M.S. Dissertation in Engineering

A study on users' acceptance on Mobility as a Service (MaaS) based on UTAUT

UTAUT 를 기반으로 한 통합 모빌리티 서비스(MaaS)에 대한 사용자의 수용에 관한 연구

2021 년 8 월

Graduate School of Seoul National University

Technology Management, Economics, and Policy Program

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이 논문을 공학석사학위 논문으로 제출함

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백신우

백신우의 공학석사학위 논문을 인준함

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Abstract

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A service that integrates various means of transportation such as cars, buses, subways, bicycles, and personal mobility into one platform is called Mobility as a Service (Maas). Maas is receiving more attention recently as it is beneficial for users not only because of the convenience of using various transportation means but also because of the convenience of making reservations and payments simultaneously, and getting all the traffic information on one app. The concept of Maas is also being highlighted as it can provide a solution for the traffic problems caused by the rapid increase in urbanization and the number of automobiles, and its related research and pilot programs are being widely promoted and implemented in Europe. However, in Korea, the qualitative research on MaaS is insufficient for its introduction. To make MaaS viable and to commercialize it, research to increase the competitiveness of MaaS from the perspective of the users is required. Therefore, this study analyzed the user acceptance of MaaS by integrating public transportation (PT) with smart mobility services (Author's definition: Mobility services and transportation means that emerged newly with the development of advanced technology) in an early stage in Korea. Using the unified theory of acceptance and use of technology (UTAUT), this study empirically analyzed and obtained the results to determine the user intentions to continue the use of MaaS in Seoul. The following independent variables were selected: Performance Expectation (PE), Effort Expectation (EE), Social Influence (SI), Individual Innovation (II), and Environment Concern (EC). To understand the commuting characteristics, we restricted our survey to people who commute regularly by their own cars or PT in metropolitan areas of Korea for a total of 529 participants. The results showed that PE, SI, II, and EC had a positive influence on their intention to use MaaS. Furthermore, the participants were divided into groups based on the following factors to perform a multigroup analysis: car ownership, main means of transportation, number of days using PT, and smart mobility experience. The influencing factors and group differences were analyzed to identify potential users to help MaaS operators develop promotional strategies and policies. As the implementation of MaaS is still in an undeveloped phase, this study provides a blueprint for building a MaaS system suitable for the Korean situation.

Keywords: Mobility as a Service, Acceptance of users, UTAUT model, Multigroup analysis, Commuting characteristics, Smart Mobility

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Contents

List of Tables

List of Figures

Chapter 1. Introduction

1.1 Introduction of Mobility as a Service

Approximately 52% of the world population lives in urban areas as of 2010, and 67% of the population is expected to live in cities by 2050. Urbanization is posing cities and governments with new, increasingly serious challenges related to public safety and security, energy supply and consumption, waste treatment, and transport management. The continuous increase in the number of congested areas in large cities is expected to become a major social problem in the future. Smart cities are emerging as solutions for severe urbanization, and smart mobility has the greatest impact on the development of smart cities. Smart mobility is essential to alleviate the problems with urban traffic flow while considering both economic and environmental aspects.

After the introduction of the iPhone in 2008, wireless internet and mobile-based shared mobility services are growing, and the environment of core technologies, including automobiles, is rapidly changing. In particular, the combination of autonomous vehicles and smart mobility services is transforming the mobility industry currently centered on automobile manufacturing into an integrated mobility service industry based on information and communication technologies (ICT). Signs of this change are already showing in Europe and the United States. An integrated public transport service that connects various means of transportation, such as existing public transport, carsharing, carpooling, sharing bicycles, and electric scooters, using technologies such as internet mobile platforms, spatial big data, and artificial intelligence is a contentious issue. This integrated mobility service is called Mobility as a Service (MaaS).

To meet the user traffic demand, it provides a customized alternative for each user utilizing next-generation mobility, such as shared mobility and autonomous driving systems, together with existing transportation means such as cars, buses, and subways. The key features include i) integration of transport modes, ii) single platform, iii) customization, iv) journey planning, and v) provision of various types of fare-based traffic packages (Kwon et al., 2020)

Because 'mobility' is the ultimate goal of MaaS, not only its role as a service but also its role as an infrastructure is being highlighted. As mobility is expected to become a key element in a smart city, MaaS has considerable potential to enhance the industrial and national competitiveness rather than simply changing the transportation system. MaaS also supports future infrastructure expansion by feeding back data to smart mobility back-end applications; therefore, it is expected to become the core of both the smart city ecosystem and the mobility ecosystem. In addition, it is possible to provide additional services to travelers using MaaS as an infrastructure, and it is expected to be a new industry that can create various profit models through partnerships with travel and lodging companies based on convenient transportation (Cho, 2019).

In Europe, discussions on the introduction of MaaS have been conducted systematically and extensively (Barreto, 2018). In 2016, Whim in Finland commercialized and provided the world's first integrated mobility service. Many types of research on the introduction, operation plan, fee payment method, platform provision method, and so on, related to MaaS are being conducted as it is being introduced to various regions of the world (Butler, 2020). However, in Korea, discussions on the introduction of MaaS remain at the regional level. Seoul (The Seoul Institute, 2018), Gyeonggi Province (Advanced Institute of Convergence Technology, 2020), and Busan Metropolitan City (Busan Development Institute, 2019) have started to promote the introduction of regionally tailored integrated mobility services.

1.2 Research Problem

As the sharing economy grows, perceptions are changing from the concept of owning cars to a means of providing services. In Korea, carsharing services (Socar, DelCar, etc.) and bicycle sharing services (Dareungi, etc.) have been introduced, and the demand for such smart mobility services has increased rapidly (Kwon, Y.M., et al., 2020). Various transportation means are currently available, but it is difficult to make multiple reservations and payments for one purpose, and services linking the different transportation means are insufficient. Therefore, an integrated platform is needed to eliminate these inconveniences by linking the different means of transportation and to process them with a single reservation and payment, thereby increasing the convenience of movement. The discussion on the introduction of MaaS can provide a blueprint for building a MaaS system suitable for the Korean situation. From a long-term perspective, it is economically, socially, and environmentally important to unify the transportation system and make it more efficient. Research on MaaS will provide insights into the demands, needs, and travel behaviors of the citizens. It is expected to result in more targeted and effective adaptations of services and investments in innovative infrastructure (Barreto, 2018).

1.3 Research Questions

Based on the research problem, the following questions were answered in this study.

Q1. How can we clearly define and select the key measures for the introduction of MaaS in Seoul, Korea?

Q2. How can we achieve a better understanding of the needs of the commuters?

Q3. What are the reasons for or difficulties in using cars or public transportation (PT) as the main means of transportation for commuting? How can we understand the "non-users" of PT and bring them into a multimodal reality?

Q4. What are the implications for the MaaS mobility operators, platform providers, and government in this regard?

This paper is organized as follows: Chapter 2 provides a review of the literature on the global MaaS cases, MaaS research, and user acceptance of MaaS. Chapter 3 outlines how the research model and hypotheses were built along with their definitions. Chapter 4 presents the research methodology with various participant characteristics. Chapter 5 presents the empirical results and a discussion of those results. Finally, Chapter 6 provides a summary, implications, and limitations of the research.

Chapter 2. Case Studies and Theoretical Background

2.1 Case Studies of MaaS

Mobility as a Service (MaaS) should not be limited to shared vehicles, so public transportation and Smart Mobility services should be linked to maximize the effectiveness of public services at the government level. Representative overseas examples include MaaS Global's 'Whim' service, automaker Daimler's 'Moovel' service, and London's location-based travel service startup ‘Citymapper’.

2.1.1 MaaS Global

MaaS Global, as a company based in Helsinki, Finland, has commercialized Whim App. The government directly plans and supports MaaS at the national level. During the financial crisis in 2009, Finland faced the most serious financial risk among the European Union, but overcame the economic crisis by focusing on ICT and digitalization. Uniquely, in Finland, communication services and transportation network are managed by the Ministry of Transport and Communications (LVM, Finnish: liikenne- ja viestintäministeriö), so the Finnish government has created a structural link between transport and ICT. It should be noted that the Finnish government has a small, centralized nature, and politicians and public officials have made rapid policy development in the market through consultations with stakeholders in various transport and communications sectors (Luukkainen P., 2020).

First, to enable MaaS development, it was assumed as a “national” agenda and was fostered to create a corporate environment where startups can find investors and transportation service providers can easily participate as service providers. Second, in response to requests for transportation service providers to sell “single tickets,” which can use various means of transportation, regulations were relaxed and related regulations were revised. Subsidies were not provided for a single pass for public transport in Finland, and each municipality was obligated to pay a subsidy for an ‘own’ resident pass, so the user has to confirm their residence when selling tickets. Therefore, Finland's MaaS is generally pursuing a direction that simplifies public transport spending and encourages inter-industry cooperation and healthy market competition for economic growth.

The order of use of the service is to set the destination, get the recommendation of the best route and method, and automatically make a reservation and payment. Trams, buses, taxis, motorcycles, rental cars, and public bicycles in Helsinki can be used in combination. The payment method is 89 euros / 249 euros / 389 euros for individual use or monthly payment, and unlimited use of public transportation is possible, and it is characterized by providing a seamless service without waiting to the destination (transfer /car reservation, etc.).

2.1.2 Moovel Group

Launched as Daimler's Mobility-as-a-Service service subsidiary, Moovel bundles various types of public transportation such as bus, subway, carsharing, bike sharing and taxi to form a multimodal transportation solution. Airline ticket reservations and payments are also possible. Since the launch of the first MaaS platform with integrated reservation and payment functions in 2015, as of August 2, 2018, 5 million people are using it. Over the year, 2 million users have been added, showing an increase of 71%. Users in Stuttgart can book and pay for fares through the moovel mobility app directly from 2015 onwards via bus and subway, car2go, mytaxi, and Deutsche Bahn. Currently, moovel North America, headquartered in Portland, Oregon, started service at Stuttgart, Hamburg, Karlsruhe and Aschaffenburg, Germany.

2.1.3 Citymapper

As a startup company that provides travel-related services such as London-based navigation and travel routes, Citymapper is an app that integrates all means of transportation into one. It combines open data and self-developed algorithms to quickly show the necessary route in real-time. In addition, it provides unique functions such as a navigation function, a location sharing function, and an automatic commuting route notification for more convenient use of public transportation. By applying the concept of car navigation to public transportation, it provides only necessary information such as stop location, waiting time, and getting off notification in real-time while following the user's current location. It also supports in smartwatches such as Apple Watch and Android Wear, so the user can easily receive guidance without taking their smartphone out of the busy road.

2.2 Literature Review

2.2.1 Researches of Future Mobility Services Based on Technology Acceptance Model (TAM)

The form of MaaS developed so far focuses on providing multi-means traffic information aimed at in this study, but efforts to advance it have been limited. Existing studies on MaaS are mainly conducted from a macroscopic point of view, such as evaluation of monthly fixed payment options, which are important factors in determining the business model of participating transport companies, or changes in public transport-centered traffic behavior caused by MaaS from a public point of view. In order for the introduction of MaaS to become visible and commercialize the services, research to increase the competitiveness of MaaS from the perspective of users is required. Through understanding the users' needs, the new services which can be differentiated from the existing service could be made and increase the users' satisfaction at the beginning of the MaaS implementation stage and hence lead to increasing the size of the market. The summary of researches on future mobility adoption can be found in following Table 1.

