adoption willingness, suggesting that social pressures may actually discourage MaaS adoption in Thai culture, possibly due to the status associated with private vehicle ownership or skepticism toward unfamiliar transportation concepts.

Non-Significant Factors: Effort Expectancy and Price Value showed no significant relationships with adoption willingness, possibly due to high digital literacy among respondents and the hypothetical nature of MaaS pricing in Thailand.

5.1.3 Addressing Research Objective 3: User Profiles and Implementation Strategies

Research Objective 3: To develop user profiles and adoption patterns that can inform stakeholder strategies for effectively implementing MaaS systems within Thailand's transportation network.

Research Question 3: What traveler characteristics and influence factors should stakeholders prioritize when planning and operating future MaaS deployments in Thailand?

The moderating effects analysis revealed distinct user profiles requiring differentiated implementation strategies:

Age-Based Profiles: Older Users (>36 years) prioritize facilitating conditions ($\beta = 0.310$, $p < 0.01$) and show strong hedonic motivation effects ($\beta = 0.444$, $p < 0.001$). They require comprehensive support systems and should be targeted with messaging emphasizing enjoyment and ease of support. Young Adults (21-35 years) show significant habit effects ($\beta = 0.624$, $p < 0.01$) and price sensitivity ($\beta = 0.193$, $p < 0.01$), suggesting they value familiar interfaces and cost-effectiveness.

Gender-Based Profiles: Female Users demonstrate stronger relationships between effort expectancy and willingness ($z = -2.124$, $p < 0.01$), indicating that ease of use is more critical for women. They also show significant effects for performance expectancy ($\beta = 0.539$, $p < 0.01$) and hedonic motivation ($\beta = 0.307$, $p < 0.001$). Male Users show stronger privacy concerns effects ($\beta = 0.517$, $p < 0.001$), suggesting they require more robust privacy assurances.

Geographic Profiles: Rural Residents show stronger effects of facilitating conditions on usage behavior ($\beta = 0.256$, $p < 0.001$ vs. suburban $\beta = 0.203$, $p < 0.05$), indicating greater need for infrastructure support and potentially offline capabilities. Urban/Suburban Residents show more balanced factor influences, allowing for standard implementation approaches.

Vehicle Ownership Profiles: Vehicle Owners require stronger hedonic motivation ($\beta = 0.271$, $p < 0.01$) and habit formation ($\beta = 0.267$, $p < 0.01$) to overcome the opportunity costs of existing transportation solutions. Non-Vehicle Owners show stronger willingness-to-usage behavior relationships ($\beta = 0.618$, $p < 0.001$), indicating more straightforward adoption pathways.

5.2 Theoretical Contributions and Knowledge Gap Addressing

This research contributes to the growing body of knowledge on MaaS adoption in several significant ways, addressing key gaps in the existing literature. The study successfully extended the UTAUT2 model by incorporating three additional constructs: privacy concerns, perceived risk, and price sensitivity, specifically relevant to transportation technology adoption. This extension enhanced the model's explanatory power and provided a more comprehensive understanding of MaaS adoption factors in emerging markets. The positive relationships found for privacy concerns and perceived risk challenge traditional assumptions about these factors as adoption barriers, contributing new theoretical insights to technology acceptance research.

The research revealed culturally specific findings, particularly the negative effect of social influence on MaaS adoption intentions. This finding contrasts with most Western studies and highlights the importance of cultural context in technology adoption research. The negative social influence may reflect Thai cultural associations between transportation choices and social status, where private vehicle ownership represents achievement and success. By focusing on Thailand as a representative emerging market, this study addresses the gap in MaaS research that has predominantly focused on developed countries, providing valuable insights for other Southeast Asian countries with similar cultural and economic contexts.

The research approached MaaS from a passenger logistics perspective, viewing mobility as an integrated supply chain of passenger movement. This approach adds a new theoretical lens to transportation research, bridging logistics management principles with technology acceptance theory. This perspective emphasizes the importance of viewing the entire passenger journey as an integrated system rather than separate transportation modes, contributing to the evolution of transportation theory from mode-specific to system-wide thinking.

5.3 Practical Implications and Policy Recommendations

The research findings provide actionable insights for multiple stakeholder groups involved in MaaS implementation. For MaaS service providers, the strong influence of performance expectancy suggests that platforms should prioritize real-time information systems with high accuracy, seamless integration between transportation modes, unified payment systems reducing transaction friction, door-to-door journey planning capabilities, and clear demonstration of time and cost savings compared to existing options.

The significant hedonic motivation effects indicate the importance of incorporating gamification elements to increase engagement, personalized recommendations based on travel patterns, social features that enhance the travel experience, reward systems for regular usage, and aesthetic and intuitive interface design. Service providers should also consider demographic-specific features, with female users requiring prioritized intuitive interfaces and comprehensive help systems, older users needing robust customer support and training programs, rural users benefiting from offline capabilities and alternative payment methods, and vehicle owners requiring emphasis on unique benefits not available through private vehicle ownership.

For government and policymakers, the significant role of facilitating conditions, particularly for rural residents, suggests the need to prioritize digital infrastructure development in rural areas, ensure reliable mobile network coverage across all regions, develop standardized APIs for transportation service integration, and create supportive regulatory frameworks for data sharing between providers. Given the positive influence of privacy concerns and perceived risk, policymakers should establish comprehensive data protection regulations specific to mobility services, mandate transparent privacy policies and user consent mechanisms, create certification programs for MaaS security standards, and develop clear guidelines for cross-border data sharing in integrated mobility systems. To address the negative social influence findings, governments should launch public awareness campaigns highlighting MaaS benefits, partner with influential community leaders and organizations, develop demonstration projects in high-visibility locations, and create incentive programs that make MaaS adoption socially attractive.

Transportation planners should focus on integrated network design by designing transfer points to minimize friction between modes, implementing dynamic routing algorithms that optimize entire journeys, developing contingency plans for service disruptions across the network, and creating performance metrics that measure end-to-end journey quality. The positive price sensitivity effects suggest implementing flexible pricing models combining subscription and pay-per-use options, developing targeted pricing for different demographic segments, creating transparent cost comparisons with private vehicle ownership, and considering subsidization programs for lower-income users.

5.4 Implementation Roadmap

Based on the research findings, a phased implementation approach is recommended to maximize the likelihood of successful MaaS deployment in Thailand. The foundation building phase should span the first twelve months and focus on establishing regulatory framework and data governance policies, developing core digital infrastructure and integration platforms, launching pilot projects in urban areas with high digital literacy, and beginning public awareness campaigns addressing social influence barriers.

The service launch and expansion phase, covering months twelve through twenty-four, should involve deploying MaaS services in major urban centers, implementing demographic-specific features based on identified user profiles, establishing performance monitoring and continuous improvement systems, and expanding infrastructure to suburban areas. The nationwide scaling phase, spanning months twenty-four through thirty-six, should extend services to rural areas with appropriate infrastructure support, develop specialized services for different user segments, implement advanced features based on usage data and feedback, and establish international connectivity for regional travel integration.

5.5 Research Limitations and Future Directions

5.5.1 Research Limitations

Several important limitations should be acknowledged when interpreting these findings, as they may affect the generalizability and applicability of the results to broader populations and contexts.

Methodological and Sampling Limitations: The online questionnaire methodology employed in this study inherently excluded populations with limited internet access or low digital literacy, particularly affecting representation from rural areas and lower socioeconomic groups. This limitation is compounded by the sample characteristics, where 65.1% of respondents held bachelor’s degrees and 82.1% had monthly incomes above the poverty line, creating an educated and relatively affluent sample that may not reflect the diversity of Thailand’s entire population. The overrepresentation of digitally literate and educated respondents may have positively biased attitudes toward technological solutions like MaaS, potentially overestimating adoption intentions across the general population.

The cross-sectional nature of the study design represents another significant limitation, as it captures perceptions and intentions at a single point in time without allowing for conclusions about long-term behavioral changes or the stability of adoption factors over time. This temporal limitation is particularly relevant given that technology adoption is often a dynamic process influenced by evolving market conditions, technological improvements, and changing social norms.

Contextual and Temporal Limitations: Data collection occurred during the early stages of MaaS implementation in Thailand, when public awareness remained limited and actual services were largely hypothetical. This timing may have affected respondents' perceptions and created challenges in evaluating realistic adoption scenarios. The study captured behavioral intentions rather than actual behavior, creating potential intention-behavior gaps that are common in technology adoption research. While the strong relationship between willingness to use and usage behavior ($\beta = 0.656$) suggests good predictive validity, actual adoption rates may differ from stated intentions when real services become available.

Cultural and economic factors specific to Thailand may limit the generalizability of findings to other emerging markets, despite similar developmental stages. The unique aspects of Thai transportation culture, including the status associations with private vehicle ownership and specific mobility patterns, may not directly translate to other Southeast Asian contexts.

Theoretical and Analytical Limitations: From a theoretical perspective, while the extended UTAUT2 model demonstrated strong explanatory power, other potentially relevant factors were not included in the analysis. Environmental consciousness, government policy support, technological readiness, and infrastructure quality may significantly influence MaaS adoption but were not systematically examined. The study focused primarily on individual-level factors without thoroughly examining organizational, institutional, or systemic influences that may affect adoption patterns at the societal level.

The study's reliance on self-reported data introduces potential social desirability bias, where respondents may have provided answers they perceived as socially acceptable rather than reflecting their true preferences. Additionally, the hypothetical nature of many MaaS-related questions may have led to responses based on incomplete understanding or unrealistic expectations about service characteristics.

5.5.2 Future Research Directions

Based on the limitations identified and the insights gained from this study, several promising directions for future research emerge that could significantly advance understanding of MaaS adoption in emerging markets.

Longitudinal and Implementation Studies: Future research should prioritize longitudinal studies that track how adoption factors evolve as MaaS services become more established in Thailand. Such studies would provide invaluable insights into the dynamic nature of technology adoption, including changes in the relative importance of different factors over time, the development of actual usage behaviors as services mature, and the evolution of social influence effects as MaaS becomes more familiar to the general population. Post-implementation studies examining real-world usage patterns after MaaS services are launched would help validate the predictive power of intention-based models and identify factors that influence the translation of intentions into actual behaviors.

Enhanced Sampling and Demographic Representation: To address the sampling limitations identified in this study, future research should employ more comprehensive sampling strategies that ensure adequate representation from rural areas, lower-income populations, and groups with limited digital literacy. Mixed-method approaches combining online surveys with face-to-face interviews in underserved areas could provide more inclusive insights. Stratified sampling techniques ensuring proportional representation across different socioeconomic groups would enhance the generalizability of findings to Thailand’s diverse population.

Comparative and Regional Studies: Conducting similar studies across other Southeast Asian countries would help identify regional variations in adoption factors, cultural similarities and differences affecting MaaS acceptance, and opportunities for regional integration of MaaS services. Such comparative research could reveal whether the culturally specific findings identified in Thailand, particularly the negative social influence effects, are consistent across similar contexts or represent unique cultural phenomena.

Impact Assessment and Evaluation Research: Future studies should examine the environmental and economic impacts of MaaS implementation, providing evidence for policy decisions and investment strategies. Research analyzing the actual effects of MaaS on travel behavior, modal shift patterns, environmental outcomes, and economic benefits would complement adoption studies by demonstrating real-world impacts. Cost-benefit analyses examining the economic viability of different MaaS implementation strategies would provide valuable guidance for policymakers and service providers.

Advanced Analytical and Methodological Approaches: Future research could employ more sophisticated analytical techniques, including advanced spatial analysis to better understand geographic variations in adoption patterns, network analysis to examine social influence mechanisms more deeply, and machine learning approaches to identify complex interaction effects between demographic, behavioral, and contextual factors. Mixed-method approaches combining quantitative analysis with qualitative insights through interviews and focus groups could provide richer understanding of the underlying reasons for adoption decisions.

Policy and Implementation Research: Research focusing on the policy and regulatory aspects of MaaS implementation would provide crucial insights for successful deployment. Studies examining the effectiveness of different policy interventions, regulatory frameworks, and public-private partnership models in promoting MaaS adoption would inform evidence-based policy development. Investigation of organizational and institutional factors affecting MaaS implementation, including stakeholder coordination, data sharing protocols, and service integration challenges, would complement individual-level adoption research.

5.6 Conclusion

This research has successfully addressed its three primary objectives, providing comprehensive insights into MaaS adoption factors in Thailand. The extended UTAUT2 framework proved effective in explaining adoption intentions and usage behavior, with particularly strong contributions from performance expectancy, habit, and hedonic motivation. The study revealed important cultural nuances, particularly the negative effect of social influence, and identified distinct user profiles requiring differentiated implementation strategies. The findings contribute significantly to both theoretical understanding and practical implementation of MaaS in emerging markets. From a theoretical perspective, the research extends technology acceptance theory by incorporating transportation-specific factors and revealing cultural variations in adoption patterns. From a practical standpoint, the research provides actionable insights for service providers, policymakers, and transportation planners developing MaaS implementations.

The positive overall acceptance level toward MaaS, combined with strong explanatory power of the identified factors, suggests favorable prospects for MaaS implementation in Thailand. However, success will require careful attention to the demographic variations identified, strategic addressing of the social influence challenges, and systematic development of supporting infrastructure and policies. As urban mobility challenges continue to grow in Thailand and similar emerging markets, understanding these adoption factors becomes increasingly critical for developing sustainable transportation solutions. This research provides a foundation for evidence-based MaaS implementation strategies that can contribute to more efficient, sustainable, and user-centered urban mobility systems.