Table 1. Summary of previous researches on Future Mobility Adoption

Author	Survey	Model & Target	Latent Variable	Dependent Variable
Sonneberg, M. O., Werth, O., Leyerer, M., Wille, W., Jarlik, M., & Breitner, M. H. (2019)	115	TAM / Ridepooling Services	Subjective Norm, Perceived Compatibility, Perceived Ease of Use, Perceived Safety, Perceived Usefulness	Attitude towards Use, Behavioral Intention to Use
Park, Sang Do (2017)	534	Innovation-diffusion theory/ Smart Mobility	Compatibility, Communication, Complexity, Service quality, Relative advantage	Perceived usefulness, Adoption Intention
Kim, Hyeong-Min (2020)	202	Theory of reasoned action / Shared Economy Based Mobility Services	Initial Trust, Relative Benefits, Propensity to Trust, Structural Assurances, Task-Technology Fit, Technology Characteristics, Task Characteristics, Technological Self-Efficacy, Switching Costs	Behavioral Intention, Use Behavior
Madigan, R., Louw, T., Wilbrink, M., Schieben, A., & Merat, N. (2017)	315	UTAUT / Automated Road Transport Systems	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation,	Behavioral Intention

Kim, S., Han, K., Nam, S., & Ahn, Y. (2019)	141	TAM / O2O Public Bicycle Service	Convenience, Reliability, Accessibility, Linkage, Mobility	Perceived Value, Satisfaction, Continuance Intention
Jahanshahi, D., Tabibi, Z., & Van Wee, B. (2020)	271	UTAUT2 / Bicycle sharing system	Performance Expectancy, Social Influence, Facilitating Conditions, Social Influence, Price Value, Perceived Safety	Behavioral Intention, Use Behavior
Lee, J., Lee, D., Park, Y., Lee, S., & Ha, T. (2019)	313	Modified TAM / Autonomous Vehicles	Perceived Ease of Use, Perceived Usefulness, Perceived Risk, Relative Advantage, Self-Efficacy, Psychological Ownership	Intention to Use
Mola, L., Berger, Q., Haavisto, K., & Soscia, I. (2020)	201	TAM / MaaS	Perceived Cost Saving, Perceived Ease of Use, Perceived Usefulness	Intention to Use

2.2.2 A Study on Users' Willingness to Accept MaaS in China

Using UTAUT , one research was done to understand the willingness to accept MaaS in the Anting New Town, suburbs of Shanghai, and 600 surveys were used for the research (Ye et al., 2020). The study contained eight variables; Performance Expectation, Social Influence, Facilitating Condition, Individual Innovation, Effort expectation, Perceived risk, Behavioral Intention and Attitude towards Using (Figure 1). Performance Expectation, Social Influence, Individual Innovation, and Effort expectation showed a positive impact on Behavioral Intention, while Perceived risk on Behavioral Intention showed the negative impact. Also, Facilitating Condition and Behavioral Intention jointly affected positively towards Attitude towards Using. Authors gave the promotional strategies related to the result, such as strengthening the publicity and promoting the MaaS concept, improving the convenience in the operations and grasping the users' curiosity and the early adopters, etc. Moreover, the authors have progressed the research with five moderator variables: gender, age, education level, membership experience, household car ownership. The result gave the insight of; providing the customized MaaS travel packages for different aged groups, making detailed tutorials for the people who have no membership experience, and inviting free experiences, etc.

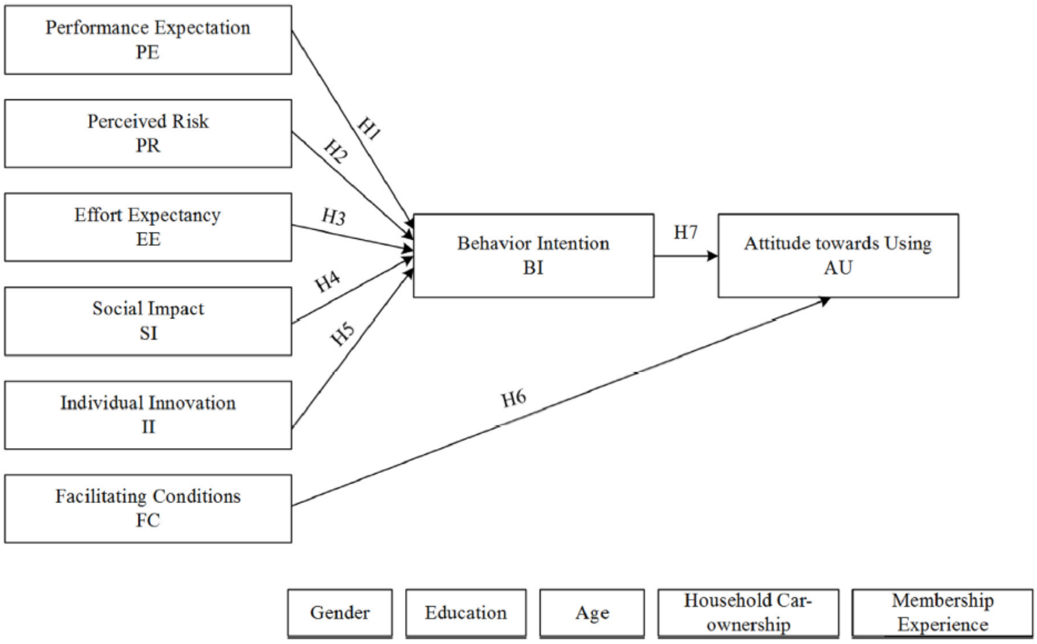

Figure 1. Research Model of Ye et al.

2.3 Factors Affecting the User Acceptance of MaaS

2.3.1 UTAUT Model: Performance Expectation, Effort Expectation, Social Influence

The most widely used model so far to explain the technology acceptance of users is the

TAM proposed by Davis (1989). In TAM, it is explained that the perceived usefulness and perceived ease of use affect the user's attitude, intention to use, and even behavior toward the new technology. However, due to the difficulty in identifying detailed variables of the perceived usefulness of the TAM and the difficulty in analyzing the relationship between variables (Agarwal & Karahanna, 2000), the Unified Theory of Acceptance and Use of Technology (UTAUT), which approaches the user's technology acceptance from an integrated perspective, started to get more attention. In the UTAUT model, four variables were derived based on the common points of variables included in eight models; TRA (theory of reasoned action), MM (motivational model), TAM (technology acceptance model), TPB (theory of planned behavior), C-TAM-TPB (combined TAM and TPB), IDT (innovation diffusion theory), MPCU (model of PC utilization), and SCT (social cognitive theory). The UTAUT model suggests Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions as variables that affect the acceptance and use of new technologies. Through these four variables, it was proved that the main cause variables affecting the intention to use and the actual use behavior had a statistically significant effect on the intention to use and the behavior of use (Venkatesh et al., 2003).

Performance expectation is a concept that is consistent with the perceived usefulness of the TAM, and refers to the degree to which the use of new technology is perceived to increase the productivity of the results. Effort expectation is a concept similar to the perceived ease of use of the TAM, which refers to the degree to which a new system is believed to be readily available. Social influence is a variable similar to the subjective norms of the TAM and refers to the degree to which others, who are important to me, believe that they will use the new technology. Facilitating conditions are factors that directly affect behavior and refer to the degree of personal belief that there is an organizational and technical basis to support the use of new systems (Venkatesh et al., 2003).

Efforts to verify user attitudes toward new technologies using an integrated technology acceptance model are being made in a wide variety of fields, including chat-bot service (Kim et al., 2019), online banking (Kim et al., 2017), Internet of Things (Cha et al., 2019), kiosk services (Kim et al., 2020), and blockchains (Kang et al., 2019). Recently, the UTAUT model has been widely applied to verify the effects of the new ICT and services on the user. It is being used in research by adding and applying necessary factors according to the researcher's new interpretations and intentions of the research model. This study used the UTAUT model, which is often used in research to accept a new information technology, as a base theory, as shown in Figure 2. This study aimed to understand the influence of performance expectation (PE), effort expectation (EE), and social influence (SI) on the behavioral intention (BI) of MaaS users.

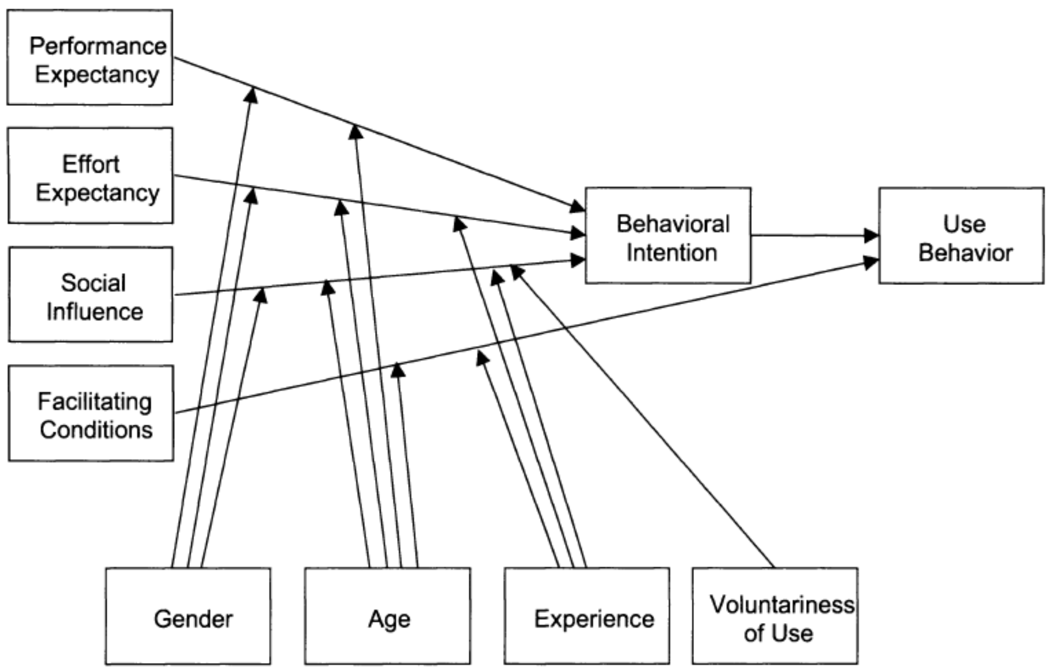

Figure 2. The UTAUT model from Venkatesh et al. (2003)

2.3.2 Individual Innovation and Environment Concern

Individual innovation (II) refers to the degree to which different members of society in the same social system adopt a new information technology before the other members. The higher the innovation of the user, the more they tend to positively accept new technologies (Orr, 2003). Highly innovative users are open to new technologies and changes, whereas less innovative users are reluctant to change and tend to be negative about new technologies. The impact of II on the adoption of new technologies has been supported by several studies (Li, 2014).

Environmental concern (EC) refers to the awareness of the consequences or effects of an individual on environmental problems (Fujii, 2006; Schultz et al., 2005). Furthermore, by exploring a broader scope of environmentally friendly behavior, many studies have showed that EC can also have an effect on the BI of a person to perform a certain action (Fujii, 2006; Hsu et al., 2017).

This study investigated II and EC as independent variables to understand their significance in adopting MaaS.

2.3.3 Travel Behavior of Commuters

The research and development of MaaS are divided into two parts: commuting and travel purposes (Lee et al., 2018). This research focuses on the commuting purpose of MaaS in the metropolitan areas of Korea. Kim et al. (2021) explored how user preferences for intermodal options of MaaS differ between car users and PT users in Seoul, Korea. They showed that even if the users are of the same socio-demographics, their preference for MaaS showed a difference according to the transportation mode they habitually use. The authors suggested that to make MaaS more attractive to car users, the operators should try to minimize the resistance to transfers between the means of transportation in the options of MaaS. Furthermore, they concluded that proposing a shorter travel time is the key factor in attracting PT users.

To reduce vehicle emissions and traffic congestion, it is important to understand the behaviors of car users and PT users, as they account for 90% of the total (Shin et al., 2019). Furthermore, it is important to understand the PT user behavior as PT is the backbone of MaaS (Yoon et al., 2019). As different strategies should be developed for targeting each group to implement MaaS, this research aimed to understand the behavior of different groups of commuters through multigroup analyses.

2.3.4 Smart Mobility Services

Smart mobility is defined in many ways, including transportation systems, transportation service concepts, and new means of transportation. The EU (2016) defined it as a system or service that decarbonizes the means of transportation and simultaneously relieves traffic congestion and improves accessibility. UNCTAD (2016) defined it as a transportation system with improved accessibility, safety, and efficiency, and a new service form such as carsharing and carpooling. The Seoul Digital Foundation (2018) defined it as the overall concept of future transportation services that are intelligent because of the combination of the existing transportation systems and advanced functions of smart devices (Hong et al., 2020)

In this study, smart mobility was defined as mobility services and means that emerged newly with the development of advanced technology. Among the various types of smart mobility services, a total of four services that are the most used in metropolitan areas were nominated. Smart mobility services used in this study were limited to shared bikes, personal mobility, ridesharing, and carsharing. Such smart mobility services are expected to contribute to the construction of a sustainable urban transportation system that maximizes the convenience of movement and minimizes travel time and costs by assisting or replacing traditional transportation means (cars, buses, railroads, taxis, and bicycles) (Park, 2019).

Chapter 3. Model and Hypothesis

3.1 Research Model and Hypothesis

To understand the user acceptance of MaaS in the metropolitan areas of Korea, this study adopted the TAM, and the overall model structure for the research is shown in Figure 3.

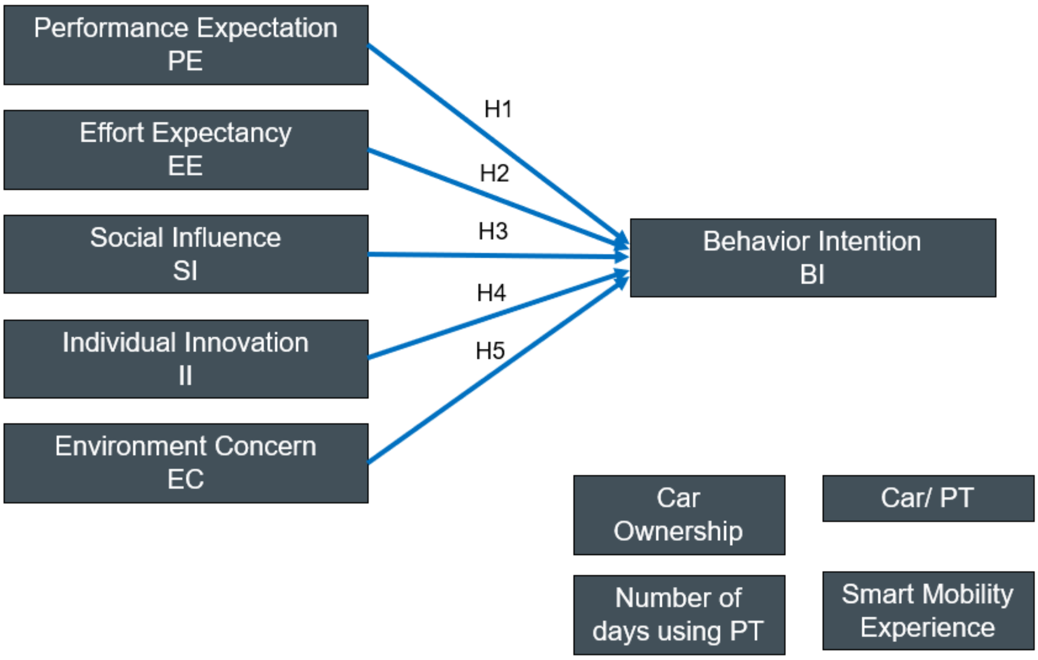

Figure 3. Research Model

In summary, there are five latent variables with one dependent variable, and four multigroup analyses have been used in the research. A summary of the hypotheses tested in this study is as follows:

H1: A user's PE for MaaS has a positive influence on the BI.

H2: A user's EE for MaaS has a positive influence on the BI.

H3: A user's SI on MaaS has a positive influence on the BI.

H4: A user's II regarding MaaS has a positive influence on the BI.

H5: A user's EC for MaaS has a positive influence on the BI.

H6: Car ownership has a moderating effect on the relationship between the hypothesized latent variables and dependent variable.

H7: Means of transportation (Car/PT) have a moderating effect on the relationship between the hypothesized latent variables and dependent variable.

H8: The number of days using PT in a week moderates the relationship between the hypothesized latent variables and dependent variable.

H9: The smart mobility experience has a moderating effect on the relationship between the hypothesized latent variables and dependent variable.

3.2 Description of Variables

The above definition of variables was adjusted to fit the MaaS model. The operational definitions are presented in Table 3. A summary of the questions for latent variables is shown in Table 4.

Table 2. Definition of variables

Variable	Definition	Source of data
Performance Expectation (PE)	the extent to which an individual believes that using an information system will help them improve their performance.	Venkatesh et al., 2003; Venkatesh et al., 2012
Effort Expectation (EE)	the ease with which an individual uses an information system	Venkatesh et al., 2003; Venkatesh et al., 2012
Social Influence (SI)	the extent to which an individual believes that the use of new technologies can enhance the profile and status in the social system.	Venkatesh et al., 2003; Venkatesh et al., 2012
Individual Innovation (II)	the ability of an individual to be good at discovering and accepting new things. It is used to assess an individual's acceptance of new things.	Rogers, 1995
Environment Concern (EC)	the awareness of consequences or effects held by an individual on environmental problems	Fujii, 2006; Schultz et al., 2005
Behavior Intention (BI)	the degree to which a person has formulated conscious plans to perform or not perform some specified future behavior.	Warshaw, Davis, 1985

3.3 Operational Definition of Variables

3.3.1 Latent Variables

The above definition of variables is adjusted to fit into our MaaS model. The operational definition is constructed in Table 3. Moreover, the summary of questions for latent variables is shown in Table 4.

Table 3. Operational definition of variables

	Variable	Number of Items	Definition
Independent Variable (IV)	Performance Expectation (PE)	8	The degree to which they believe that the use of a new information technology (MaaS) will help improve mobility.
	Effort Expectation (EE)	5	The degree to which they believe that it is easy to use a new information technology (MaaS).
	Social Influence (SI)	5	The degree to which important people around the users feel that the users need to use a new information technology (MaaS).
	Individual Innovation (II)	5	The degree to which users tend to embrace new information technology (MaaS) before others
	Environment Concern (EC)	5	The degree to which the users are aware of the consequences or effects of a new information technology (MaaS) on environmental problems
Dependent Variable (DV)	Behavior Intention (BI)	5	The degree of subjective preference for MaaS technology

Table 4. Measurement conversion

Latent Variable	Variable number	Definition
Performance Expectation (PE)	PE 1	With MaaS, I will save money on the move.
	PE 2	MaaS will save my travel time.
	PE 3	If I use MaaS, I will be able to travel more conveniently.
	PE 4	Using MaaS will help me move more safely.
	PE 5	With MaaS, it will be convenient to experience various means of transportation on a single platform.
	PE 6	If I use MaaS, it will be convenient to check real-time information of various means of transportation.
	PE 7	If I use MaaS, it will be convenient to make integrated reservations and payments within a single platform (interface).
	PE 8	If I use MaaS, it will be convenient to recommend a variety of alternatives that reflect my own tastes and requirements.
Effort Expectation (EE)	EE 1	I will be able to easily learn how to use MaaS
	EE 2	I will be able to quickly learn how to use MaaS.
	EE 3	I will be able to easily become proficient in using MaaS.
	EE 4	I will not have any difficulties using MaaS.
	EE 5	I won't need much effort to use MaaS
Social Influence (SI)	SI 1	My people around me will encourage me to use MaaS.
	SI 2	People around me will think positively about my use of MaaS.
	SI 3	People around me will think that it is desirable for me to use MaaS.
	SI 4	People around me will expect me to use MaaS a lot.
	SI 5	People around me will be willing to try MaaS if I use MaaS.
Individual Innovation (II)	II 1	I tend to use or purchase new services/products like MaaS faster than others.
	II 2	I tend to try to learn how to use new services/products like MaaS.

	II 3	I am interested in finding information about new services/products such as MaaS.
	II 4	I have no fear of using new services/products like MaaS.
	II 5	I like to experiment with new services/products like MaaS.
Environment Concern (EC)	EC 1	I think MaaS will help reduce global warming.
	EC 2	I think energy saving can be done through MaaS.
	EC 3	I think using MaaS can reduce some air pollution.
	EC 4	I think the use of MaaS is more environmentally friendly than my existing mobile method.
	EC 5	I think MaaS will contribute to revitalizing the eco-friendly mobility ecosystem.
Behavior Intention (BI)	BI 1	I think MaaS is great.
	BI 2	I am positive about using MaaS.
	BI 3	I think MaaS is worth using.
	BI 4	I think MaaS will help a lot when traveling.
	BI 5	I think using MaaS will benefit me a lot.

3.3.2 Moderating Variables

As the goal of MaaS is to reduce or replace the use of private cars, this study aimed to understand the commuter characteristics and behaviors, considering car ownership, main means of transportation, number of days using PT, and smart mobility experience as moderator variables. The results would confirm whether these variables would have an impact on the technology acceptance behavior.

1) Car ownership

One of the main goals of developing MaaS is to reduce emissions from vehicles and traffic congestion. It is important to understand car owner behaviors by relating them to the latent variables.

2) Main means of transportation – Car/PT

As most users use a car or PT as their main means of transportation for commuting, it is important to understand the commuter behavior and their need to travel to encourage car users to use MaaS. The results can also show the need to use different approaches or strategies for each group.

3) Number of days using PT

It is highly likely that users with zero days of using PT would have a similar result as that of car users, and those five or more days of using PT would have a similar result to that of PT users. However, it is also important to understand users who use both the means for commuting. These users could be the key to help the switch from using a car to MaaS, thereby growing the market pie.

4) Experience with smart mobility services

As all the transport modes available in the market should be included in MaaS, it is crucial to relate MaaS to various kinds of smart mobility services. It can be presumed that users who have experience with smart mobility services will have a higher willingness to use MaaS than those who have no experience.

Chapter 4. Research Methods

4.1 Data Collection and Analysis Method

The survey was conducted online through the survey firm, *Macromill Embrain* in Korea. A total number of 571 participants was surveyed from May 5th to 10th, 2021. We had five restrictions toward participants. First, we restricted our participants to the people who live in the Metropolitan area, where half of Korean citizens are living in. Secondly, as the commuting purpose is the most traveling reason, we have selected people who are commuting regularly. Thirdly, students and the under 20s were exempted from the group since their commuting purpose and the way of choosing transportation is very restricted, unlike the other groups. Fourthly, we only let the participants participate in the survey only if they had an option to use public transportation. Fifthly, we split the group into car users and public transportation users by asking their main means of transportation for commuting. When the participants chose walking or carpooling for the answer, we exempted them from the survey since the percentage was very low and our main goal was to find different needs between Car users and PT users.

After reaching the desired restriction, participants went through a short quiz where they had to learn and understand the concept of MaaS. They were able to go to the next step until they got all quiz right. Then, participants were asked about their transportation characteristics, such as the possession of the car, duration time for commuting, duration time to the subway station from home, number of days for PT usage in a week, transfer times, and the method they use when using PT.

Next, a survey for learning the factors for accepting Smart Mobility of participants was followed. To have a clear definition for Smart Mobility services, characteristics and photos of Sharing Bike, Carsharing, Ridesharing, and Personal Mobility were given to the participants. The group was divided into two, according to their experience in using the given means of Smart Mobility. When the participant had experience with the given Smart Mobility, they were asked to rate the attitudes into 1) Very Dissatisfied, 2) Dissatisfied, 3) Moderate, 4) Satisfied and 5) Very Satisfied. The question asking desire to use Smart Mobility services in the future was followed.

Participants were then asked to answer the measurement variables of the research model. The operational definitions of the variables used in this study are shown in detail in Chapter 3.3.1 Latent Variables. All measurement items were made upon a 5-point Likert scale (1: not at all ~ 5: very much).

Participants were finally asked whether they would use MaaS for the different purposes of passage 1) Commuting, 2) shopping, 3) personal routine, 4) work, and 5) Leisure and travel. They were asked to rate the attitudes into 1) Not used, 2) Rarely, 3) Sometimes, 4) Often and 5) Always.