The research demonstrates that MaaS adoption in Thailand is not simply a matter of technology deployment but requires a nuanced understanding of user needs, cultural contexts, and demographic variations. By applying passenger logistics principles to transportation service design and considering the complex interplay of technological, social, and economic factors, stakeholders can develop more effective strategies for implementing integrated mobility solutions that truly serve the diverse needs of Thai commuters.

5.7 Ethical Considerations

This research was conducted following ethical standards for human participant studies. The study received approval from the Mae Fah Luang University Ethics Committee on Human Research (protocol number EC 23220-12, dated November 24, 2023), with the certificate presented in Appendix A. All participants were informed about the study’s purpose, and their participation was entirely voluntary. Data confidentiality and anonymity were strictly maintained throughout the research process, with secure data management protocols implemented to protect participants’ information.

REFERENCES

Alalwan, A. A., Dwivedi, Y. K., & Rana, N. P. (2017). Factors influencing adoption of mobile banking by Jordanian bank customers: Extending UTAUT2 with trust. *International Journal of Information Management*, *37*(3), 99–110. https://doi.org/10.1016/j.ijinfomgt.2017.01.002

Alalwan, A. A., Dwivedi, Y. K., Rana, N. P., & Algharabat, R. (2018). Examining factors influencing Jordanian customers' intentions and adoption of internet banking: Extending UTAUT2 with risk. *Journal of Retailing and Consumer Services*, *40*, 125–138. https://doi.org/10.1016/j.jretconser.2017.08.026

Alalwan, A. A., Dwivedi, Y. K., Rana, N. P., Lal, B., & Williams, M. D. (2015). Consumer adoption of internet banking in Jordan: Examining the role of hedonic motivation, habit, self-efficacy and trust. *Journal of Financial Services Marketing*, *20*(2), 145–157. https://doi.org/10.1057/FSM.2015.5

Alalwan, A. A., Dwivedi, Y. K., Rana, N. P. P., & Williams, M. D. (2016). Consumer adoption of mobile banking in Jordan: Examining the role of usefulness, ease of use, perceived risk and self-efficacy. *Journal of Enterprise Information Management*, *29*(1), 118–139. https://doi.org/10.1108/JEIM-04-2015-0035/FULL/XML

Alalwan, A. A., Rana, N. P., Dwivedi, Y. K., Lal, B., & Williams, M. D. (2015). Adoption of mobile banking in Jordan: Exploring demographic differences on customers' perceptions. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *9373*, 13–23. https://doi.org/10.1007/978-3-319-25013-7_2

Alhassan, I. B., Matthews, B., Toner, J. P., & Susilo, Y. O. (2022). Public transport users' willingness-to-pay for a multi-county and multi-operator integrated ticket: Valuation and policy implications. *Research in Transportation Business & Management*, 100836. https://doi.org/10.1016/J.RTBM.2022.100836

Alkhwaldi, A., & Kamala, M. (2017). Why do users accept innovative technologies? A critical review of models and theories of technology acceptance in the information system literature. *Journal of Multidisciplinary Engineering Science and Technology (JMEST)*, *4*(8), 2458–9403.

Alonso-González, M. J., Hoogendoorn-Lanser, S., van Oort, N., Cats, O., & Hoogendoorn, S. (2020). Drivers and barriers in adopting Mobility as a Service (MaaS) – A latent class cluster analysis of attitudes. *Transportation Research Part A: Policy and Practice*, *132*, 378–401. https://doi.org/10.1016/J.TRA.2019.11.022

Altay, B. C., & Okumuş, A. (2022). User adoption of integrated mobility technologies: The case of multimodal trip-planning apps in Turkey. *Research in Transportation Business and Management*, *43*. https://doi.org/10.1016/j.rtbm.2021.100706

Alyoussef, I. Y. (2022). Acceptance of a flipped classroom to improve university students' learning: An empirical study on the TAM model and the unified theory of acceptance and use of technology (UTAUT). *Heliyon*, *8*(12), e12529. https://doi.org/10.1016/J.HELIYON.2022.E12529

Andersson, A., Winslott Hiselius, L., & Adell, E. (2018). Promoting sustainable travel behaviour through the use of smartphone applications: A review and development of a conceptual model. *Travel Behaviour and Society*, *11*, 52–61. https://doi.org/10.1016/j.tbs.2017.12.008

Arias-Molinares, D., & García-Palomares, J. C. (2020). The Ws of MaaS: Understanding mobility as a service fromaliterature review. In *IATSS Research* (Vol. 44, Issue 3, pp. 253–263). Elsevier B.V. https://doi.org/10.1016/j.iatssr.2020.02.001

Ayanwale, M. A., & Ndlovu, M. (2024). Investigating factors of students' behavioral intentions to adopt chatbot technologies in higher education: Perspective from expanded diffusion theory of innovation. *Computers in Human Behavior Reports*, *14*, 100396. https://doi.org/10.1016/J.CHBR.2024.100396

Ayuning Budi, N. F., Adnan, H. R., Firmansyah, F., Hidayanto, A. N., Kurnia, S., & Purwandari, B. (2021). Why do people want to use location-based application for emergency situations? The extension of UTAUT perspectives. *Technology in Society*, *65*, 101480. https://doi.org/10.1016/J.TECHSOC.2020.101480

Baabdullah, A. M., Alalwan, A. A., Rana, N. P., Kizgin, H., & Patil, P. (2019). Consumer use of mobile banking (M-Banking) in Saudi Arabia: Towards an integrated model. *International Journal of Information Management*, *44*, 38–52. https://doi.org/10.1016/J.IJINFOMGT.2018.09.002

Bagozzi, R. P. (2007). The legacy of the technology acceptance model and a proposal for a paradigm shift. *Journal of the Association for Information Systems*, *8*(4), 244–254. https://doi.org/10.17705/1jais.00122

Bamberg, S., Fujii, S., Friman, M., & Gärling, T. (2011). Behaviour theory and soft transport policy measures. *Transport Policy*, *18*(1), 228–235. https://doi.org/10.1016/j.tranpol.2010.08.006

Belletti, F., & Bayen, A. M. (2017). Privacy-preserving MaaS fleet management. *Transportation Research Procedia*, *23*, 1000–1024. https://doi.org/10.1016/J.TRPRO.2017.05.055

Benbasat, I., & Barki, H. (2007). Quo vadis, TAM? *Journal of the Association for Information Systems*, *8*(4), 211–218. https://doi.org/10.17705/1jais.00126

Bhattacherjee, A. (2000). Acceptance of e-commerce services: The case of electronic brokerages. *IEEE Transactions on Systems, Man, and Cybernetics Part A:Systems and Humans.*, *30*(4), 411–420. https://doi.org/10.1109/3468.852435

Bhukya, R., & Paul, J. (2023). Social influence research in consumer behavior: What we learned and what we need to learn? – A hybrid systematic literature review. *Journal of Business Research*, *162*, 113870. https://doi.org/10.1016/J.JBUSRES.2023.113870

Bollen, K. A. (1989). *Structural Equations with Latent Variables*. Wiley. https://doi.org/10.1002/9781118619179

Brown, S. A., Venkatesh, V., Allen, J., & Hu, P. (2005). Model of Adoption of Technology in Households: A Baseline Model Test and Extension Incorporating Household Life Cycle Households: A Baseline Model Test and Extension Incorporating Household Life Cycle1. In *Source: MIS Quarterly* (Vol. 29, Issue 3).

Buehler, R., & Pucher, J. (2012). Demand for Public Transport in Germany and the USA: An Analysis of Rider Characteristics. In *Transport Reviews* (Vol. 32, Issue 5, pp. 541–567). https://doi.org/10.1080/01441647.2012.707695

Burhan, A. Z., & Sihite, J. (2023). Analysis of the effects of attitude, subjective norms, and perceived behavioral control on consumer purchase intention of natural gas for vehicle with the moderating role of price sensitivity. *International Journal of Management Science and Application*, *2*(1), 1–10. https://doi.org/10.58291/IJMSA.V2I1.110

Caiati, V., Rasouli, S., & Timmermans, H. (2020). Bundling, pricing schemes and extra features preferences for Mobility as a Service: Sequential portfolio choice experiment. *Transportation Research Part A: Policy and Practice*, *131*, 123–148. https://doi.org/10.1016/j.tra.2019.09.029

Chang, I. C., Hwang, H. G., Hung, W. F., & Li, Y. C. (2007). Physicians' acceptance of pharmacokinetics-based clinical decision support systems. *Expert Systems with Applications*, *33*(2), 296–303. https://doi.org/10.1016/j.eswa.2006.05.001

Chansuk, C., Arreeras, T., Chiangboon, C., Phonmakham, K., Chotikool, N., Buddee, … Arreeras, S. (2022). Using factor analyses to understand the post-pandemic travel behavior in domestic tourism through a questionnaire survey. *Transportation Research Interdisciplinary Perspectives*, *16*. https://doi.org/10.1016/j.trip.2022.100691

Chansuk, C., Arreeras, T., Chiangboon, C., Pumjampa, S., Chotikool, N., Phonmakham, K., Yanasoi, T., & Buddee, R. (2022). Females' Travel Intention in Post-Pandemic using Structural Modeling Analysis. *2022 International Conference on Decision Aid Sciences and Applications, DASA 2022*, 151–156. https://doi.org/10.1109/DASA54658.2022.9765081

Chorus, C. G., Molin, E. J. E., & Van Wee, B. (2006). Use and Effects of Advanced Traveller Information Services (ATIS): A review of the literature. *Transport Reviews*, *26*(2), 127–149. https://doi.org/10.1080/01441640500333677

Cocosila, M., & Turel, O. (2022). Consumer risk perceptions in mobile health services adoption: Do they matter? *E-Health Telecommunication Systems and Networks*, *11*(2), 67–84. https://doi.org/10.4236/ETSN.2022.112005

Das, S., & Datta, B. (2024). Application of UTAUT2 on Adopting Artificial Intelligence Powered Lead Management System (AI-LMS) in passenger car sales. *Technological Forecasting and Social Change*, *201*. https://doi.org/10.1016/J.TECHFORE.2024.123241

Dastjerdi, A. M., Kaplan, S., de Abreu e Silva, J., Nielsen, O. A., & Pereira, F. C. (2019). Participating in environmental loyalty program with a real-time multimodal travel app: User needs, environmental and privacy motivators. *Transportation Research Part D: Transport and Environment*, *67*, 223–243. https://doi.org/10.1016/j.trd.2018.11.013

Datson, J. (2016). *Mobility as a service: exploring the opportunity for mobility as a service in the UK*.

Davis, F. D. (1993). User acceptance of information technology: system characteristics, user perceptions and behavioral impacts. *International Journal of Man-Machine Studies*, *38*(3), 475–487. https://doi.org/10.1006/IMMS.1993.1022

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, *35*(8), 982–1003. https://doi.org/10.1287/mnsc.35.8.982

de Blanes Sebastián, M. G., Antonovica, A., & Sarmiento Guede, J. R. (2023). What are the leading factors for using Spanish peer-to-peer mobile payment platform Bizum? The applied analysis of the UTAUT2 model. *Technological Forecasting and Social Change*, *187*. https://doi.org/10.1016/J.TECHFORE.2022.122235

De Leon, M. V. (2019). Factors influencing behavioural intention to use mobile banking among retail banking clients. *Jurnal Studi Komunikasi (Indonesian Journal of Communications Studies), 3*(2). https://doi.org/10.25139/JSK.V3I2.1469

Department of Land Transport. (2021). *MOT Data Catalog*. https://datagov.mot.go.th/group/statistical

Dichabeng, P., Merat, N., & Markkula, G. (2021). Factors that influence the acceptance of future shared automated vehicles – A focus group study with United Kingdom drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, *82*, 121–140. https://doi.org/10.1016/j.trf.2021.08.009

Dwivedi, Y. K., Ismagilova, E., Hughes, D. L., Carlson, J., Filieri, R., Jacobson, J., … Wang, Y. (2021). Setting the future of digital and social media marketing research: Perspectives and research propositions. *International Journal of Information Management*, *59*, 102168. https://doi.org/10.1016/J.IJINFOMGT.2020.102168

Eriksson, L., Garvill, J., & Nordlund, A. M. (2006). Acceptability of travel demand management measures: The importance of problem awareness, personal norm, freedom, and fairness. *Journal of Environmental Psychology*, *26*(1), 15–26. https://doi.org/10.1016/j.jenvp.2006.05.003

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, 5(1), 1-4.DOI:10.11648/j.ajtas.20160501.11

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1). https://doi.org/10.2307/3151312

Gansser, O. A., & Reich, C. S. (2021). A new acceptance model for artificial intelligence with extensions to UTAUT2: An empirical study in three segments of application. *Technology in Society*, *65*. https://doi.org/10.1016/j.techsoc.2021.101535

García de Blanes Sebastián, M., Azuara Grande, A., & Sarmiento Guede, J. R. (2024). Understanding the use of travel and restaurant platforms through the UTAUT2 model. *British Food Journal*, *126*(2), 774–794. https://doi.org/10.1108/BFJ-07-2023-0636

Goldsmith, R. E. (2009). Some antecedents of price sensitivity. *Journal of Marketing Theory and Practice*. https://doi.org/10.2753/MTP1069-6679170301