Out of total of 571 collected responses, 529 responses were used for analysis, excluding 42 inappropriate responses such as omissions or insincere responses. The efficiency of the questionnaires was 92.6%. The readers can find the detailed survey sheets in the Appendix. Descriptive statistics and reliability verification were performed using SPSS 24.0. Confirmatory factor analysis, structural model fit, and multi-group analysis were performed using AMOS 24.0.

4.2 Sociological and Demographic Characteristics of Participants

The demographic characteristics of the participants of this study are shown in Table 5. A total of 529 participants were surveyed, including 259 males (49.0%) and 270 females (51.0%). The age of the survey participants was evenly distributed with the number of 133 people (25.1%) in their 30s and 40s. It was followed by 132 people in their 50s (25.0%)

and 131 people in their 20s (24.8%). The number of people who earn an income of less than 3,000,000 won was 248 (46.9%) while the number of people who earn income more than 3,000,000 won was 281 (53.1%). When looking at the educational level, the majority of participants have graduated from college with the number of 379 people (71.6%). The next was followed by 74 people who have higher than graduate school enrolled. The number of high school graduates was 69 (13.0%) and that of college students was 7 (1.3%). Moreover, looking at the occupations of the survey participants, office/technical workers accounted for the most with 368 (69.6%), and it was followed by 59 Professional/Freelancer (11.2%), 42 Sales/Service (7.9%), 26 Management/managerial positions (4.9%), 12 Self-employed (2.3%), 12 General jobs (2.3%), and 10 Skilled/Skilled (1.9%).

Table 5. Socio-demographic distribution of participants

Moderator Variable	Variable	Total Sample Distribution (n=529)	Car Users Distribution (n=262)	PT Users Distribution (n=267)
Gender	Male	49.0% (259)	48.1% (126)	49.8% (133)
	Female	51.0% (270)	51.9% (136)	50.2% (134)
Age	20s	24.8% (131)	25.2% (66)	24.3% (65)
	30s	25.1% (133)	24.4% (64)	25.8% (69)
	40s	25.1% (133)	25.2% (66)	25.1% (67)
	50s	25.0% (132)	25.2% (66)	24.7% (66)
Income	Under 1,500,000 Won	2.1% (11)	0.4% (1)	3.7% (10)

	1,500,000 ~ 3,000,000Won	44.8% (237)	43.1% (113)	46.4% (124)
	3,000,000 ~ 5,000,000 Won	34.0% (180)	32.1% (84)	36.0% (96)
	Above 5,000,000 Won	19.1% (101)	24.4% (64)	13.9% (37)
Education	High School graduated	13.0% (69)	13.4% (35)	12.7% (34)
	University / college enrolled	1.3% (7)	1.5% (4)	1.1% (3)
	University / college graduated	71.6% (379)	68.3% (179)	74.9% (200)
	Higher than graduate school enrolled	14.0% (74)	16.8% (44)	11.2% (30)
Occupation	Self-employed	2.3% (12)	3.4% (9)	1.1% (3)
	Sales/Service	7.9% (42)	7.3% (19)	8.6% (23)
	Skilled/Skilled	1.9% (10)	2.7% (7)	1.1% (3)
	General job	2.3% (12)	2.3% (6)	2.2% (6)
	Office/Technical	69.6% (368)	63.7% (167)	75.3% (201)
	Management/manageria l positions	4.9% (26)	5.7% (15)	4.1% (11)
	Professional/Freelancer	11.2% (59)	14.9% (39)	7.5% (20)

4.3 Commuting Characteristics and Behavior of Participants

Participants' commuting characteristics and behavior can be found in table 6. First of all, the number of people who takes 10 or fewer minutes to get to public transportation was 289 (54.6%), while the number of people who takes more than 10 minutes to get to public transportation was 240 (45.4%). Next, the traveling time for commuting was surveyed. The most selected duration time was from 30 minutes to 1 hour (42.7%). Less than 30 minutes accounted for 30.4% and more than 1 hour accounted for 26.8%. While 25.5 percent of participants did not own a car, 74.5 percent of participants owned a car. However, the main means of transportation for commuting showed a somewhat different number. It was evenly distributed, with car users with 262 participants (49.5%) and PT users with 267 (50.5%) participants. Furthermore, when looking at the number of days of using PT, 5 or more days showed the most with 42.2 percentage. The reply for 1 to 4 days accounted for 27.0 percentage while no usage accounted for 30.8 percentage.

Table 6. Commuting characteristics and behavior of participants

Moderator Variable	Variable	Total Sample Distribution (n=529)	Car Users Distribution (n=262)	PT Users Distribution (n=267)
Means of Transportation	Car Users	49.5% (262)	-	-
	PT Users	50.5% (267)	-	-
Car Ownership	Yes	74.5% (394)	95.4% (250)	53.9% (144)
	No	25.5% (135)	4.6% (12)	46.1% (123)

No. of days using PT	0	30.8% (163)	62.2% (163)	0.0% (0)
	1~4	27.0% (143)	34.4% (90)	19.9% (53)
	5 or more	42.2% (223)	3.4% (9)	80.1% (214)
Distance to Public Transportation	Within 10 min.	54.6% (289)	49.6% (130)	59.6% (159)
	More than 10 min.	45.4% (240)	50.4% (132)	40.4% (108)
Duration Time	Less than 30 min.	30.4% (161)	48.1% (126)	13.1% (35)
	30 min. ~1h.	42.7% (226)	37.8% (99)	47.6% (127)
	More than 1h.	26.8% (142)	14.1% (37)	39.3% (105)
Smart Mobility Experience	Yes	49.9% (264)	45.0% (118)	54.7% (146)
	No	50.1% (265)	55.0% (144)	45.3% (121)

Next, questions were asked to understand participants' reason and discomfort for using Car/PT as their main means of transportation for commuting. Participants were asked to choose two reasons.

The main reason for choosing a car as a main means of transportation for commuting was the time (76.3%)(Figure 4). They answered that the car takes less time to their work than PT. The second was the convenience of traveling (47.3%). Accessibility to PT was 37.0

percentage and punctuality showed the least with 31.7 percentage. When using PT, two major discomforts were found, the crowd (80%) and inconvenience (65.2%)(Figure 5). The third discomfort factor was a transfer with 23.2 percentage and accessibility accounted for 22.1 percentage.

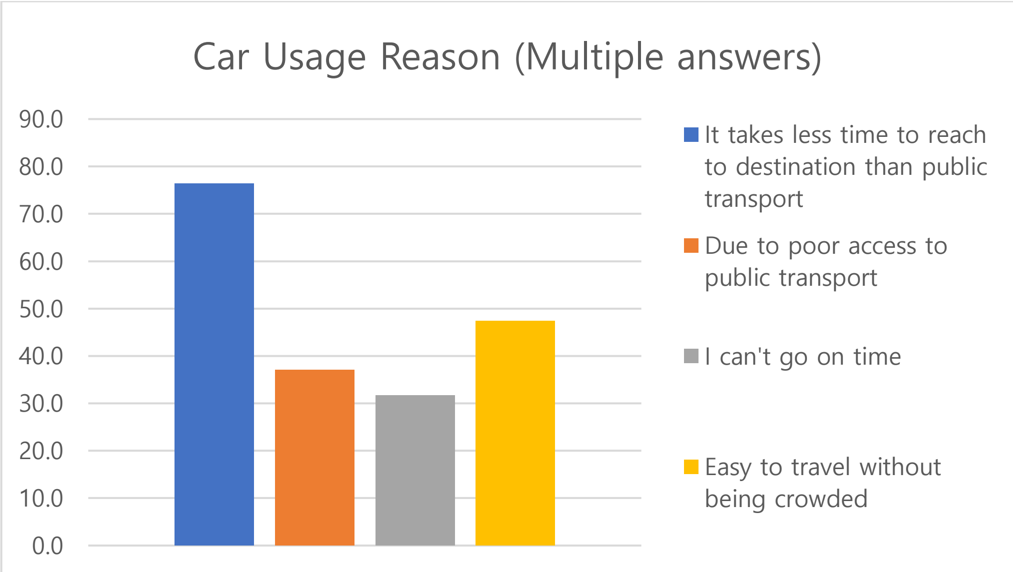

Figure 4. Reason for using a car when commuting

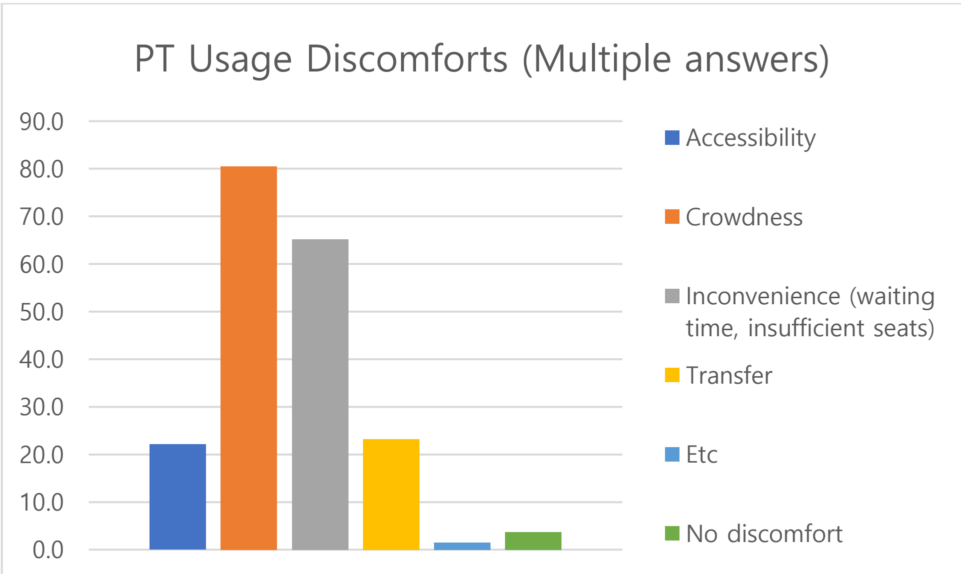

Figure 5. Discomforts when using PT for commuting

As it can be seen in Figure 6, most of the people were acquiring PT information by their phones before/while traveling (77.3%). The rest of the answers showed a somewhat similar ratio. Percentage of checking the information by the computer before traveling and at PT station showed the same rate of 7.4 percentage, while the percentage of not confirming the information indicated 7.9 percentage. This result shows again the validity and necessity of the development of MaaS as it would be beneficial for most of the people who use the smartphone for getting information for traveling.

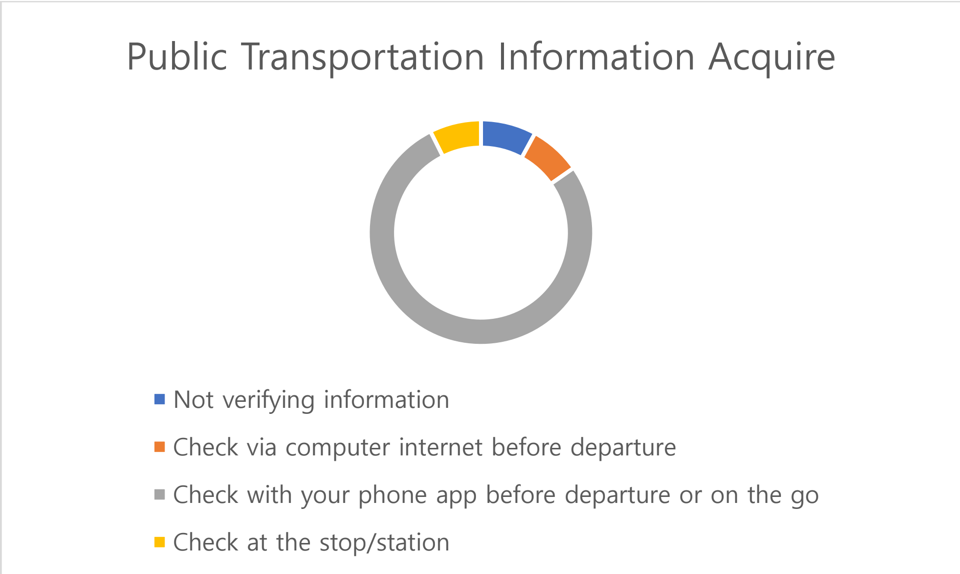

Figure 6. Method for acquiring PT information

4.4 Smart Mobility Experience of Participants

It is clear that most of the participants were aware of various kinds of Smart Mobility services as shown in Figure 7. Participants were asked to reply if they had known or experienced each type of Smart Mobility service; Carsharing, Shared Bikes, Personal Mobility, and Ridesharing. The type of Smart Mobility service which most of the participants have experienced was Carsharing (32.7%). The second most experienced mean was Shared Bikes (27.0%). Personal Mobility was followed by (16.3 %), and the least experienced mean was Ridesharing (9.8%).