Gu, W., Shirayama, M., Conte, D., Vasale, J., Batista, P. J., Claycomb, J. M., Moresco, J. J., Youngman, E. M., Keys, J., Stoltz, M. J., Chen, C. C. G., Chaves, D. A., Duan, S., Kasschau, K. D., Fahlgren, N., Yates, J. R., Mitani, S., Carrington, J. C., & Mello, C. C. (2009). Distinct argonaute-mediated 22G-RNA pathways direct genome surveillance in the C. elegans germline. *Molecular Cell*, *36*(2), 231–244. https://doi.org/10.1016/J.MOLCEL.2009.09.020

Hair, J. F., Sarstedt, M., Pieper, T. M., & Ringle, C. M. (2012). The use of partial least squares structural equation modeling in strategic management research: A review of past practices and recommendations for future applications. *Long Range Planning*, *45*, 320–340. https://doi.org/10.1016/j.lrp.2012.09.008

Han, S., Gupta, S., & Lehmann, D. R. (2001). Consumer price sensitivity and price thresholds. *Journal of Retailing*, *77*(4), 435–456. https://doi.org/10.1016/S0022-4359(01)00057-4

Hasbullah, N. A., Osman, A., Abdullah, S., Salahuddin, S. N., Ramlee, N. F., & Soha, H. M. (2016). The relationship of attitude, subjective norm and website usability on consumer intention to purchase online: An evidence of Malaysian youth. *Procedia Economics and Finance*, *35*, 493–502. https://doi.org/10.1016/S2212-5671(16)00061-7

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/S11747-014-0403-8/FIGURES/8

Hensher, D. A. (2020). Potential uptake and willingness-to-pay for mobility as a service. In *Bus Transport* (pp. 427–445). Elsevier. https://doi.org/10.1016/B978-0-12-820132-9.00032-7

Hewitt, C., Politis, I., Amanatidis, T., & Sarkar, A. (2019). Assessing public perception of self-driving cars. *Proceedings of the 24th International Conference on Intelligent User Interfaces*, *Part F147615*, 518–527. https://doi.org/10.1145/3301275.3302268

Ho, C. Q., Hensher, D. A., Mulley, C., & Wong, Y. Z. (2018). Potential uptake and willingness-to-pay for Mobility as a Service (MaaS): A stated choice study. *Transportation Research Part A: Policy and Practice*, *117*, 302–318. https://doi.org/10.1016/J.TRA.2018.08.025

Hough, G., & Hassanien, A. (2010). Transport choice behaviour of Chinese and Australian tourists in Scotland. *Research in Transportation Economics*, *26*(1), 54–65. https://doi.org/10.1016/j.retrec.2009.10.008

Huang, C.-Y., & Kao, Y.-S. (2015). UTAUT2 based predictions of factors Influencing the technology acceptance of phablets by DNP. *Mathematical Problems in Engineering*, *2015*, 1–23. https://doi.org/10.1155/2015/603747

Huang, S. (2022). Listening to users' personal privacy concerns. The implication of trust and privacy concerns on the user's adoption of a MaaS-pilot. *Case Studies on Transport Policy*, *10*(4), 2153–2164. https://doi.org/10.1016/j.cstp.2022.09.012

Jain, T., Johnson, M., & Rose, G. (2020). Exploring the process of travel behaviour change and mobility trajectories associated with car share adoption. *Travel Behaviour and Society*, *18*, 117–131. https://doi.org/10.1016/j.tbs.2019.10.006

Jittrapirom, P., Caiati, V., Feneri, A. M., Ebrahimigharehbaghi, S., Alonso-González, M. J., & Narayan, J. (2017). Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges. *Urban Planning*, *2*(2), 13–25. https://doi.org/10.17645/up.v2i2.931

Jittrapirom, P., Caiati, V., Feneri, A.-M., Ebrahimigharehbaghi, S., González, M. J. A., & Narayan, J. (2017). Mobility as a Service: A critical review of definitions, assessments of schemes, and key challenges. *Urban Planning*, *2*(2), 13–25. https://doi.org/10.17645/up.v2i2.931

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

Jöreskog, K. G., & Sörbom, D. (1982). Recent Developments in Structural Equation Modeling. *Journal of Marketing Research*, *19*(4), 404–416. https://doi.org/10.1177/002224378201900402

Kaiser, H. F., & Rice, J. (1974). Little Jiffy, Mark Iv. *Educational and Psychological Measurement*, *34*(1), 111–117. https://doi.org/10.1177/001316447403400115

Kamargianni, M., Li, W., Matyas, M., & Schäfer, A. (2016). A Critical Review of New Mobility Services for Urban Transport. *Transportation Research Procedia*, *14*, 3294–3303. https://doi.org/10.1016/J.TRPRO.2016.05.277

Kapser, S., & Abdelrahman, M. (2020). Acceptance of autonomous delivery vehicles for last-mile delivery in Germany – Extending UTAUT2 with risk perceptions. *Transportation Research Part C: Emerging Technologies*, *111*, 210–225. https://doi.org/10.1016/j.trc.2019.12.016

Khaimook, S., Yoh, K., Inoi, H., & Doi, K. (2019). Mobility as a service for road traffic safety in a high use of motorcycle environment. *IATSS Research*, *43*(4), 235–241. https://doi.org/10.1016/J.IATSSR.2019.10.002

Khan, H. H., Khan, S., & Ghafoor, A. (2023). Fintech adoption, the regulatory environment and bank stability: An empirical investigation from GCC economies. *Borsa Istanbul Review*, *23*(6), 1263–1281. https://doi.org/10.1016/J.BIR.2023.10.010

Khan, I. U., Hameed, Z., & Khan, S. U. (2017). Understanding online banking adoption in a developing country: UTAUT2 with cultural moderators. *Journal of Global Information Management*, *25*(1), 43–65. https://doi.org/10.4018/JGIM.2017010103

Kii, M., Goda, Y., Vichiensan, V., Miyazaki, H., & Moeckel, R. (2021). Assessment of spatiotemporal peak shift of intra-urban transportation taking a case in bangkok, thailand. *Sustainability (Switzerland)*, *13*(12). https://doi.org/10.3390/su13126777

Kim, E. J., Kim, Y., Jang, S., & Kim, D. K. (2021). Tourists' preference on the combination of travel modes under Mobility-as-a-Service environment. *Transportation Research Part A: Policy and Practice*, *150*, 236–255. https://doi.org/10.1016/J.TRA.2021.06.016

Kim, H. W., Chan, H. C., & Gupta, S. (2007). Value-based Adoption of Mobile Internet: An empirical investigation. *Decision Support Systems*, *43*(1), 111–126. https://doi.org/10.1016/j.dss.2005.05.009

Kim, S. S., & Malhotra, N. K. (2005). A longitudinal model of continued IS use: An integrative view of four mechanisms underlying postadoption phenomena. *Management Science*, *51*(5), 741–755. https://doi.org/10.1287/mnsc.1040.0326

Kim, S. S., Malhotra, N. K., & Narasimhan, S. (2005). Two competing perspectives on automatic use: A theoretical and empirical comparison. *Information Systems Research*, *16*(4), 418–432. https://doi.org/10.1287/isre.1050.0070

Kong, Q., Lu, R., Yin, F., & Cui, S. (2021). Blockchain-based privacy-preserving driver monitoring for MaaS in the vehicular IoT. *IEEE Transactions on Vehicular Technology*, *70*(4), 3788–3799. https://doi.org/10.1109/TVT.2021.3064834

Korkmaz, H., Fidanoglu, A., Ozcelik, S., & Okumus, A. (2021). User acceptance of autonomous public transport systems: Extended UTAUT2 model. *Journal of Public Transportation*, *23*(1). https://doi.org/10.5038/2375-0901.23.1.5

Kun, A. L., Boyle, L., Reimer, B., Riener, A., SIGCHI (Group : U.S.), Association for Computing Machinery, & ACM Digital Library. (n.d.). *AutomotiveUI 2012 : 4th International Conference on Automotive User Interfaces and Interactive Vehicular Applications : October 17--19, 2012, Portsmouth, New Hampshire, US : proceedings*.

Lee, H. J., & Joh, C. H. (2010). Comportement des touristes à Séoul: Analyse de la séquenced'activités touristiques en utilisant des alignements séquentiels multi dimensionnels. *Tourism Geographies*, *12*(4), 487–504. https://doi.org/10.1080/14616688.2010.516399

Le-Klähn, D. T., Roosen, J., Gerike, R., & Hall, C. M. (2015). Factors affecting tourists' public transport use and areas visited at destinations. *Tourism Geographies*, *17*(5), 738–757. https://doi.org/10.1080/14616688.2015.1084527

Li, X., Lai, P. L., Yang, C. C., & Yuen, K. F. (2021). Determinants of blockchain adoption in the aviation industry: Empirical evidence from Korea. *Journal of Air Transport Management*, *97*. https://doi.org/10.1016/j.jairtraman.2021.102139

Li, Y., & Voege, T. (2017). Mobility as a Service (MaaS): Challenges of implementation and policy required. *Journal of Transportation Technologies*, *07*(02), 95–106. https://doi.org/10.4236/jtts.2017.72007

Limayem, M., Hirt, S. G., & Cheung, C. M. K. (2007). How habit limits the predictive power of intention: The case of information systems continuance. *MIS Quarterly: Management Information Systems*, *31*(4), 705–737. https://doi.org/10.2307/25148817

Lopez-Carreiro, I., Monzon, A., Lois, D., & Lopez-Lambas, M. E. (2021). Are travellers willing to adopt MaaS? Exploring attitudinal and personality factors in the case of Madrid, Spain. *Travel Behaviour and Society*, *25*, 246–261. https://doi.org/10.1016/J.TBS.2021.07.011

Lopez-Carreiro, I., Monzon, A., Lopez, E., & Lopez-Lambas, M. E. (2020). Urban mobility in the digital era: An exploration of travellers' expectations of MaaS mobile-technologies. *Technology in Society*, *63*, 101392. https://doi.org/10.1016/J.TECHSOC.2020.101392

Lopez-Carreiro, I., Monzon, A., & Lopez-Lambas, M. E. (2021). Comparison of the willingness to adopt MaaS in Madrid (Spain) and Randstad (The Netherlands) metropolitan areas. *Transportation Research Part A: Policy and Practice*, *152*, 275–294. https://doi.org/10.1016/J.TRA.2021.08.015

Low, W. S., Lee, J. Da, & Cheng, S. M. (2013). The link between customer satisfaction and price sensitivity: An investigation of retailing industry in Taiwan. *Journal of Retailing and Consumer Services*, *20*(1), 1–10. https://doi.org/10.1016/J.JRETCONSER.2012.06.011

Lyons, G. (2006). The role of information in decision-making with regard to travel. *IEE Proceedings: Intelligent Transport Systems*, *153*(3). https://doi.org/10.1049/ip-its:20060001

Lyons, G., Avineri, E., & Farag, S. (2008). *Assessing the demand for travel information: Do we really want to know?* https://www.researchgate.net/publication/267998034

Lyons, G., Hammond, P., & Mackay, K. (2019). The importance of user perspective in the evolution of MaaS. *Transportation Research Part A: Policy and Practice*, *121*, 22–36. https://doi.org/10.1016/j.tra.2018.12.010

Matyas, M., & Kamargianni, M. (2019). The potential of Mobility as a Service bundles as a mobility management tool. *Transportation*, *46*(5), 1951–1968. https://doi.org/10.1007/s11116-018-9913-4

Merhi, M., Hone, K., & Tarhini, A. (2019). A cross-cultural study of the intention to use mobile banking between Lebanese and British consumers: Extending UTAUT2 with security, privacy and trust. *Technology in Society*, *59*, 101151. https://doi.org/10.1016/J.TECHSOC.2019.101151

Monzon, A., Hernandez, S., & Cascajo, R. (2013). Quality of bus services performance: Benefits of real time passenger information systems. *Transport and Telecommunication*, *14*(2), 155–166. https://doi.org/10.2478/ttj-2013-0013

Narupiti, S. (2019). Exploring the possibility of MaaS service in Thailand, implications from the existing conditions and experts' opinions on "Who should be the MaaS provider in Bangkok?" *Journal of the International Association of Traffic and Safety Sciences*, *43*(4), 226–234. https://doi.org/10.1016/j.iatssr.2019.11.003

Natarajan, T., Balasubramanian, S. A., & Kasilingam, D. L. (2017). Understanding the intention to use mobile shopping applications and its influence on price sensitivity. *Journal of Retailing and Consumer Services*, *37*, 8–22. https://doi.org/10.1016/J.JRETCONSER.2017.02.010

Neufeld, D. J., Dong, L., & Higgins, C. (2007). Charismatic leadership and user acceptance of information technology. *European Journal of Information Systems*, *16*(4), 494–510. https://doi.org/10.1057/palgrave.ejis.3000682

Nikolopoulou, K., Gialamas, V., & Lavidas, K. (2021). Habit, hedonic motivation, performance expectancy and technological pedagogical knowledge affect teachers' intention to use mobile internet. *Computers and Education Open*, *2*. https://doi.org/10.1016/j.caeo.2021.100041

Öztaş Karlı, R. G., Karlı, H., & Çelikyay, H. S. (2022). Investigating the acceptance of shared e-scooters: Empirical evidence from Turkey. *Case Studies on Transport Policy*, *10*(2), 1058–1068. https://doi.org/10.1016/j.cstp.2022.03.018

Pai, J. Te, & Pai, S. Y. (2015). User behaviour analysis of the public bike system in Taipei. *International Review for Spatial Planning and Sustainable Development*, *3*(2), 39–52. https://doi.org/10.14246/irspsd.3.2_39