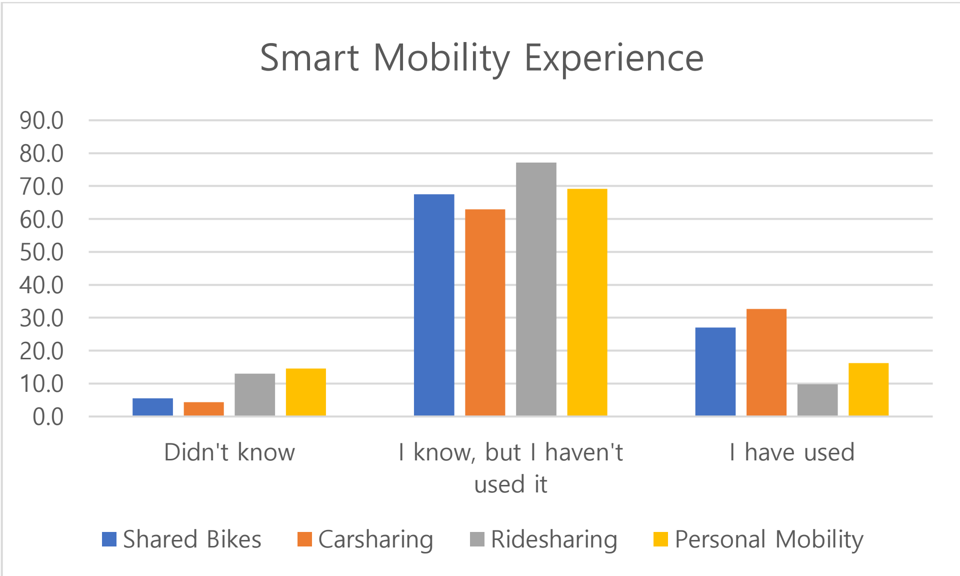

Figure 7. User's experience on Smart Mobility

As shown in Figure 8, the users' satisfaction with Smart Mobility was mostly high. The most satisfactory Smart Mobility service was found out to be Shared Bikes. While Carsharing and Ridesharing showed somewhat similar satisfactory rates, Personal Mobility was the only Smart Mobility service that showed a certain rate of dissatisfaction. Its' total dissatisfactory rate showed 11.6 percentage, while the other services showed less than 3 percentage.

Even if the users did not have experience with Smart Mobility yet as shown in Figure 7, many users showed high willingness to use Smart Mobility services in general as shown in Figure 9. Shared Bikes showed the most interest, as 70.3 percent of participants indicated that they would use them. The second most nominated Smart Mobility service was

Carsharing (58.8 %). The third was Personal Mobility (47.4 %) and Ridesharing (41.0 %) was followed by.

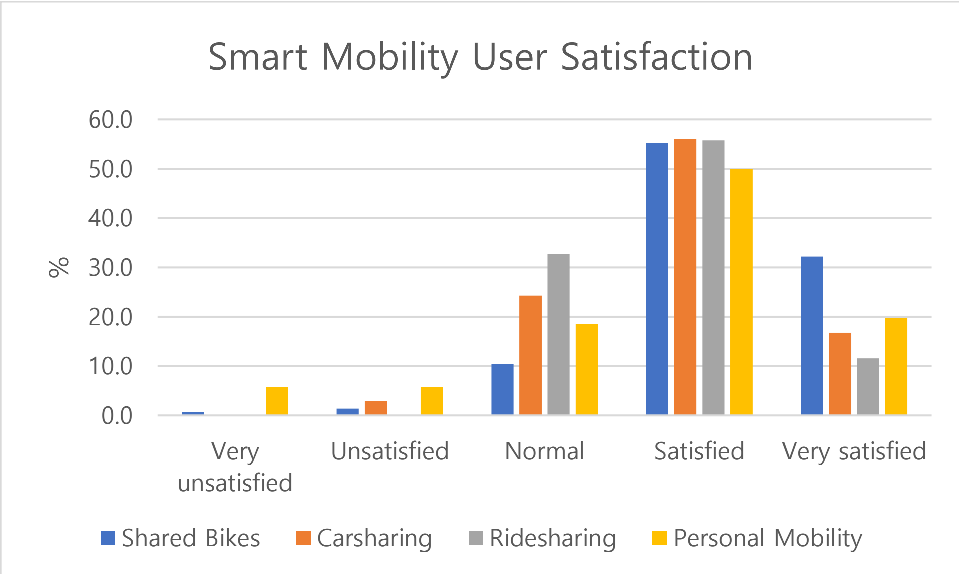

Figure 8. The degree of user's satisfaction of Smart Mobility

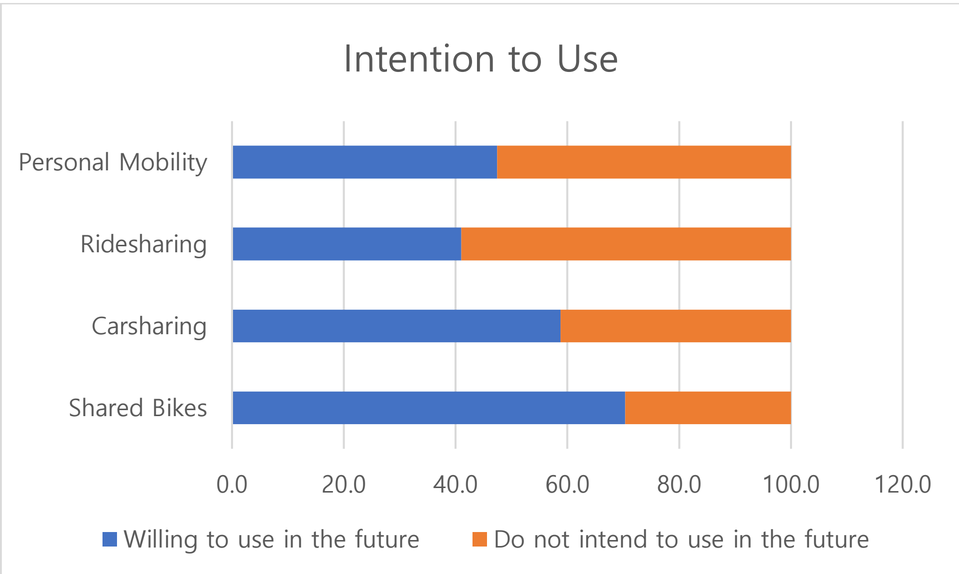

Figure 9. Intention to use Smart Mobility

Chapter 5. Results and Discussion

5.1 Reliability and Validity Tests

Before testing the research model using the structural equation model, reliability and validity analysis of the measured variables was performed (Table 7). For the reliability test, Chronbach's alpha coefficient was used. As a result of the reliability analysis, all variables met the generally accepted statistical criterion for determining reliability, 0.6 or higher. Both CR (Composite Reliability) and AVE (Average Variance Extracted) were higher than the general threshold values of 0.7 and 0.5, suggesting that the concentration validity of the construct was secured (Fornell and Larcker, 1981).

Table 7. Descriptive Statistics including Cronbach's Alpha

Variable	Items	Cronbach's Alpha	Composite Reliability	AVE
Performance Expectation (PE)	6	0.898	0.895	0.588
Effort Expectation (EE)	4	0.918	0.919	0.741
Social Influence (SI)	4	0.868	0.868	0.623
Individual Innovation (II)	4	0.881	0.881	0.650
Environment Concern (EC)	5	0.907	0.904	0.653
Behavior Intention (BI)	4	0.858	0.874	0.634

5.2 Exploratory Factor Analysis

As a result of the exploratory factor analysis with the model in Figure 10, 2 items of Performance Expectation, 1 item of Effort Expectation, 1 item of Social Influence, 1 item of Individual Innovativeness, 1 item of Behavioral Intention were dropped due to lack of identification and concentration validity.

However, overall, most of the measurement items of each variable were classified into 6 factors (Performance Expectation, Effort Expectation, Social Influence, Individual Innovation, Environment Concern, Behavior Intention) as expected. In addition, as a result of calculating the correlation coefficient between constructs in the measurement model (Table 8), the square value of the correlation coefficient between constructs was smaller than the variance extraction value, so discriminant validity was secured (Fornell and Larcker, 1981). In addition, the correlation between the constructs did not exceed 0.9 or more as suggested by Hair et al. (1998), indicating that multicollinearity does not exist.

Table 8. Model Validity Measures

	CR	AVE	MSV	MaxR(H)	II	PE	EE	SI	EC	BI
II	0.881	0.650	0.397	0.886	0.806					
PE	0.895	0.588	0.569	0.903	0.420	0.767				
EE	0.919	0.741	0.319	0.927	0.565	0.542	0.861			
SI	0.868	0.623	0.607	0.872	0.630	0.664	0.490	0.789		
EC	0.904	0.653	0.473	0.905	0.399	0.470	0.289	0.524	0.808	
BI	0.874	0.634	0.607	0.877	0.588	0.754	0.492	0.779	0.688	0.797

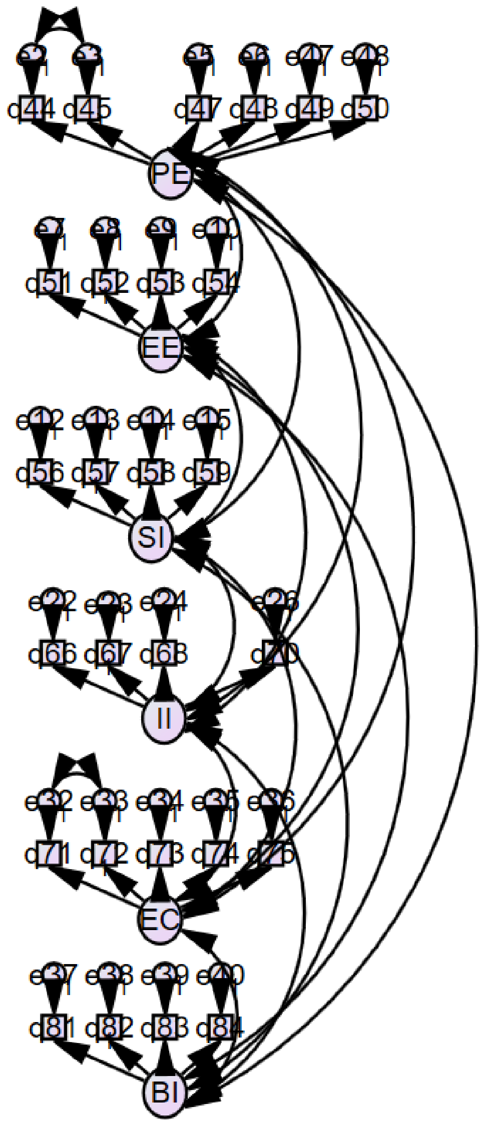

Figure 10. Exploratory Factor Analysis

5.3 Confirmatory Factor Analysis

A confirmatory factor analysis was performed on items whose conceptual validity was proven in the exploratory factor analysis. The path of the hypothesis model can be found in Figure 11. The overall goodness of fit of the model is the task of confirming the consistency of the actual or observed input matrix predicted from the proposed model (Suh & Han, 2003).

The verification results of the model are shown in Table 9 below and most of the overall fitness index met the recommended level of existing studies. The chi-square statistical value was found to be out of the recommended range. But, as the chi-square value is very sensitive to the size of the sample (Bentler & Bonett, 1980), it tends to appear insignificant when the sample size is rather large as in this study. (Suh & Han, 2003). The GFI (Goodness of Fit Index) was found to exceed the recommended value of 0.8 (Etezadi-Amoli & Farhoomand, 1996) of previous studies, indicating that the overall model was suitable. In addition, since the incremental fit indices (NFI, CFI) and absolute fit indices (GFI, AGFI, RMR, RMSEA) all met the recommended values, it can be judged that the fit of the model of this study was secured.

Table 9. Model Fit Measures for Confirmatory Factor Analysis

Measure	Estimate	Recommendation	Interpretation
χ^2	530.767		Acceptable
NFI	0.947	>0.90	Acceptable
CFI	0.977	>0.90	Acceptable
GFI	0.931	>0.80	Acceptable
AGFI	0.914	>0.80	Acceptable
RMR	0.026	<0.10	Acceptable
RMSEA	0.037	<0.08	Acceptable

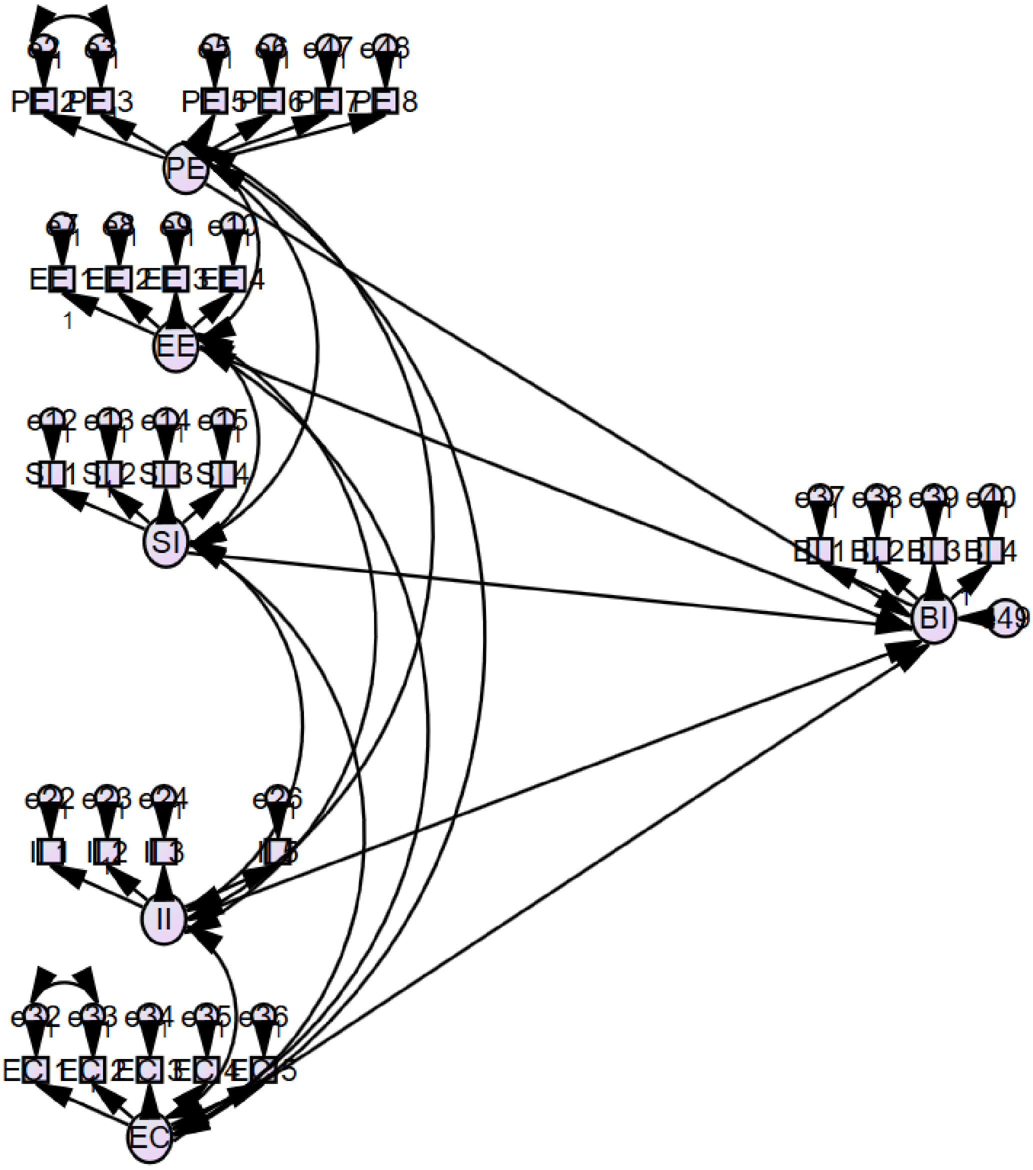

Figure 11. Path Analysis Model

5.4 Structural Equation Modeling Results – Total Sample

The modified adaption model calculated with Amos 24.0. is shown in Table 10. When reading the standardized regression estimates, it can be interpreted that a greater influence is expected from the coefficient with a higher absolute value. In addition, whether to accept the hypothesis or not is expressed as a C.R. value and is judged based on ±1.96, and the significance level value (P-Value), which is judged based on 0.05 or less. The P-value which is less than 0.001 is indicated with the '***' sign, that which is less than 0.01 is indicated with the '**' sign, and that which is less than 0.05 is indicated with the '*' sign.

5.4.1 Total Sample Result

As shown in Table 10, all paths except EE had a significant coefficient value. PE, SI, and EC strongly influenced the BI with P-values less than 0.001. II also showed an influence with p-values less than 0.004. The study then focused on obtaining the standardized coefficients of the paths. Figure 12 shows the results of the standardized coefficients written on the research model.

Detailed hypothesis results of the observed variables can be found in Table 11. As the P-value of EE toward the BI was 0.689, H2 was rejected. On the other hand, H1, H3, H4, and H5 were supported as PE, SI, and EC showed positive influences on the BI.

PE gave an important result by showing a significant positive impact on the user willingness to use MaaS. As the observed variables were compared, the convenience of checking the real-time information of various means of transportation (PE 6) was found to be the main user demand from the MaaS performance. The second-ranked demand was the convenience of making reservations and payments on a single platform (PE 7). The third was the convenience of experiencing various means of transportation on a single platform (PE 5). The convenience of obtaining a recommendation of various alternatives that reflected the user tastes and requirements (PE 8) was ranked fourth.

Furthermore, PE showed the largest path impact coefficient on the BI. This means that commuters had a strong willingness to use MaaS if the above stated demands (PE 3,5,6,7,8) for commuting or the reduction of time (PE 2) were met. EC showed the second largest path impact coefficient on the BI. As environmental issues are increasing, if the reduction of CO_2 can be validated and emphasized using MaaS, more people would become users of MaaS. SI also showed a significant path impact coefficient on the BI. This indicates that MaaS usage will be affected by public opinion or that of the people close to the user to some extent. Lastly, as II showed some positive path impact coefficient on the BI, willingness to use MaaS exists to some extent in commuters who are more open to innovation.

Table 10. Regression Weights for the Total Sample

Hypothesis & Path	Estimate (Standardized)	S.E.	C.R.	P-Value	Significance
H1 PE → BI	0.362	0.046	7.009	<0.001	***
H2 EE → BI	-0.016	0.029	-0.4	0.689	
H3 SI → BI	0.300	0.046	5.407	<0.001	***
H4 II → BI	0.132	0.033	2.893	0.004	**
H5 EC → BI	0.313	0.029	7.98	<0.001	***

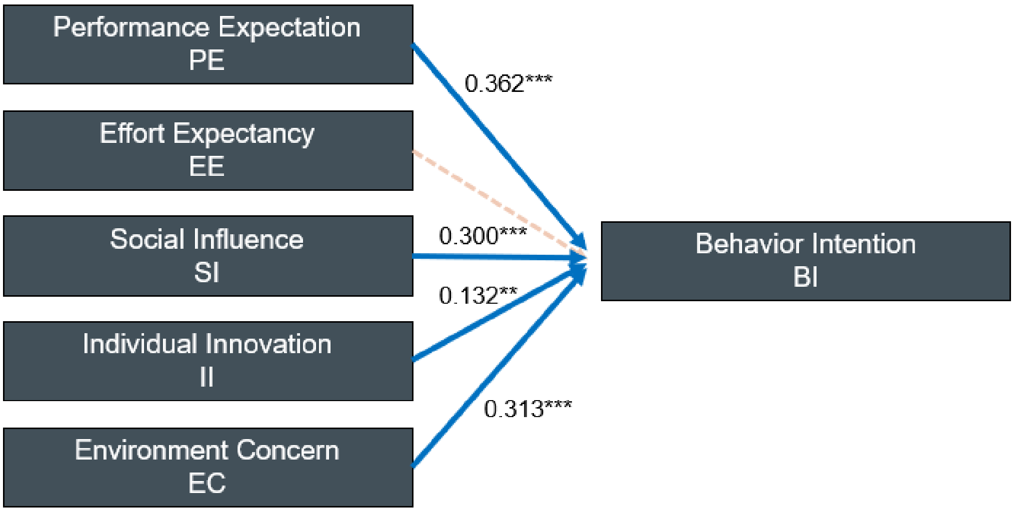

Figure 12. SEM Results of Total Sample

Table 11. Hypotheses Testing from SEM Results

Hypothesis & Path			C.R.	P-Value	Estimate (Standardized)	Result
BI	<---	PE	7.009	***	0.362	Supported
PE 2	<---	PE			0.677	Supported
PE 3	<---	PE	19.679	***	0.707	Supported
PE 5	<---	PE	16.033	***	0.782	Supported
PE 6	<---	PE	17.066	***	0.843	Supported
PE 7	<---	PE	16.627	***	0.816	Supported
PE 8	<---	PE	15.718	***	0.764	Supported
BI	<---	EE	-0.4	0.689	-0.016	Not Supported
EE 1	<---	EE			0.906	Supported
EE 2	<---	EE	30.469	***	0.893	Supported
EE 3	<---	EE	26.82	***	0.839	Supported
EE 4	<---	EE	24.429	***	0.8	Supported
BI	<---	SI	5.407	***	0.3	Supported
SI 1	<---	SI			0.818	Supported
SI 2	<---	SI	21.243	***	0.828	Supported

SI 3	<---	SI	19.149	***	0.764	Supported
SI 4	<---	SI	18.464	***	0.743	Supported
BI	<---	II	2.893	0.004	0.132	Supported
II 1	<---	II			0.762	Supported
II 2	<---	II	19.684	***	0.841	Supported
II 3	<---	II	19.748	***	0.844	Supported
II 5	<---	II	18.006	***	0.774	Supported
BI	<---	EC	7.98	***	0.313	Supported
EC 1	<---	EC			0.809	Supported
EC 2	<---	EC	24.398	***	0.811	Supported
EC 3	<---	EC	21.169	***	0.835	Supported
EC 4	<---	EC	19.375	***	0.777	Supported
EC 5	<---	EC	20.338	***	0.808	Supported
BI 1	<---	BI			0.736	Supported
BI 2	<---	BI	18.496	***	0.814	Supported
BI 3	<---	BI	18.713	***	0.823	Supported
BI 4	<---	BI	18.394	***	0.81	Supported

5.5 Structural Equation Modeling Results - Multigroup Analysis

After testing the model with all the participants, this study analyzed several grouping dimensions to understand the characteristics and behavior of different groups of commuters. The first group analysis was performed by grouping the commuters into car owners and non-owners. The second group analysis was performed by grouping them into car users and PT users. The third group analysis was performed by grouping them according to the number of days per week they used PT for commuting: those that used PT for zero days, one to four days, and five or more days per week. The fourth group analysis was performed by grouping them into people who have experienced smart mobility and those who have not experienced smart mobility. All the group analyses were done on two or three groups, and it was possible to calculate the path impact coefficients as the number of people in each divided group was more than 20% of the total participants, which is the minimum requirement.