Polydoropoulou, A., Pagoni, I., & Tsirimpa, A. (2020). Ready for Mobility as a Service? Insights from stakeholders and end-users. *Travel Behaviour and Society*, *21*, 295–306. https://doi.org/10.1016/J.TBS.2018.11.003

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*(3), 879–891. https://doi.org/10.3758/BRM.40.3.879

Ratanavaraha, V., & Jomnonkwao, S. (2015). Trends in Thailand CO2 emissions in the transportation sector and Policy Mitigation. *Transport Policy*, *41*, 136–146. https://doi.org/10.1016/J.TRANPOL.2015.01.007

Riquelme, H. E., & Rios, R. E. (2010). The moderating effect of gender in the adoption of mobile banking. *International Journal of Bank Marketing*, *28*(5), 328–341. https://doi.org/10.1108/02652321011064872

Rodríguez-Espíndola, O., Chowdhury, S., Dey, P. K., Albores, P., & Emrouznejad, A. (2022). Analysis of the adoption of emergent technologies for risk management in the era of digital manufacturing. *Technological Forecasting and Social Change*, *178*. https://doi.org/10.1016/j.techfore.2022.121562

Rowe, N. C. (2016). Privacy concerns with digital forensics. *Ethical Issues and Citizen Rights in the Era of Digital Government Surveillance*, 145–162. https://doi.org/10.4018/978-1-4666-9905-2.CH008

Sakai, K. (2020). Public transport promotion and mobility-as-a-service. *IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences*, *E103A*(1), 226–230. https://doi.org/10.1587/transfun.2019TSI0001

Saxena, S. (2018). Role of "perceived risks" in adopting mobile government (m-government) services in India. *Foresight*, *20*(2), 190–205. https://doi.org/10.1108/FS-08-2017-0040

Schikofsky, J., Dannewald, T., & Kowald, M. (2020). Exploring motivational mechanisms behind the intention to adopt Mobility as a Service (MaaS): Insights from Germany. *Transportation Research Part A: Policy and Practice*, *131*, 296–312. https://doi.org/10.1016/j.tra.2019.09.022

Stiegemeier, D., Bringeland, S., Kraus, J., & Baumann, M. (2022). "Do I really need it?": An explorative study of acceptance and usage of in-vehicle technology. *Transportation Research Part F: Traffic Psychology and Behaviour*, *84*, 65–82. https://doi.org/10.1016/j.trf.2021.11.011

Terborg, J. R. (1981). Interactional Psychology and Research on Human Behavior in Organizations. *The Academy of Management Review*, *6*(4), 569–576. https://doi.org/10.5465/amr.1981.4285694

Tian, Y., & Wang, X. (2022). A study on psychological determinants of users' autonomous vehicles adoption from anthropomorphism and UTAUT perspectives. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.986800

Tsai, H. S., & LaRose, R. (2015). Broadband internet adoption and utilization in the inner city: A comparison of competing theories. *Computers in Human Behavior*, *51*, 344–355. https://doi.org/10.1016/j.chb.2015.04.022

Tsouros, I., Tsirimpa, A., Pagoni, I., & Polydoropoulou, A. (2021). MaaS users: Who they are and how much they are willing-to-pay. *Transportation Research Part A: Policy and Practice*, *148*, 470–480. https://doi.org/10.1016/J.TRA.2021.04.016

Tucker, L. R., & Lewis, C. (1973). A Reliability Coefficient for Maximum Likelihood Factor Analysis. *Psychometrika*, *38*(1), 1–10. https://doi.org/10.1007/BF02291170

Van Der Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly*, *28*(4), 695–704. https://doi.org/10.2307/25148660

Van, H. T., & Fujii, S. (2011). A cross Asian country analysis in attitudes toward car and public transport. *Journal of the Eastern Asia Society for Transportation Studies*, *9*, 411–421. https://doi.org/10.11175/easts.9.411

Van Middelkoop, M., Borgers, A., & Timmermans, H. (2003). Inducing heuristic principles of tourist choice of travel mode: A rule-based approach. *Journal of Travel Research*, *42*(1), 75–83. https://doi.org/10.1177/0047287503254116

Venkatesh, V., Davis, F. D., & Morris, M. G. (2007). Dead or alive? The development, trajectory and future of technology adoption research. *Journal of the Association for Information Systems*, *8*(4), 267–286. https://doi.org/10.17705/1jais.00120

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27*(3), 425–478. https://doi.org/10.2307/30036540

Venkatesh, V., Walton, S. M., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly*, *36*(1), 157–178. http://ssrn.com/abstract=2002388

Ye, J., Zheng, J., & Yi, F. (2020). A study on users' willingness to accept Mobility as a Service based on UTAUT model. *Technological Forecasting and Social Change*, *157*. https://doi.org/10.1016/j.techfore.2020.120066

Yein, N., & Pal, S. (2021). Analysis of the user acceptance of exergaming (fall-preventive measure) – Tailored for Indian elderly using unified theory of acceptance and use of technology (UTAUT2) model. *Entertainment Computing*, *38*. https://doi.org/10.1016/j.entcom.2021.100419

Yi, M. Y., Jackson, J. D., Park, J. S., & Probst, J. C. (2006). Understanding information technology acceptance by individual professionals: Toward an integrative view. *Information and Management*, *43*(3), 350–363. https://doi.org/10.1016/j.im.2005.08.006

Zhou, M., Long, P., Kong, N., Zhao, L., Jia, F., & Campy, K. S. (2021). Characterizing the motivational mechanism behind taxi driver's adoption of electric vehicles for living: Insights from China. *Transportation Research Part A: Policy and Practice*, *144*, 134–152. https://doi.org/10.1016/j.tra.2021.01.001

Zhou, T., Lu, Y., & Wang, B. (2010). Integrating TTF and UTAUT to explain mobile banking user adoption. *Computers in Human Behavior*, *26*(4), 760–767. https://doi.org/10.1016/J.CHB.2010.01.013

Zijlstra, T., Durand, A., Hoogendoorn-Lanser, S., & Harms, L. (2020). Early adopters of Mobility-as-a-Service in the Netherlands. *Transport Policy*, *97*, 197–209. https://doi.org/10.1016/j.tranpol.2020.07.019

APPENDIX A

CERTIFICATE OF EXAMPTION

บันทึกข้อความ

หน่วยงาน ส่วนบริหารงานวิจัย สถาบันวิจัยและนวัตกรรมมหาวิทยาลัยแม่ฟ้าหลวง โทรศัพท์ ๗๑๗๑ (ศิรินทร์ทิพย์)

ที่ อว ๗๗๐๖/๓๙๖๓ **วันที่** ๒๙ พฤศจิกายน ๒๕๖๖

เรื่อง แจ้งผลพิจารณาโครงการวิจัยที่ขอรับรองจริยธรรมการวิจัยในมนุษย์ EC 23220-12

เรียน นางสาวสุชาดา พลสิทธางกูร

ตามที่ ท่านได้ส่งโครงการวิจัย เรื่อง การศึกษาความเต็มใจของผู้ที่เดินทางสาธารณะในการนำแนวคิด Mobility as a Service (MaaS) มาใช้เป็นแอปพลิเคชันบริการในประเทศไทย (A study on public commuter's Willingness to adopt Mobility as a Service application: An evidence from Thailand.) รหัส EC 23220-12 เพื่อขอรับการพิจารณาจริยธรรมการวิจัยในมนุษย์จากคณะกรรมการจริยธรรมการวิจัย ในมนุษย์มหาวิทยาลัยแม่ฟ้าหลวง เมื่อวันที่ ๒๔ พฤศจิกายน ๒๕๖๖ นั้น

บัดนี้ คณะกรรมการจริยธรรมการวิจัยในมนุษย์ ได้พิจารณาโครงร่างการวิจัยดังกล่าวเป็นที่เรียบร้อยแล้ว ซึ่งเป็นโครงการวิจัยประเภท Exemption ทั้งนี้ ผู้วิจัย/ผู้ประสานงานโครงการวิจัย สามารถติดต่อรับหนังสือยกเว้นการพิจารณาด้านจริยธรรมการวิจัยหรือท่านสามารถติดต่อสอบถาม หรือขอคำปรึกษาได้จากผู้ประสานงาน นางสาวศิรินทร์ทิพย์ อรินต๊ะทราย สำนักงานคณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง อาคารบริการวิชาการ (AS) ชั้น ๔ หมายเลขโทรศัพท์ ๐๕๓ ๙๑๗-๑๗๑

จึงเรียนมาเพื่อโปรดดำเนินการ

(ผู้ช่วยศาสตราจารย์ ดร.ศิวาภรณ์ ศิวะศิลป์ประศาสน์)
กรรมการและเลขานุการจริยธรรมการวิจัยในมนุษย์
มหาวิทยาลัยแม่ฟ้าหลวง

The Mae Fah Luang University Ethics Committee on Human Research
333 Moo 1, Thasud, Muang, ChiangRai 57100
Tel: (053) 917-170 to 71 Fax: (053) 917-170 E-mail: rec.human@mfu.ac.th

หนังสือยกเว้นการพิจารณาด้านจริยธรรมการวิจัย

COE: 235/2023 **รหัสโครงการวิจัย:** EC 23220-12

ชื่อโครงการวิจัย : การศึกษาความเต็มใจของผู้ที่เดินทางสาธารณะในการนำแนวคิด Mobility as a Service (MaaS) มาใช้เป็นแอปพลิเคชันบริการในประเทศไทย

ชื่อผู้วิจัยหลัก: นางสาวสุชาดา พลสิทธางกูร

สำนักวิชา: การจัดการ

คณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง พิจารณาโครงร่างการวิจัย โดยยึด แนวทางจริยธรรมสากล ได้แก่ ปฏิญญาเฮลซิงกิ (Declaration of Helsinki) รายงานเบลมองต์ (Belmont Report) แนวทางจริยธรรมสากลสำหรับการวิจัยในมนุษย์ของสภาองค์การสากลด้านวิทยาศาสตร์การแพทย์ (CIOMS) และแนวทางการปฏิบัติการวิจัยที่ดี (ICH GCP) ได้พิจารณาแล้วเห็นว่า โครงการวิจัยดังกล่าวข้างต้น เข้าข่ายยกเว้นการพิจารณาด้านจริยธรรมการวิจัย

วันที่รับรองยกเว้นการพิจารณาด้านจริยธรรมการวิจัย: 27 พฤศจิกายน 2566

ลงนาม ....(signature)..........

(รองศาสตราจารย์ พลตรีหญิง แพทย์หญิง แสงแข ชำนาญวนกิจ)

ประธานคณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง

ผู้วิจัยที่โครงร่างการวิจัยได้รับยกเว้นการพิจารณาด้านจริยธรรมการวิจัย จากคณะกรรมการจริยธรรมการวิจัยในมนุษย์ มหาวิทยาลัยแม่ฟ้าหลวง ต้องปฏิบัติดังต่อไปนี้

- ไม่ต้องส่งรายงานความก้าวหน้าของการวิจัย
- ในกรณีที่มีการเปลี่ยนแปลงโครงการวิจัย ส่งแบบรายงานการแก้ไขเพิ่มเติมโครงร่างการวิจัย (AP 06/2022) และโครงร่างการวิจัยที่มีการแก้ไขเพิ่มเติม เพื่อแจ้งให้คณะกรรมการฯ พิจารณาก่อนดำเนินการวิจัยตามที่ต้องการเปลี่ยนแปลง
- ส่งแบบรายงานสรุปผลการวิจัย (AP 09_2022)

<u>หมายเหตุ</u> สามารถ Download แบบรายงานต่าง ๆ ได้ที่ https://ec.mfu.ac.th

ข้าพเจ้าในฐานะ ผู้วิจัย ยินยอมที่จะปฏิบัติตามข้อกำหนดดังกล่าว
..........(signature)..........
(นางสาวสุชาดา พลสิทธางกูร)
วันที่ 30 พ.ย. 2566

The Mae Fah Luang University Ethics Committee on Human Research
333 Moo 1, Thasud, Muang, ChiangRai 57100
Tel: (053) 917-170 to 71 Fax: (053) 917-170 E-mail: rec.human@mfu.ac.th

CERTIFICATE OF EXEMPTION

COE: 235/2023 Protocol No: EC 23220-12

Title: A study on public commuter's Willingness to adopt Mobility as a Service application: An evidence from Thailand.

Principal investigator: Miss Suchada Phonsitthangkun

School: Management

The Mae Fah Luang University Ethics Committee on Human Research (MFU EC) reviewed the protocol in compliance with international guidelines such as Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use - Good Clinical Practice (ICH GCP) and decided to exempt the above research protocol.

Date of Exemption: November 27, 2023

Sangkh
....
(Assoc. Prof., Maj. Gen. Sangkae Chamnanvanakij, M.D)
Chairperson of the MFU Ethics Committee on Human Research

For research protocol exempted by the Mae Fah Luang University Ethics Committee on Human Research (MFU EC), the investigators must comply with the followings:

- No need to submit a progress report.
- When there are changes of the protocol, the investigator must send an amendment report (AP 06/2022) to the MFU EC.
- When the research finishes, the investigator must send a final report (AP 09/2022).

Please go to https://ec.mfu.ac.th to download MFU EC forms for reporting.

I, as an investigator, agree to comply with the above obligation.
Suchada .... (Miss Suchada Phonsitthangkun) Date ....30 Nov. 2023....

APPENDIX B

CERTIFICATE OF ETHICAL CONSIDERATIONS

คณะกรรมการจริยธรรมการวิจัยในคน มหาวิทยาลัยธรรมศาสตร์ สาขาแพทยศาสตร์

ประกาศนียบัตรฉบับนี้ให้ไว้เพื่อแสดงว่า

สุชาดา พลสิทธางกูร

ได้ผ่านการอบรมหลักสูตร GCP online training (Computer-based)

“แนวทางการปฏิบัติการวิจัยทางคลินิกที่ดี (ICH-GCP:E6(R2))”

ประกาศนียบัตรฉบับนี้มีผลตั้งแต่วันที่ 19 มกราคม 2566 ถึงวันที่ 19 มกราคม 2568

(รองศาสตราจารย์ นายแพทย์ไวพจน์ จันทร์วิเมลือง)
ประธานคณะกรรมการจริยธรรมการวิจัยในคน
มหาวิทยาลัยธรรมศาสตร์ สาขาแพทยศาสตร์

(รองศาสตราจารย์ นายแพทย์สมบัติ มุ่งทวีพงษา)
รองคณบดีฝ่ายวิจัยและนวัตกรรม

APPENDIX C

QUESTIONNAIRE FROM GOOGLE FORM

การศึกษาความเต็มใจของผู้ที่เดินทางสาธารณะในการนำแนวคิด Mobility as a Service (MaaS) มาใช้เป็นแอปพลิเคชันบริการในประเทศไทย

Mobility as a Service หรือ MaaS เป็นแนวคิดการขนส่งที่มีจุดมุ่งหมายเพื่อให้การเดินทางของคุณง่ายขึ้นโดยการรวมรูปแบบการขนส่งต่างๆ ไว้ในบริการเดียวที่สะดวกสบาย เหมือนกับมีแอปหรือแพลตฟอร์มเดียวที่ช่วยให้คุณวางแผน จอง และชำระเงินสำหรับการเดินทางประเภทต่างๆ เช่น รถประจำทาง รถไฟ แท็กซี่ รถโดยสาร และอื่นๆ ได้ในที่เดียว แทนที่จะใช้ตั๋วหรือแอพแยกต่างหากสำหรับการขนส่งแต่ละรูปแบบ MaaS นำมารวมกันเพื่อมอบประสบการณ์การเดินทางที่ราบรื่น เหมือนกับมีผู้ช่วยส่วนตัวสำหรับความต้องการด้านการขนส่งของคุณ ทำให้การเดินทางจากที่หนึ่งไปยังอีกที่หนึ่งเป็นเรื่องง่ายและสะดวกยิ่งขึ้น

วัตถุประสงค์ แบบสอบถามนี้จัดทำขึ้นเพื่อเก็บรวบรวมข้อมูลพฤติกรรมการเดินทางและปัจจัยที่ส่งผลต่อการนำระบบใหม่มาใช้สำหรับการเดินทาง

คำชี้แจง

1. กรุณาทำเครื่องหมาย ✔ หน้าคำตอบที่ท่านต้องการลงแบบสอบถามและเติมข้อความลงในช่องว่างที่กำหนด

2. แบบสอบถามฉบับนี้ประกอบด้วย 4 ส่วน คือ

- **ส่วนที่ 1** ข้อมูลเชิงประชากรศาสตร์
- **ส่วนที่ 2** ข้อมูลเชิงพฤติกรรมการเดินทาง
- **ส่วนที่ 3** ข้อมูลด้านความตระหนักและความคาดหวัง
- **ส่วนที่ 4** ข้อมูลปัจจัยที่ส่งผลต่อการใช้ระบบใหม่สำหรับการเดินทาง (13 ปัจจัย)

3. ข้อมูลที่ได้รับจากท่านจะถูกเก็บไว้เป็นความลับ

ข้อมูลจากผู้ตอบแบบสอบถามซึ่งจะถูกเก็บไว้เป็นความลับไปวิเคราะห์และนำเสนอในภาพรวมเท่านั้น ดังนั้นการเข้าร่วมการตอบแบบสอบถามครั้งนี้จะเป็นไปตามความสมัครใจของท่าน หากท่านยินดีให้ความร่วมมือ โปรดตอบแบบสอบถามให้ครบทุกข้อและตรงความเป็นจริงมากที่สุด

* Indicates required question

1. ท่านได้ทำความเข้าใจรายละเอียดและจุดประสงค์ของการทำวิจัยนี้แล้ว โดยท่านให้ความยินยอมเข้าร่วมการทำแบบสอบถามวิจัยนี้หรือไม่ *

Mark only one oval.

- ◯ ยินยอม
- ◯ ไม่ยินยอม

ส่วนที่1 ข้อมูลเชิงประชากรศาสตร์

2. 1. เพศ *

Mark only one oval.

- ( ) เพศชาย
- ( ) เพศหญิง

3. อายุ *

Mark only one oval.

- ( ) ต่ำกว่า 21 ปี
- ( ) 21-35 ปี
- ( ) 36-50 ปี
- ( ) 51-64 ปี
- ( ) 65 ปี ขึ้นไป

4. 3. ระดับการศึกษาสูงสุดของท่าน *

Mark only one oval.

- ( ) ต่ำกว่าระดับปริญญาตรี
- ( ) ระดับปริญญาตรี
- ( ) สูงกว่าระดับปริญญาตรี

5. 4. รายได้ส่วนบุคคลต่อเดือนของท่าน *

Mark only one oval.

- ( ) น้อยกว่าหรือเท่ากับ 15,000 บาท
- ( ) 15,001-25,000 บาท
- ( ) 25,001-35,000 บาท
- ( ) 35,001-45,000 บาท
- ( ) มากกว่า 45,000 บาท

6. 5. อาชีพ *

Mark only one oval.

- พนักงาน/ราชการ
- พนักงานเอกชน
- การจ้างงานตนเอง
- เกษียณแล้ว
- พ่อบ้าน/แม่บ้าน
- นักเรียน/นักศึกษา
- ผู้ว่างงาน

7. 6. มียานพาหนะในครอบครอง *

Mark only one oval.

- มี
- ไม่มี

8. 7. สมาชิกครัวเรือนที่อาศัยอยู่ด้วยกัน ณ ปัจจุบันรวมผู้ตอบแบบสอบถาม *

Mark only one oval.

- 1 คน
- 2 คน
- 3 คน
- 4 คนหรือมากกว่าขึ้นไป

9. 8. ที่อยู่อาศัย ณ ปัจจุบัน *

Mark only one oval.

- เขตในเมือง
- เขตชานเมือง
- เขตนอกเมือง

ส่วนที่2 พฤติกรรมการเดินทาง

10. 1.คุณใช้บริการขนส่งสาธารณะบ่อยแค่ไหน?(เช่น รถโดยสารประจำทาง,รถไฟ, รถไฟฟ้า BTS ,รถไฟฟ้าใต้ดิน MRT ,รถแท็กซี่, รถตุ๊กตุ๊ก) *

Mark only one oval.

- น้อยกว่า 5 ครั้ง / สัปดาห์
- 5-10 ครั้ง / สัปดาห์
- 11-15 ครั้ง / สัปดาห์
- มากกว่า 15 ครั้ง / สัปดาห์

11. 2.คุณใช้บริการเรียกรถผ่านแอพพลิเคชั่นบ่อยแค่ไหน? (เช่น Grab, Bolt, line man เป็นต้น) *

Mark only one oval.

- น้อยกว่า 5 ครั้ง / สัปดาห์
- 5-10 ครั้ง / สัปดาห์
- 11-15 ครั้ง / สัปดาห์
- มากกว่า 15 ครั้ง / สัปดาห์

12. 3.คุณใช้รถส่วนตัวในการเดินทางบ่อยแค่ไหน? *

Mark only one oval.

- 5-10 ครั้ง / สัปดาห์
- 11-15 ครั้ง / สัปดาห์
- มากกว่า 15 ครั้ง / สัปดาห์
- ฉันไม่มียานพาหนะส่วนตัว

13. 4.วัตถุประสงค์หลักในการเดินทางครั้งล่าสุด *

Mark only one oval.

- ทำงาน
- การเรียน
- ท่องเที่ยว
- กลับบ้าน
- ธุรกิจ

14. 5.จากวัตถุประสงค์หลักในการเดินทางคุณใช้ระยะเวลาในการเดินทางโดยเฉลี่ยเท่าไหร่/ครั้ง * Dropdown

Mark only one oval.

- น้อยกว่า 15 นาที
- 15 - 30 นาที
- 30 - 45 นาที
- 45 - 60 นาที
- มากกว่า 60 นาที
- 1 วัน
- มากกว่า 1 วัน

15. 6.จากวัตถุประสงค์หลักในการเดินทางคุณมีค่าใช้จ่ายในการเดินทางโดยเฉลี่ยกี่บาท/ครั้ง * Dropdown

Mark only one oval.

- น้อยกว่าหรือเท่ากับ 50 บาท
- 50 - 100 บาท
- 100 - 150 บาท
- 150 - 200 บาท
- 200 - 250 บาท
- 250 - 300 บาท
- มากกว่า 300 บาท

16. 7. จากวัตถุประสงค์หลักในการเดินทางคุณต่อรถกี่ครั้ง *
เช่น จากบ้านไปถึงที่ทำงาน คุณเดินทางโดย รถโดยสารประจำทาง แล้วขึ้นรถไฟฟ้า เท่ากับ 2 ครั้ง

Dropdown

Mark only one oval.

- 1
- 2
- 3
- 4
- 5
- มากกว่า 5 ครั้ง

17. 8.คุณใช้ช่องทางใดบ้างสำหรับการเดินทางในชีวิตประจำวันต่อครั้ง(เลือกทั้งหมดที่ใช้ครั้งล่าสุด) *

Check all that apply.

- รถส่วนตัว (Private car)
- รถโดยสารประจำทาง (Bus)
- รถตู้โดยสาร (Public van)
- รถไฟ (Train)
- รถไฟฟ้าขนส่งมวลชน BTS MRT (Electric Train)
- รถแท็กซี่ (Taxi)
- รถตุ๊กตุ๊ก หรือ รถยนต์รับจ้างสามล้อ (Motortricycle Taxi : Tuk Tuk)
- รถจักรยานยนต์รับจ้าง (Motorcycle Taxi)
- รถสองแถว (Minibus)
- เรือข้ามฟาก (Ferry boat)
- แอพพลิเคชั่นบริการเรียกรถ (เช่น Grab, Bolt, line man เป็นต้น)
- การแชร์จักรยานหรือการแชร์สกูตเตอร์ (Bicycle sharing or Scooter sharing)
- การเดิน (walking)

ส่วนที่3 ความตระหนักและความคาดหวัง

Mobility as a Service หรือ MaaS เป็นแนวคิดการขนส่งที่มีจุดมุ่งหมายเพื่อให้การเดินทางของคุณง่ายขึ้นโดยการรวมรูปแบบการขนส่งต่างๆ ไว้ในบริการเดียวที่สะดวกสบาย เหมือนกับมีแอปหรือแพลตฟอร์มเดียวที่ช่วยให้คุณวางแผน จอง และชำระเงินสำหรับการเดินทางประเภทต่างๆ เช่น รถประจำทาง รถไฟ แท็กซี่ รถโดยสาร และอื่นๆ ได้ในที่เดียว แทนที่จะใช้ตั๋วหรือแอพแยกต่างหากสำหรับการขนส่งแต่ละรูปแบบ MaaS นำมารวมกันเพื่อมอบประสบการณ์การเดินทางที่ราบรื่น เหมือนกับมีผู้ช่วยส่วนตัวสำหรับความต้องการด้านการขนส่งของคุณ ทำให้การเดินทางจากที่หนึ่งไปยังอีกที่หนึ่งเป็นเรื่องง่ายและสะดวกยิ่งขึ้น

18. 1.คุณคุ้นเคยกับแนวคิดของ Mobility as a service (MaaS) หรือไม่? *

Mark only one oval.

- ใช่
- ไม่ใช่

19. 2.คุณรู้จักแนวคิดเกี่ยวกับ Mobility as a Service (MaaS) ได้อย่างไร (เลือกทั้งหมดที่ใช่) *

Check all that apply.

- บทความข่าว
- สื่อสังคม (Social media)
- การบอกต่อ
- โฆษณาออนไลน์
- ฉันรู้จักแนวคิด MaaS จากแบบสอบถามนี้

20. 3.โหมดการขนส่งใดที่คุณต้องการเห็นรวมอยู่ในระบบ Mobility as a Service (MaaS) (เลือกทั้งหมดที่ใช่) *

Check all that apply.

- การขนส่งสาธารณะ เช่น รถโดยสารประจำทาง, รถไฟ, รถไฟฟ้าBTS, MRT ,รถแท็กซี่ , รถตุ๊กตุ๊ก เป็นต้น
- แอพพลิเคชั่นบริการเรียกรถ เช่น Grab, Bolt, line man เป็นต้น
- การแชร์จักรยานหรือการแชร์สกู๊ตเตอร์
- การแชร์รถหรือเช่ารถ
- เส้นทางที่สะดวกและเป็นมิตรสำหรับคนเดินเท้า

21. 4.คุณลักษณะหรือบริการใดที่คุณคิดว่าสำคัญในระบบ Mobility as a Service (MaaS) (เลือกทั้งหมดที่ใช่) *

Check all that apply.