A chi-square difference test was performed to understand and compare the groups. P-values were found through a nested model comparison, which constrained one path across the groups equally. If the chi-square difference test shows significant results, it indicates that the effect on each group is different. In the case of the chi-square difference test, the path with a coefficient less than 0.10 is highlighted in bold, meaning the study had a 90% confidence level.

5.5.1 Multigroup Analysis - Car Ownership

To understand the commuter travel behavior thoroughly, the first group comparison was performed by dividing them into two groups according to car ownership. The same analysis procedure as on the total sample group was performed, and the results are shown in Figure

13 and 14. The number of car owners was 394 (74.5%), and that of non-owners was 135 (25.5%).

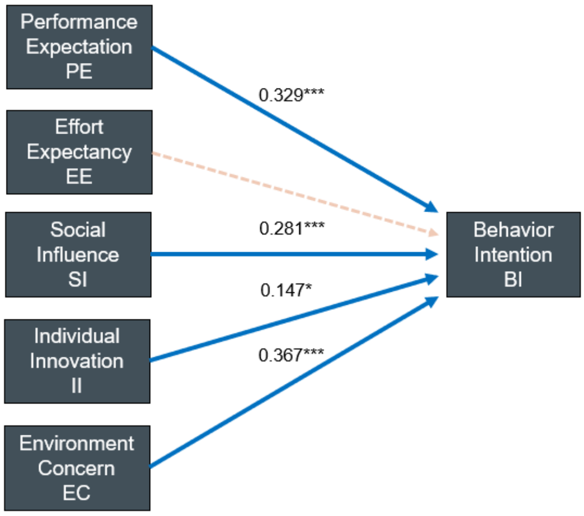

Figure 13. SEM Results for car owners

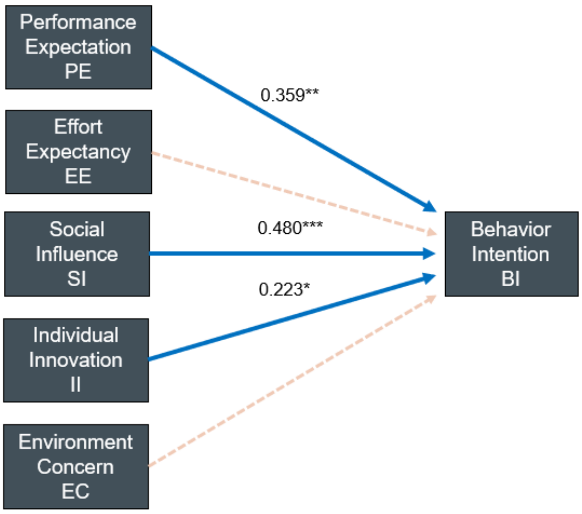

Figure 14. SEM Results for non-owners

For the car owner group, the sign and magnitude of the results showed a similar pattern to those of the total sample group. However, this was not the case for the non-owner group.

The significant difference was from the EC, which showed a significant effect on the car owner group similar to the total sample group, whereas it showed no significance on the non-owner group. As shown in the nested model comparison in Table 12, car owners showed more EC when using MaaS than non-owners.

Table 12. Comparison of Coefficients and P-Value on Car Owners/Non-owners Groups

Hypothesis & Path	Owners		Non-owners		Nested Model Comparison (P)
	Path Coefficient	P-Value	Path Coefficient	P-Value	
H1 PE → BI	0.329	***	0.359	**	0.782
H2 EE → BI	-0.032	0.474	-0.102	0.249	0.565
H3 SI → BI	0.281	***	0.48	***	0.205
H4 II → BI	0.147	*	0.223	*	0.468
H5 EC → BI	**0.367**	***	0.088	0.284	**0.002**

5.5.2 Multigroup Analysis - Car Users and PT Users

The second group comparison was performed by dividing the total sample into two groups: car users and PT users. The same analysis procedure as on the total sample group was performed, and the results are shown in Figure 15 and 16. There were 262 car users (49.5%) and 267 PT users (50.5%).

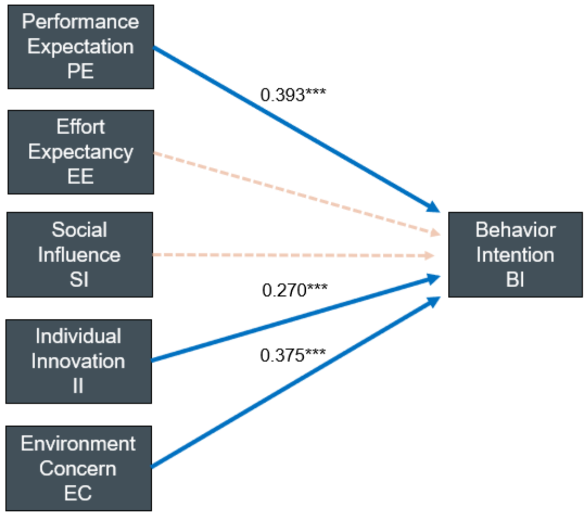

Figure 15. SEM Results for a group of car users

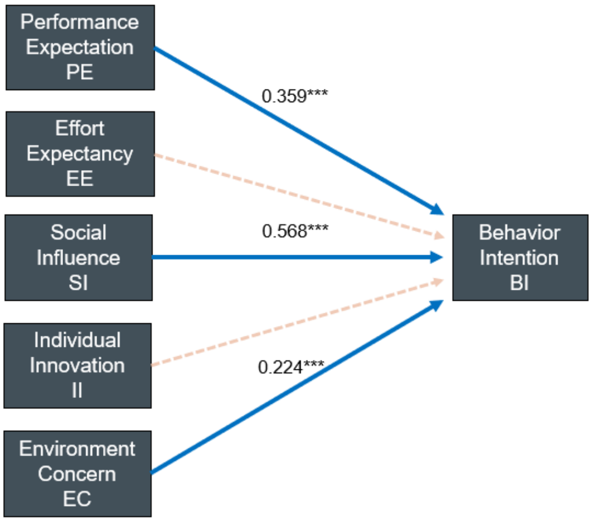

Figure 16. SEM Results for a group of PT users

For the car user group, the sign and magnitude of the results showed a similar pattern to those of the total sample group except for SI, which had no impact, and II, which showed a more significant effect than on the total sample group. In contrast, the magnitude of the results for the PT user group showed a similar pattern to those of the total sample group except II, which showed no impact, and SI, which showed a more significant effect than on the total sample group.

The nested model comparisons for II and SI given in Table 13 show that car users had a greater tendency to embrace the new technology (MaaS) than PT users, whereas PT users were more affected by SI when using MaaS than car users.

Table 13. Comparison of Coefficients and P-Value on Car/PT Groups

Hypothesis & Path	Car Users		PT Users		Nested Model Comparison (P)
	Path Coefficient	P-Value	Path Coefficient	P-Value	
H1 PE → BI	0.393	***	0.256	***	0.25
H2 EE → BI	-0.026	0.668	-0.058	0.288	0.67
H3 SI → BI	0.124	0.139	**0.568**	***	**0.001**
H4 II → BI	**0.27**	***	0.025	0.689	**0.012**
H5 EC → BI	0.375	***	0.224	***	0.174

5.5.3 Multigroup Analysis - Days of Using PT

The third group analysis was performed by grouping the commuters according to the number of days they used PT for commuting per week into three groups: zero days, one to four days, and five or more days. The same analysis procedure as on the total sample group was performed, and the results are shown in Figure 17, 18, and 19. The number of people was 163 (30.8%) in the first group (PT use of zero days), 143 (27.0%) in the second group (one to four days of PT use), and 223 (42.2%) in the third group (five or more days of PT use).

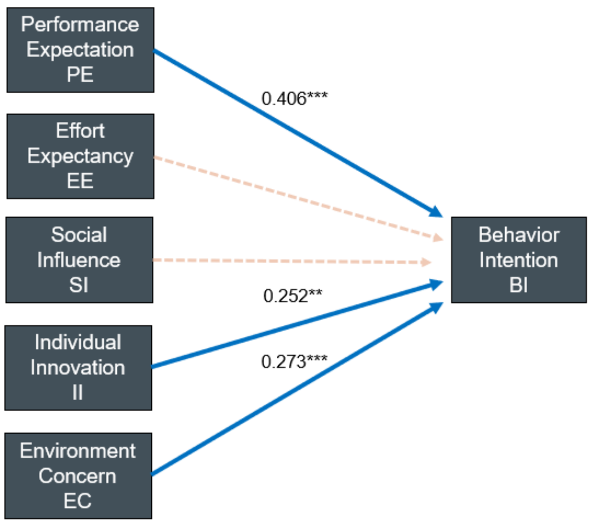

Figure 17. SEM Results for a group of 0 days of using PT

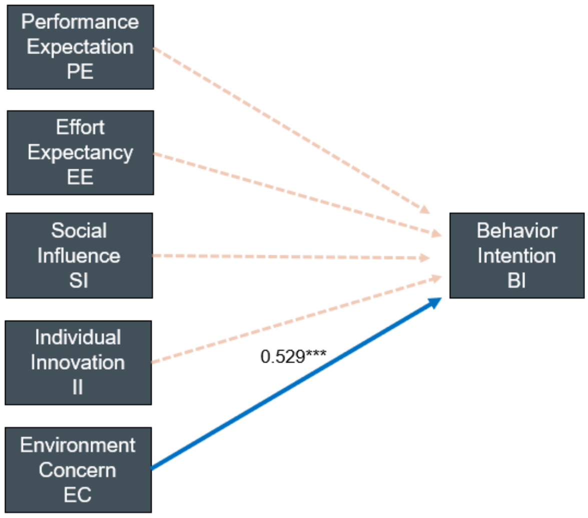

Figure 18. SEM Results for a group of 1 to 4 days of using PT

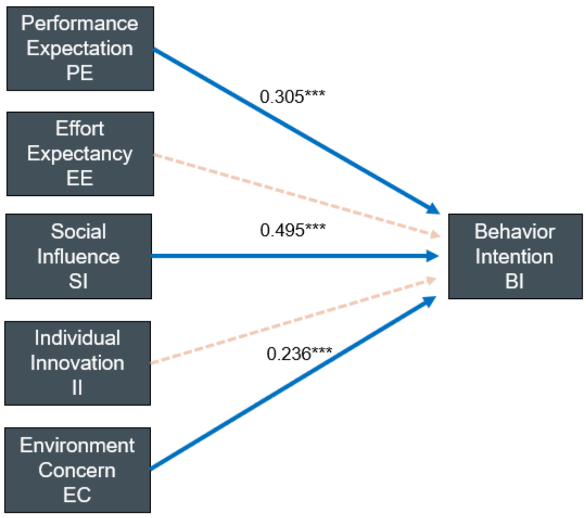

Figure 19. SEM Results for a group of 5 or more days of using PT

The first and third group results showed a similar pattern as those of the car user group and PT user group from the previous group analysis, respectively, which was expected. The most interesting result was seen in the second group, where, unlike all other groups, EC was the only factor that showed a significant effect. The nested model comparisons for SI and EC are given in Table 14. The results showed that EC had a larger effect on the MaaS usage of commuters who use both car and PT than those who use only cars or PT for commuting. Moreover, SI affected the MaaS usage of the third group, which consists of people from the PT user group from the previous analysis, more than the other groups.