- การผสานรวมและการจองที่ไร้รอยต่อระหว่างโหมดการขนส่งต่างๆ
- ข้อมูลเรียลไทม์เกี่ยวกับตัวเลือกการขนส่ง เส้นทาง และตารางเวลา
- ระบบการชำระเงินแบบบูรณาการสำหรับทุกโหมดการขนส่ง
- โครงสร้างราคาที่คุ้มค่า
- แอพมือถือหรือแพลตฟอร์มที่ใช้งานง่าย
- ความคิดริเริ่มด้านความยั่งยืนด้านสิ่งแวดล้อม

ส่วนที่ 4 ปัจจัยที่ส่งผลต่อการนำระบบใหม่ (MaaS) มาใช้สำหรับการเดินทาง

Mobility as a Service หรือ MaaS เป็นแนวคิดการขนส่งที่มีจุดมุ่งหมายเพื่อให้การเดินทางของคุณง่ายขึ้นโดยการรวมรูปแบบการขนส่งต่างๆ ไว้ในบริการเดียวที่สะดวกสบาย เหมือนกับมีแอปหรือแพลตฟอร์มเดียวที่ช่วยให้คุณวางแผน จอง และชำระเงินสำหรับการเดินทางประเภทต่างๆ เช่น รถประจำทาง รถไฟ แท็กซี่ รถโดยสาร และอื่นๆ ได้ในที่เดียว แทนที่จะใช้ตั๋วหรือแอพแยกต่างหากสำหรับการขนส่งแต่ละรูปแบบ MaaS นำมารวมกันเพื่อมอบประสบการณ์การเดินทางที่ราบรื่น เหมือนกับมีผู้ช่วยส่วนตัวสำหรับความต้องการด้านการขนส่งของคุณ ทำให้การเดินทางจากที่หนึ่งไปยังอีกที่หนึ่งเป็นเรื่องง่ายและสะดวกยิ่งขึ้น

- ท่านมีความเห็นอย่างไรต่อข้อความดังต่อไปนี้ เรียงตามลำดับจากเห็นด้วยน้อยที่สุดไปมากที่สุด
- โดย 1=เห็นด้วยน้อยที่สุด, 2= เห็นด้วยน้อยมาก, 3= เห็นด้วยปานกลาง, 4= เห็นด้วยมาก, 5= เห็นด้วยมากที่สุด

22. **1.ปัจจัยด้านความคาดหวังในการปฏิบัติงาน** *

1.1.การใช้ระบบใหม่(MaaS)สำหรับการเดินทางจะช่วยให้ประหยัดเวลา

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

23. 1.2. การใช้ระบบใหม่(MaaS)เพื่อการเดินทางที่สะดวกยิ่งขึ้น *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

24. 1.3. การใช้ระบบใหม่(MaaS)นั้นสามารถเช็คบริการการขนส่งได้ทุกที่ทุกเวลา *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

25. 1.4. ฉันหวังว่าระบบใหม่(MaaS)นี้จะรวมกับการเดินทางที่เข้ากับวิถีชีวิตในท้องถิ่น *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

26. 1.5. ฉันหวังว่าระบบการเดินทางใหม่(MaaS)นี้จะเป็นประโยชน์ในชีวิตประจำวันของฉัน *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

2.ปัจจัยด้านความคาดหวังด้านความพยายามของผู้ใช้งานระบบใหม่

27. 2.1. การใช้ระบบใหม่(MaaS)จะเป็นเรื่องง่ายสำหรับฉันที่จะเรียนรู้ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

28. 2.2. การใช้ระบบใหม่(MaaS)จะง่ายสำหรับฉันที่จะใช้ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

29. 2.3. การใช้ระบบใหม่(MaaS)นั้นไม่ต้องใช้ความพยายามมากนัก *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

30. 2.4. ฉันสามารถยอมรับระบบใหม่(MaaS)นี้ได้ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

3.ปัจจัยด้านอิทธิพลทางสังคม

31. 3.1. ฉันยินดีใช้ถ้าทุกคนใช้ระบบใหม่(MaaS) *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

32. 3.2. ฉันยินดีที่จะใช้ระบบใหม่(MaaS)หากได้รับการสนับสนุนจากคนรอบข้างที่เคยใช้ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

33. 3.3. ฉันยินดีที่จะใช้(MaaS)หากการประเมินสื่ออยู่ในเกณฑ์ที่ดี *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

4.ปัจจัยด้านสภาพของสิ่งอำนวยความสะดวกในระบบใหม่ (MaaS)

34. 4.1. ฉันคุ้นเคยกับการทำงานของสมาร์ทโฟนและพกติดตัวไปด้วยเมื่อออกไปนอกบ้าน *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

35. 4.2. เครือข่ายมือถือในการเดินทางของฉันมีความเสถียร *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

36. 4.3. ฉันคุ้นเคยกับการชำระเงินผ่านมือถือ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

5.ปัจจัยด้านแรงจูงใจด้านความบันเทิง

37. 5.1. การใช้ระบบใหม่(MaaS)น่าจะสนุกเพราะมีความยืดหยุ่นในการเดินทาง *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

38. 5.2. การใช้ระบบใหม่(MaaS)น่าตื่นเต้น *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

39. 5.3. การใช้ระบบใหม่ (MaaS) จะทำให้ฉันพอใจ *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

40. 5.4. การใช้ระบบใหม่(MaaS)จะทำให้ฉันเพลิดเพลินกับการเดินทาง *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

6.ปัจจัยด้านมูลค่าราคา

41. 6.1. การใช้ระบบใหม่(MaaS)ควรจะมีราคาสมเหตุสมผล *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

42. 6.2. ระบบใหม่(MaaS)นี้จะคุ้มค่ากับเงินที่เสียไป *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

43. 6.3. ควรมีการสนับสนุนด้านค่าใช้จ่ายในการเดินทางจากภาครัฐ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

7.ปัจจัยด้านความอ่อนไหวต่อราคา

44. 7.1.ฉันยินดีที่จะจ่ายเงินเพิ่มเพื่อลองใช้ระบบใหม่(MaaS)เป็นตัวเลือกการเดินทาง *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

45. 7.2. ฉันยินดีที่จะจ่ายเงินจำนวนมากในการเดินทางโดยระบบใหม่(MaaS) *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

46. 7.3. ฉันไม่สนใจที่จะใช้งานถ้าระบบใหม่(MaaS) มีค่าใช้จ่ายที่สูงกว่าระบบการเดินทางเก่า *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

8.ปัจจัยด้านความเคยชิน

47. 8.1. การใช้แอพพลิเคชั่นบนสมาร์ทโฟนกลายเป็นนิสัยของฉันไปแล้ว *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

48. 8.2. ฉันคุ้นเคยกับการใช้เทคโนโลยีที่คล้ายกันกับระบบใหม่(MaaS) *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

49. 8.3. ฉันคิดว่าฉันต้องใช้ระบบใหม่(MaaS)แม้ยังไม่มีความคุ้นชิน *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

50. 8.4. การใช้ระบบใหม่(MaaS)อาจกลายเป็นเรื่องปกติสำหรับฉัน *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

9.ปัจจัยด้านความชอบเทคโนโลยี

51. 9.1. ฉันรู้สึกตื่นเต้นที่ได้ลองใช้ระบบหรือแอพพลิเคชั่นบนสมาร์ทโฟนใหม่ๆ *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

52. 9.2. แอปพลิเคชันบนสมาร์ทโฟนช่วยฉันในชีวิตประจำวันให้สะดวกขึ้น *

Mark only one oval.

	1	2	3	4	5
	◯	◯	◯	◯	◯

53. 9.3. ฉันใช้แอปพลิเคชันบนสมาร์ทโฟนเป็นประจำในการชำระเงิน การจอง ฯลฯ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

54. 9.4. ฉันชอบลองใช้แอพพลิเคชั่นบนสมาร์ทโฟนใหม่ๆอยู่เสมอ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

10.ปัจจัยด้านข้อกังวลเกี่ยวกับความเป็นส่วนตัว

55. 10.1. ฉันกังวลเกี่ยวกับความเป็นส่วนตัวของข้อมูลส่วนบุคคลของฉันเมื่อใช้ระบบใหม่(MaaS) *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

56. 10.2.ฉันกังวลเกี่ยวกับการแบ่งปันข้อมูลส่วนบุคคลลของฉันกับบริษัทบุคคลที่สามเมื่อใช้ระบบใหม่(MaaS) *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

57. 10.3. ฉันยินดีที่จะแบ่งปันโปรไฟล์,ความคิดเห็นของฉัน กับผู้ใช้คนอื่นเมื่อใช้ระบบใหม่ (MaaS) *

Mark only one oval.

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◯	◯	◯	◯	◯

58. 10.4. ฉันยินดีที่จะแบ่งปันข้อมูลส่วนตัวกับบริษัทต่างๆที่เกี่ยวข้องเมื่อใช้ระบบใหม่ (MaaS) *

Mark only one oval.

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◯	◯	◯	◯	◯

11.ปัจจัยด้านข้อกังวลเกี่ยวกับความเสี่ยง

59. 11.1. ฉันกังวลว่าความเป็นส่วนตัวจะรั่วไหล *

Mark only one oval.

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◯	◯	◯	◯	◯

60. 11.2.ฉันกังวลว่าการใช้ระบบใหม่(MaaS)นั้นจะยุ่งยาก *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

61. 11.3.ฉันกังวลเกี่ยวกับความไม่เสถียรของระบบบริการ *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

12.ปัจจัยด้านพฤติกรรมความตั้งใจที่จะใช้งานระบบใหม่

62. 12.1. ฉันจะลองใช้ระบบใหม่(MaaS)นี้เป็นตัวเลือกการเดินทางในชีวิตประจำวันของฉันเสมอ เมื่อพร้อมใช้งานในอนาคต. *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

63. 12.2. ฉันวางแผนที่จะใช้ระบบใหม่บ่อยๆ เมื่อพร้อมใช้งานในอนาคต *

Mark only one oval.

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◯	◯	◯	◯	◯

64. 12.3. ฉันจะพยายามใช้ระบบใหม่เสมอหากต้องเดินทาง *

Mark only one oval.

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◯	◯	◯	◯	◯

13.ปัจจัยด้านลักษณะการใช้งาน

65. 13.1. จะเป็นประสบการณ์ที่น่าพึงพอใจหากได้ใช้ระบบใหม่(MaaS)ในการเดินทาง *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

66. 13.2. ระบบใหม่(MaaS)จะเป็นตัวเลือกแรกของฉันเมื่อพร้อมใช้งาน *

Mark only one oval.

1	2	3	4	5
◯	◯	◯	◯	◯

67. 13.3. ฉันจะแนะนำให้เพื่อนใช้ระบบใหม่(MaaS) เมื่อพร้อมใช้งาน *

Mark only one oval.

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APPENDIX D

CERTIFICATE OF CONFERENCE IEEE


ASU
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APPLIED SCIENCE UNIVERSITY

DASA 2024

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Suchada Phonsitthagkun

for presenting a paper titled

Mobility as a Service (MaaS): A Bibliometric Analysis of Research Trends, Technology Acceptance, and Urban Logistics Integration

at the 2024 International Conference on Decision Aid Sciences and Applications (DASA), held on December 11–12, 2024, at the Applied Science University in the Kingdom of Bahrain.

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Prof. Hatem Masri
Conference Steering Committee

APPENDIX E

PUBLICATION PAPER OF CONFERENCE

2024 International Conference on Decision Aid Sciences and Applications (DASA)

Mobility as a Service (MaaS): A Bibliometric Analysis of Research Trends, Technology Acceptance, and Urban Logistics Integration

Suchada Phonsitthangkun
International Logistics and Supply Chain Management, School of Management
Mae Fah Luang University
Chiang Rai, Thailand
phonsitthangkun@gmail.com

Tosporn Arreeras*
Urban Mobility Lab, School of Management
Mae Fah Luang University
Chiang Rai, Thailand
*Corresponding: tosporn.arr@mfu.ac.th

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***Abstract*— This study presents a comprehensive bibliometric analysis of Mobility as a Service (MaaS) research, focusing on its implications for urban transport planning, engineering, and logistics management. Utilizing the Scopus database and VOSviewer software, we analyzed 603 documents published between 2016 and 2023. Our findings reveal a significant surge in MaaS research, particularly from 2020 onwards, with the United Kingdom, Australia, and the Netherlands emerging as leading contributors. The keyword analysis, facilitated by VOSviewer, uncovered four main research clusters, highlighting the multidisciplinary nature of MaaS studies. Transportation Research Part A: Policy and Practice was identified as the most influential journal in the field. This study provides crucial insights into the evolving landscape of MaaS research, emphasizing its potential to revolutionize urban mobility and address complex demand-supply dynamics in city logistics.**

Keywords—Mobility, Bibliometric Analysis, Technology Acceptance, Urban Logistics, Mobility as a Service (MaaS)

I. Introduction

The landscape of urban transportation is undergoing a profound transformation, driven by the complex interplay of demographic shifts, technological advancements, and evolving consumer expectations. For decades, public transport systems have grappled with the dominance of private vehicles, a trend exacerbated by rising incomes and increased car affordability globally. The decentralization of urban areas has further challenged the efficacy of traditional mass transit models, necessitating innovative solutions to meet the diverse mobility needs of city dwellers [1]. Projections indicate a substantial surge in global passenger transport demand, expected to reach 110 trillion passenger-kilometers by 2060, with developing nations at the forefront of this growth due to burgeoning populations and economies [2]. This unprecedented increase in mobility demand presents both challenges and opportunities for urban planners and policymakers. In the realm of urban logistics, the demand-supply dynamics are equally complex. The rise of e-commerce and on-demand services has dramatically altered urban freight patterns, creating a need for more agile and responsive logistics systems. This shift has led to increased pressure on last-mile delivery networks, exacerbating issues of traffic congestion and environmental impact. The delicate balance between meeting consumer expectations for rapid delivery and maintaining sustainable urban environments has become a critical focus for logistics managers and city planners alike. Amidst these challenges, the concept of Mobility as a Service (MaaS) has emerged as a promising paradigm shift. Originating in Europe and rapidly gaining global traction, MaaS leverages advanced information and communication technologies (ICT), the Internet of Things (IoT), and wireless sensor networks (WSNs) to enhance the convenience and efficiency of public transport [3] . By offering integrated mobility solutions that cater to individual needs, MaaS aims to facilitate a transition from private car ownership to more sustainable and flexible transportation options[4].

This study aims to provide a comprehensive survey of ongoing efforts in the MaaS domain, with a particular focus on its potential to address urban logistics challenges. Through rigorous bibliometric analysis, we seek to identify emerging trends, scrutinize the latest research developments, and uncover strategies to drive the future adoption of MaaS concepts in both passenger transport and urban freight logistics.

II. Literature Review

A. Mobility as a Service (MaaS)

Mobility as a Service (MaaS) represents a paradigm shift in urban transport planning, integrating various transport modes into a single, user-centric digital platform. This innovative concept aims to optimize urban mobility by offering personalized, on-demand transportation solutions that cater to individual needs while maximizing the efficiency of existing infrastructure [5]. From a transport engineering perspective, MaaS leverages advanced information and communication technologies (ICT), the Internet of Things (IoT), and wireless sensor networks (WSNs) to create a seamless, intermodal transportation ecosystem [6]. This integration encompasses public transit, ride-sharing, bike-sharing, car-sharing, and other mobility services, presenting a holistic approach to urban transportation [7]. The demand-supply dynamics in MaaS are particularly significant from a logistics management standpoint. MaaS platforms employ sophisticated algorithms to match real-time demand with available supply across various transport modes, effectively balancing the utilization of resources and reducing inefficiencies in the urban transport network [8]. This dynamic allocation of resources has the potential to alleviate congestion, reduce emissions, and improve overall urban livability [9]. The adoption of MaaS is influenced by multiple factors, including user awareness, satisfaction with existing mobility options, and the perceived value of the MaaS offering [10]. Structural equation modeling (SEM) has been employed to analyze these factors and predict user adoption patterns [11]. Additionally, stated choice surveys have been utilized to

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assess the potential market for MaaS and determine the value users place on different elements of MaaS plans, providing crucial insights for urban planners and policymakers.

B. Technology Acceptance in Urban Mobility Innovations

The acceptance of innovative technologies (IT) is crucial for successful implementation in various domains, including urban transport planning and logistics management. Since the 1970s, extensive research has been conducted to understand, predict, and explain the factors influencing IT acceptance at both individual and organizational levels [12]. User acceptance of technology is influenced by multiple factors, including the selection of appropriate theoretical models [13], pre-established user expectations, and the socio-technical environments in which innovations are introduced [14].

The integration of IoT and smart systems has become increasingly important in technology acceptance, particularly in the context of urban mobility. Recent research has demonstrated how IoT-based smart detection systems can enhance user trust and system reliability [15]. This technological advancement is particularly relevant for MaaS platforms, where real-time detection and monitoring systems play a crucial role in service delivery and user safety [16].

Furthermore, the technology's ability to support the operational and strategic objectives of organizations plays a significant role in its acceptance [17]. Recent studies have emphasized the importance of organizational justice and trust in technology adoption, suggesting that successful implementation of new mobility technologies requires careful consideration of both technical and organizational factors [18]. In Mobility as a Service (MaaS) context, user acceptance is particularly critical. MaaS platforms offer customized and integrated mobility solutions that cater to users' specific requirements [19].

The successful implementation of MaaS technologies hinges on their adoption by travelers [10]. User-centric research approaches focusing on individual perspectives can aid in developing more acceptable MaaS technologies[12].

The Unified Theory of Acceptance and Use of Technology (UTAUT) is frequently employed to predict technology acceptance in transport engineering and logistics management. However, it's important to note that UTAUT does not fully consider the technology adoption process [11]. This limitation suggests the need for more comprehensive models that account for the dynamic nature of technology acceptance in the rapidly evolving field of urban mobility. To enhance acceptance, developers and planners should consider providing information on the environmental and health implications of travel behaviors, as users find this relevant [20]. This approach aligns with the growing emphasis on sustainability in urban transport planning and can potentially influence the demand-supply dynamics in mobility services.

III. METHODOLOGY

A. Data Collection

The data collection process followed these structured steps (Fig. 2). This study leverages the Scopus database, the largest peer-reviewed interdisciplinary scientific repository, to compile comprehensive literature on Mobility as a Service (MaaS). The search query "Mobility as a Service" AND "MaaS" was applied to article titles, abstracts, and keywords, yielding 603 documents spanning from 2016 to 2023 (Table I). Of these, 337 were scholarly articles, representing the predominant form of dissemination in MaaS research at approximately 56%. The collected data encompasses crucial metadata including authors, publication years, journals, keywords, titles, abstracts, citation counts, affiliations, and document types.

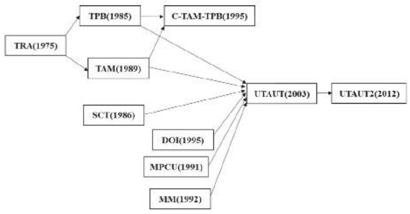

Fig. 1. Development of theory of technology acceptance [13].

This information was systematically extracted and organized into CSV format for further analysis. Utilizing VOSviewer version 1.6.18, we conducted a multifaceted examination of the dataset, including co-occurrence analysis, thematic exploration, citation patterns, co-citation networks, and bibliographic coupling. This methodical approach allows for a nuanced understanding of the MaaS landscape, particularly in the context of urban transport planning and engineering. It facilitates the identification of key trends in demand-supply dynamics within logistics management, crucial for advancing MaaS implementation strategies. By analyzing publication patterns, collaboration networks, and thematic developments, this study provides valuable insights for researchers, policymakers, and practitioners working to enhance urban mobility solutions [5], [7].

Table II provides a comprehensive overview of the bibliometric indicators for the analyzed publications related to Mobility as a Service (MaaS). The dataset comprises 337 documents, reflecting the growing body of research in this field. A total of 2,399 keywords were identified, with 1,076 being author-specific keywords, indicating the diverse range of topics within MaaS research. The average citation per document of 19.26 suggests a moderate impact of these publications. With 159 authors contributing to the analyzed papers, the average of 2.72 documents per author implies a collaborative research environment.

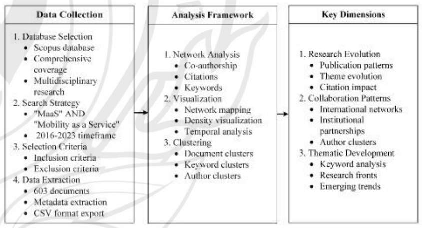

Fig. 2. MaaS research methodology framework.

TABLE I. PRESENTS VARIED DOCUMENT TYPES IN THE MAAS FIELD WITHIN SCOPUS DATABASES

Document Type	Documents
Article	337
Conference paper	175
Book chapter	63
Review	14
Book	6
Editorial	4
Conference review	4
Total	603

This metric offers insights into the level of specialization and cooperation among researchers in the MaaS domain [5], [6], [7]. However, it's important to note that these values may be influenced by factors such as dataset size, time frame, and selection criteria [8], [9], [10]. Fig. 3 illustrates the trajectory of individual and cumulative publications in the field of Mobility as a Service (MaaS) from 2016 to 2023. The graph demonstrates a significant upward trend in research output over this period, with a particularly notable surge in 2022. The blue bars represent the number of individual publications per year, while the orange line depicts the cumulative count. The data reveals a modest beginning in 2016, followed by steady growth in subsequent years. The field experiences a marked acceleration from 2020 onwards, culminating in a peak of 80 documents published in 2022. This rapid increase suggests growing academic interest and investment in MaaS research, likely driven by technological advancements, urban mobility challenges, and shifting consumer preferences in transportation services.

TABLE II. THE AVERAGE NUMBER OF DOCUMENTS PER AUTHOR IN THE ANALYZED PUBLICATIONS RELATED TO MAAS

Description	Results
Document	337
All Keywords	2,399
Author's keywords	1,076
Average citation per document	19.26
Authors	159
Document per author	2.72

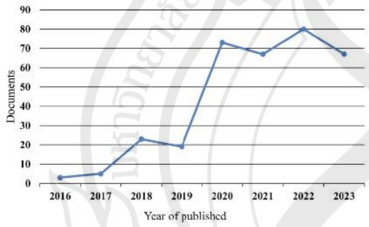

Fig. 3. The documents published in the realm of MaaS.

B. Bibliometric Analysis of Publication Country

A comprehensive examination of the Scopus database yielded 337 publications centered on Mobility as a Service (MaaS), spanning 50 countries (Fig. 4). This global distribution reflects the widespread interest in MaaS as a potential solution to urban transport challenges. The United Kingdom, Australia, the Netherlands, the United States, and Germany emerged as the top contributors, indicating a concentration of MaaS research in developed economies with advanced urban transport systems. The United Kingdom led with 45 documents, accumulating 1,431 citations and an average citation impact of 31.80 (Table III). This prominence suggests the UK's significant influence in shaping MaaS concepts, likely driven by its complex urban transport needs and progressive transport policies. Australia and the Netherlands followed closely, with 50 and 27 documents respectively, demonstrating their strong focus on innovative urban mobility solutions. Notably, China's presence in the top ten (29 documents, 410 citations) highlights the growing interest in MaaS within rapidly urbanizing developing economies. This trend indicates a global recognition of MaaS's potential to address the increasing demand-supply gaps in urban logistics and passenger transport. The geographical distribution reveals a correlation between MaaS research intensity and countries grappling with urban congestion, seeking sustainable transport solutions, and investing in smart city initiatives. The dominance of European countries suggests a regional clustering of expertise, possibly facilitated by EU-wide urban transport policies and funding mechanisms. This analysis underscores the need for increased participation from diverse geographical contexts, particularly from developing countries facing unique urban transport challenges.

C. Bibliometric Analysis Of Keywords

The keyword analysis provides crucial insights into the thematic evolution and research focus within the Mobility as a Service (MaaS) domain. Fig. 5 illustrates a comprehensive network visualization of keyword co-occurrences, revealing four distinct clusters that represent the multifaceted nature of MaaS research. The largest nodes in Fig. 5 represent the most frequently occurring keywords, including "MaaS," "Mobility," "Public transportation," "Travel behavior," and "Urban transportation." These core themes underscore the centrality of urban transport planning and engineering in MaaS research. Fig. 6 delves deeper into the technology acceptance aspects of MaaS, revealing seven interconnected clusters (as detailed in Table IV). This visualization underscores the importance of understanding user behavior and adoption patterns in the success of MaaS implementations. The prominence of keywords such as "Technology Acceptance Model (TAM)," "UTAUT," and "UTAUT2" indicates a strong focus on theoretical frameworks for predicting and explaining user acceptance of new mobility technologies.

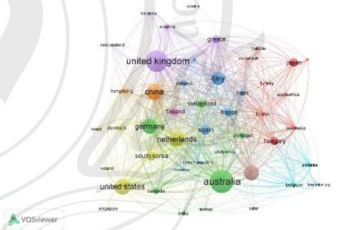

Fig. 4. Network visualization represents countries' interconnectedness within the context of the selected papers.

TABLE III. TOP TEN COUNTRIES OF MAAS RESEARCH CITATIONS

Country	Documents	Citations	Avg. Citation Impact
United Kingdom	45	1,431	31.80
Australia	50	1,374	27.48
Netherlands	27	1,188	44.00
Sweden	27	976	36.15
Finland	13	464	35.69
Germany	27	419	15.52
China	29	410	14.14
United States	28	378	13.50
Greece	11	324	29.45
Italy	22	297	13.50

From a logistics management standpoint, the presence of keywords like "travel demand" and "willingness to pay" in Fig. 5 points to the critical role of demand-supply dynamics in shaping MaaS offerings. These keywords suggest that researchers are actively investigating how to align MaaS solutions with user preferences and market demand, which is essential for creating sustainable and economically viable mobility services. Table IV, which categorizes the keywords into seven distinct clusters, further illustrates the multidisciplinary nature of MaaS research. The diversity of these clusters, ranging from technology adoption (red cluster) to behavioral intentions (yellow cluster), underscores the complex interplay of factors influencing MaaS implementation and success. This comprehensive keyword analysis reveals that MaaS research is at the intersection of urban planning, transport engineering, and logistics management, with a strong emphasis on user acceptance and sustainable development.

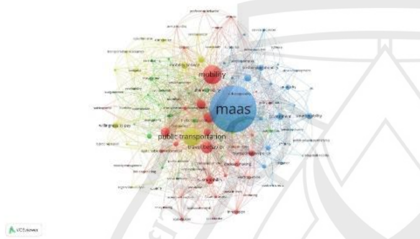

Fig. 5. The visualization of keywords co-occurrence within the realm of MaaS (node frequencies inferior to three are not exhibited).

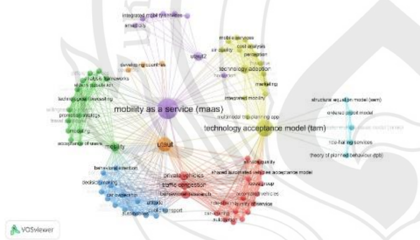

Fig. 6. The visualization of keyword co-occurrence within the theory of technology acceptance in MaaS.

The interconnectedness of these themes suggests that successful MaaS implementation requires an integrated approach that considers technological, behavioral, and policy aspects of urban mobility.

TABLE IV. THE NUMBER OF KEYWORDS CO-OCCURRENCE IN THE MAAS OF TECHNOLOGY ACCEPTANCE FIELD

Cluster	Items
1 (red)	18
2 (green)	16
3 (blue)	15
4 (yellow)	15
5 (purple)	9
6 (light blue)	5
7 (orange)	4

D. Bibliometric Analysis of Citation

The co-citation network analysis of authors, visualized in Fig. 7, provides invaluable insights into the intellectual structure of Mobility as a Service (MaaS) research. By setting a minimum threshold of 20 citations, 223 authors out of 17,461 were identified as key contributors. The resulting network comprises six interconnected clusters, with 22,578 links and a total link strength of 596,820. The most prominent authors, represented by larger nodes, include Sochor J., Hensher D.A., Mulley C., Kamargianni M., and Matyas M. These scholars have made significant contributions to MaaS research, shaping the field's theoretical and empirical foundations. Table V presents the top ten authors based on Scopus citation impact. Notably, Jittrapirom P. leads with 372 citations for a single paper, demonstrating exceptional influence. Other highly cited authors include Smith G., Hensher D.A., and Matyas M., representing diverse geographical locations such as the Netherlands, Sweden, Australia, and the United Kingdom.

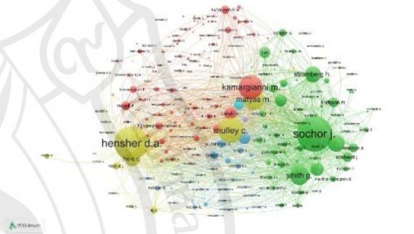

Fig. 7. The visualization co-citation analysis of the cited author.

TABLE V. AUTHORS AND CITATION STATISTICS ON MAAS

Author	Documents	Citations	Nation	Avg. Citation Impact
Jittrapirom P.	1	372	NL	372.00
Smith G.	4	229	SE	57.25
Hensher D.A.	2	210	AU	105.00
Matyas M.	3	153	UK	51.00
Pangbourne K.	1	150	UK	150.00
Ho C.Q.	1	144	AU	144.00
Wong Y.Z.	1	130	AU	130.00
Nikitas A.	1	123	UK	123.00
Lyons G.	2	120	UK	60.00
Sochor J.	1	119	SE	119.00

This geographical diversity underscores the global nature of MaaS research and the international collaboration driving the field forward.

E. Joural populality in the feild

This analysis reveals the most influential and prolific journals in the rapidly evolving field of Mobility as a Service (MaaS). By examining both publication volume and citation impact, we can identify the key platforms disseminating cutting-edge MaaS research. Transportation Research Part A: Policy and Practice emerges as the preeminent journal in this domain, with an impressive 44 papers accumulating 2,104 citations. This journal's significant lead underscores its pivotal role in shaping MaaS discourse and policy directions. Following closely is Research in Transportation Business and Management, which, despite fewer publications (18), has garnered substantial attention with 492 citations, indicating high-impact contributions. Notably, Urban Planning stands out for its exceptional impact, with a single paper amassing 372 citations, highlighting the interdisciplinary nature of MaaS and its relevance to urban studies as shown in Table VI. Other significant contributors include Research in Transportation Economics, Sustainability (Switzerland), and Travel Behaviour and Society, each offering unique perspectives on MaaS implementation and its socio-economic implications. The presence of diverse journals such as Transport Policy, Transportation, and Case Studies on Transport Policy in this ranking demonstrates the multifaceted nature of MaaS research, spanning policy, economics, sustainability, and behavioral studies. This diversity reflects the complex ecosystem of urban mobility and the need for interdisciplinary approaches in addressing contemporary transportation challenges.

TABLE VI. TOP TEN JOURNALS OF MAAS RESEARCH

Journals	Papers	Citations
Trans. Research Part A: Policy and Practice	44	2,104
Research in Trans. Business and Management	18	492
Urban Planning	1	372
Research in Trans. Economics	12	342
Sustainability (Switzerland)	30	329
Travel Behaviour and Society	15	291
Trans. Policy	15	282
Transportation	8	254
Case Studies on Trans. Policy	14	183
Trans. Research Record	5	149

IV. CONCLUSION

This bibliometric analysis reveals the interdisciplinary nature of Mobility as a Service (MaaS) research, bridging urban transport planning, engineering, and logistics management. The study identifies key research clusters, influential authors, and prominent journals, highlighting the critical role of demand-supply dynamics in MaaS implementation. Analysis of MaaS applications shows a growing focus on user-centric design, yet adoption varies across urban contexts, necessitating adaptive strategies. Future research should integrate behavioral economics and social psychology with traditional transport models, employing mixed-method approaches to capture nuanced user experiences. As MaaS gains global traction, studies should focus on integrating sustainable development goals, addressing urban logistics challenges, developing context-specific models, exploring long-term impacts on urban form, and investigating emerging technologies' role. The geographical concentration of research in developed economies underscores the need for diverse perspectives, particularly from developing countries, to create inclusive, sustainable MaaS solutions catering to varied urban populations worldwide.

ACKNOWLEDGMENT

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REFERENCES

[1] X. Zhou, J. Liang, X. Ji, and C. D. Cottrill, “The influence of information services on public transport behavior of urban and rural residents,” *Sustainability (Switzerland)*, vol. 11, no. 19, Oct. 2019, doi: 10.3390/su11195454.

[2] M. Kii, H. Nakanishi, K. Nakamura, and K. Doi, “Transportation and spatial development: An overview and a future direction,” *Transp Policy (Oxf)*, vol. 49, pp. 148–158, Jul. 2016, doi: 10.1016/j.tranpol.2016.04.015.

[3] K. Sakai, “Public transport promotion and mobility-as-a-service,” *IEICE Transactions on Fundamentals of Electronics, Communications and Computer Sciences*, vol. E103A, no. 1, pp. 226–230, 2020, doi: 10.1587/transfun.2019TSI0001.

[4] T. Arreeras, M. Endo, H. Takahashi, T. Asada, and M. Arimura, “An Association Rule Mining-Based Exploration of Travel Patterns in Wide Tourism Areasusing A Wi-Fi Package Sensing Survey,” Journal of the Eastern Asia Society for Transportation Studies, vol.13, pp. 1099-1113, 2019.

[5] M. Kamargianni, W. Li, M. Matyas, and A. Schäfer, “A critical review of new mobility services for urban transport,” *Transportation Research Procedia*, vol. 14, pp. 3294–3303, Jan. 2016, doi: 10.1016/j.trpro.2016.05.277.

[6] G. Lyons, P. Hammond, and K. Mackay, “The importance of user perspective in the evolution of MaaS,” *Transp Res Part A Policy Pract*, vol. 121, pp. 22–36, Mar. 2019, doi: 10.1016/j.tra.2018.12.010.

[7] C. Q. Ho, D. A. Hensher, C. Mulley, and Y. Z. Wong, “Potential uptake and willingness-to-pay for Mobility as a Service (MaaS): A stated choice study,” *Transp Res Part A Policy Pract*, vol. 117, pp. 302–318, Nov. 2018, doi: 10.1016/J.TRA.2018.08.025.

[8] I. Lopez-Carreiro, A. Monzon, D. Lois, and M. E. Lopez-Lambas, “Are travellers willing to adopt MaaS? Exploring attitudinal and personality factors in the case of Madrid, Spain,” *Travel Behav Soc*, vol. 25, pp. 246–261, Oct. 2021, doi: 10.1016/J.TBS.2021.07.011.

[9] R. M. Gandia, F. Antonialli, J. R. Oliveira, J. Y. Sugano, I. Nicolaï, and I. R. Cardoso Oliveira, “Willingness to use Maas in a Developing Country,” *International Journal of Transport Development and Integration*, vol. 5, no. 1, pp. 57–68, Apr. 2021, doi: 10.2495/TDI-V5-N1-57-68.

[10] I. Lopez-Carreiro, A. Monzon, E. Lopez, and M. E. Lopez-Lambas, “Urban mobility in the digital era: An exploration of travellers' expectations of MaaS mobile-technologies,” *Technol Soc*, vol. 63, p. 101392, Nov. 2020, doi: 10.1016/J.TECHSOC.2020.101392.

[11] I. Lopez-Carreiro, A. Monzon, and M. E. Lopez-Lambas, “Comparison of the willingness to adopt MaaS in Madrid (Spain) and Randstad (The Netherlands) metropolitan areas,” *Transp Res Part A Policy Pract*, vol. 152, pp. 275–294, Oct. 2021, doi: 10.1016/J.TRA.2021.08.015.

[12] A. Alkhwaldi and M. Kamala, “Why do users accept innovative technologies? A critical review of models and theories of technology acceptance in the information system literature,” Journal of Multidisciplinary Engineering Science and Technology (JMEST), vol. 4, no. 8, pp. 2458–9403, 2017.

[13] F. D. Davis, “User acceptance of information technology: system characteristics, user perceptions and behavioral impacts,” Int J Man Mach Stud, vol. 38, no. 3, pp. 475–487, Mar. 1993, doi: 10.1006/IMMS.1993.1022.

[14] P. Meier, J. H. Beinke, and F. Teuteberg, “Participatory requirements engineering – Using factorial surveys to understand users' attitude towards emerging technologies,” in Lecture Notes in Informatics (LNI), Proceedings - Series of the Gesellschaft fur Informatik (GI),

Gesellschaft fur Informatik (GI), 2017, pp. 677–690. doi: 10.18420/in2017_64.

[15] M. N. M. Alshekhly et al., "Design and Development of Smart Metal Detection System Based on IoT Technology," Studies in Systems, Decision and Control, vol. 538, pp. 283–292, 2024, doi: 10.1007/978-3-031-62102-4_23.

[16] A. H. (Ed.). Al-Hamami, Handbook of Research on Threat Detection and Countermeasures in Network Security. IGI Global, 2014.

[17] T. Miroshnikova, "Innovative Technologies in Education," in E3S Web of Conferences, EDP Sciences, Dec. 2020. doi: 10.1051/e3sconf/202021018135.

[18] A. M. Al Samman and A. Mohamed, "Artificial Intelligence, Organizational Justice and Organizational Trust: Towards a Conceptual Framework," 2024 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems, ICETSIS 2024, pp. 17–22, 2024, doi: 10.1109/ICETSIS61505.2024.10459667.

[19] A. Athanasopoulou, T. Deijkers, B. Ozkan, and O. Turetken, "MaaS platform features: An exploration of their relationship and importance from supply and demand perspective," Journal of Urban Mobility, vol. 2, p. 100028, Dec. 2022, doi: 10.1016/J.URBMOB.2022.100028.

[20] A. Kiwanuka, "Acceptance Process: The Missing Link between UTAUT and Diffusion of Innovation Theory," American Journal of Information Systems, vol. 3, no. 2, pp. 40–44, 2015, doi: 10.12691/ajis-

CURRICULUM VITAE

NAME	Suchada Phonsitthangkun
EDUCATIONAL BACKGROUND	
2020	Bachelor of Logistics and Supply chain Management (2nd degree honors) School of Business Administration Rajamangala University of Technology Suvarnabhumi
ACADEMIC AND WORK EXPERIENCE	
January 2023 - May 2023	Teacher Assistant School of Logistics and Supply Chain Management, Mae Fah Luang University
August 2023 - December 2023	Teacher Assistant School of Business Administration, Mae Fah Luang University
June 2023 - May 2024	Researcher Assistant "Building platform for Cross Border E-Commerce Logistic express and Cold chain" project, College of Arts, Media and Technology, Chiang Mai University
April 2024 - July 2024	International Student Exchange Program Muroran Institute of Technology, Hokkaido, Japan
August 2024 - Present	Project Coordinator College of Arts, Media and Technology, Chiang Mai University

PUBLICATION

Phonsitthagkun, S., & Arreeras, T. (2024). Mobility as a Service (MaaS): A bibliometric analysis of research trends, technology acceptance, and urban logistics integration. In *2024 International Conference on Decision Aid Sciences and Applications (DASA)* (pp. 1–6). IEEE. https://doi.org/10.1109/DASA63652.2024.10836433

Arreeras, S., Phonsitthangkun, S., Arreeras, T., Arimura, M. (2024). Spatial Analysis on the Service Coverage of Emergency Facilities for Fire Disaster Risk in an Urban Area Using a Web Scraping Method: A Case Study of Chiang Rai City, Thailand. *Urban Sci*, *8*, 140. https://doi.org/10.3390/urbansci8030140

Sunmud, S., Arreeras, T., Phonsitthangkun, S., Prommakhot, S., & Sititvangkul, K. (2024). Examining risky riding behaviors: Insights from a questionnaire survey with middle-aged and older motorcyclists in Thailand. *Safety, 10*(2), 48. https://doi.org/10.3390/safety10020048

Phopluechai, R., Arreeras, T., Jia, X., Phonsitthangkun, S., Arreeras, S., & Prommakhot, S. (2024, January). Examining factors affected to travel decision during air pollution crisis in Chiang Rai using exploratory factor analysis. In *2024 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETSIS)* (pp. 1602–1606). IEEE. https://doi.org/10.1109/ICETSIS61505.2024.10459670

Ketchaichana, A., Arreeras, T., & Phonsitthagkun, S. (2023, May). Analyzing travel time savings on commuters' decision to use transit service involving transfers. In *2023 8th International Conference on Business and Industrial Research (ICBIR)* (pp. 184–189). IEEE. https://doi.org/10.1109/ICBIR57571.2023.10147448