Table 14. Comparison of Coefficients and P-Value on days of using PT

Hypothesis & Path		0 day		1 to 4 days		5 or more		Nested Model Comparison (P)
		Path Coefficient	P-Value	Path Coefficient	P-Value	Path Coefficient	P-Value	
H1	PE → BI	0.406	***	0.187	0.083	0.305	***	0.497
H2	EE → BI	-0.053	0.462	0.103	0.255	-0.072	0.22	0.193
H3	SI → BI	0.21	0.07	0.159	0.204	**0.495**	***	**0.059**
H4	II → BI	0.252	**	0.187	0.086	0.059	0.373	0.152
H5	EC → BI	0.273	***	**0.529**	***	0.236	***	**0.003**

5.5.4 Multigroup Analysis - Smart Mobility Experience

The fourth group analysis was performed by dividing the total sample into two groups: people who have experience with smart mobility (experienced group) and those who have no experience with smart mobility (inexperienced group). The same analysis procedure as on the total sample group was performed, and the results are shown in Figure 20 and 21. The number of people was 264 (49.9%) in the experienced group, and 265 (50.1%). in the inexperienced group. The experienced group included the participants who had experience with any of the following four smart mobility services: carsharing, shared bikes, personal mobility, and ridesharing.

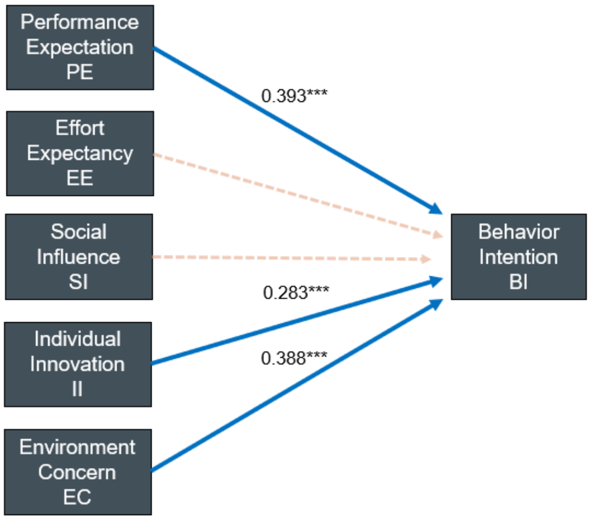

Figure 20. SEM Results for Smart Mobility Experienced Group

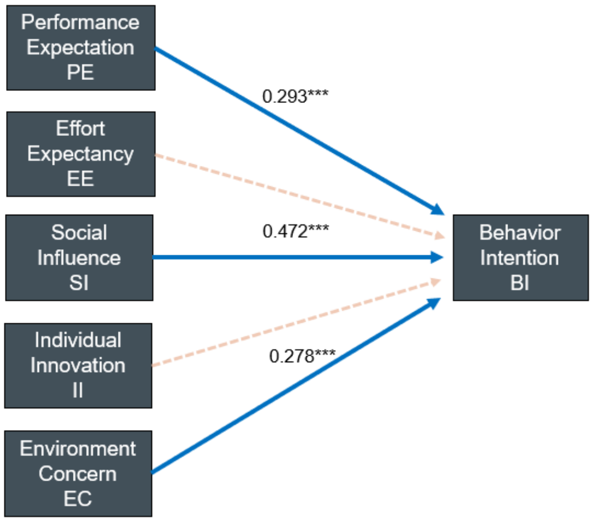

Figure 21. SEM Results for Smart Mobility Inexperienced Group

Interestingly, for such a division of the groups, the sign and the magnitude of the results showed a similar pattern as those of the Car/PT user groups from the second group analysis except PE. SI had no impact on the experienced group, whereas II showed a more significant effect than on the total sample group. In contrast, the results of the inexperienced group showed a similar pattern to those of the total sample group, except II, which had no impact, and SI, which showed a more significant effect than on the total sample group.

The nested model comparisons for PE, II, and SI are given in Table 15. First, PE had a significant effect on the BI of both the groups, with the effect being larger on that of the experienced group. Second, the positive effect of II was stronger on the BI of the experienced group than on that of the inexperienced group. Third, the positive effect of SI was stronger on the BI of the inexperienced group than on that of the experienced group.

Table 15. Comparison of Coefficients and P-Value on Smart Mobility Groups

Hypothesis & Path	Experienced		Inexperienced		Nested Model Comparison (P)
	Path Coefficient	P-Value	Path Coefficient	P-Value	
H1 PE → BI	**0.393**	***	0.293	***	**0.087**
H2 EE → BI	-0.009	0.887	-0.075	0.175	0.465
H3 SI → BI	0.059	0.563	**0.472**	***	**0.003**
H4 II → BI	**0.283**	***	0.077	0.186	**0.047**
H5 EC → BI	0.388	***	0.278	***	0.183

Chapter 6. Conclusion

6.1 Research Summary

This study explored the factors that affect the user acceptance of MaaS using the constructs from the UTAUT model along with the concepts of II and EC. PE, EE, SI, II, and EC were considered as the independent variables, with BI as the dependent variable. We tested the hypotheses using structural equation modeling (SEM) by analyzing the data from our own survey of 529 commuters from the metropolitan areas of Korea. The empirical results showed that most of the hypotheses were supported by the analysis, except the hypothesis stating the effect of EE on BI, which was not supported. After understanding the model with all the participants, we analyzed several grouping dimensions to understand the characteristics and behaviors of different groups of commuters. The group analyses were performed by grouping the participants based on car ownership, car/PT use, number of days they use PT for commuting, and experience with smart mobility. The implications of the results of the multigroup analyses are discussed in detail in the following section.

6.2 Implications

Several market penetration strategies can be developed for the early stages of MaaS development in metropolitan areas in Korea.

First, MaaS is a service that provides the convenience for users to experience various means of transportation on a single platform, to check the real-time information of various means of transportation, to make reservations and payments on a single platform, and to obtain a recommendation of various alternatives that reflect their tastes and requirements. These factors complicate the separate tasks during early development because the data and algorithms from many related companies have to fit into one platform. By comparing the effects of the observed variables PE, it was found that the users valued the convenience of checking the real-time information of various means of transportation the most. The second-most valued service was the option of making reservations and payments on a single platform. The value of experiencing various means of transportation on a single platform was ranked third. The least valued service was receiving a recommendation of various alternatives that reflected their tastes and requirements. Furthermore, as the PE showed the largest path impact coefficient on the BI, once the above stated conveniences for commuting or the reduction of time are ensured, commuters would show a high willingness to use MaaS. This can also be seen from the results of the survey from section 4.3.

Second, EC and SI showed significant influence on the BI. As environmental issues are increasing, if the reduction of CO_2 can be validated and emphasized using MaaS, more people would start using it. The SI result indicates that MaaS usage will be affected by public opinion or the opinion of those close to the users to some extent. When SI and EC are put together, as the usage of MaaS becomes more environmentally friendly and the people's awareness of environmental issues increases, MaaS is expected to have a synergistic effect on market growth.

Third, multigroup analyses were performed to understand the characteristics and behavior of different groups of commuters. The multigroup analysis based on car ownership found that car owners showed more EC when using MaaS than non-owners. A similar result was obtained from the multigroup analysis based on the number of days people use PT for commuting. EC had the greatest influence on the MaaS usage of commuters using PT for one to four days in a week. It would be an effective promotional strategy to emphasize the environmental friendliness of MaaS to attract car owners and PT users to use MaaS. Moreover, the results showed that car users have a greater tendency to embrace a new technology (MaaS) than PT users. As most car users use navigation apps such as T maps or Kakao Maps in Korea, updating users with new services or information related to MaaS could lead to MaaS becoming a dominant player in the market. On the other hand, as SI affects the MaaS usage of PT users more than that of car users, a valid strategy could be to promote MaaS among PT users via social network service.

Lastly, a multigroup analysis was performed based on the level of experience of the users with smart mobility. PE and II had a positive influence on the BI of users with smart mobility experience. Moreover, as seen from section 4.4, although smart mobility experience of participants was low, their intention to use rate was high. The smart mobility services are ranked as follows based on the user demand: 1. Shared Bikes, 2. Carsharing, 3. Personal Mobility, and 4. Ridesharing. When developing MaaS in the early stages, it would be wise to combine the stated smart mobility services in the order of demand by updating the functions of the stated conveniences (observed variables of PE) in order. Moreover, as II showed a positive path impact on the BI of users with smart mobility experience, it would be a win-win strategy for MaaS platform developers to make joint MaaS packages with smart mobility companies.

6.3 Limitations

This study has several limitations as listed below. First, this study was restricted to metropolitan areas in Korea. The areas of the country where the rest of the Korean citizens live do not have well developed PT. MaaS could have a higher demand in such local regions (Park, 2019). Second, this study focused only on the commuting purpose of traveling, excluding the many other purposes of traveling, such as shopping, leisure or trips, and daily trips (Shin et al., 2019). There is considerable room for further research to be done on the user willingness to use MaaS for the several purposes of travel as shown in Figure 22. As MaaS development is mainly split into two paths of the commuting purpose and other purposes of travel, further research is needed to understand the users acceptance of MaaS for other purposes of travel. Third, smart mobility is not equally developed within the metropolitan areas in Korea; therefore, more precise results would be obtained by conducting further research in specific regions with certain modes of smart mobility to help the early adoption of MaaS in those targeted regions (Kim et al, 2019). Fourth, because of their invalidity and high correlation with the other variables, 'Facilitating Condition' and 'Perceived Risk' were excluded from the very first planned model. Further research could be done to observe the effects of the 'Facilitating Condition' and 'Perceived Risk' variables with carefully designed questions.

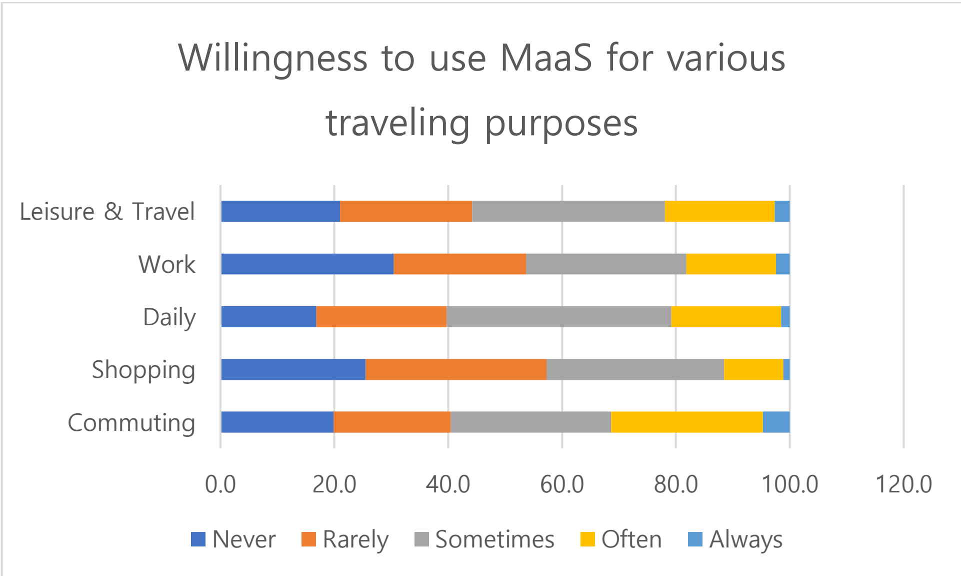

Figure 22. Willingness to use MaaS for various traveling purposes

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Appendix 1: Survey Sheet

SQ1. 귀하의 성별은 무엇입니까?

1) 남성 2) 여성

SQ2. 귀하의 연령은 어떻게 되십니까? [출생연도]

1) 만 19 세 미만 2) 만 19~29 세 3) 만 30~39 세 4) 만 40~49 세

5) 만 50~59 세 6) 만 60 세 이상

[2~6 번 보기 응답자만 진행]

SQ3-1. 귀하의 거주지역은 어떻게 되십니까? [지도제시][시군구까지 제시]

[서울, 경기, 인천 거주자 진행]

SQ3-2. 귀하의 회사(또는 출근 기관) 위치는 어디 십니까? [지도제시] [시군구까지 제시]

[서울, 경기, 인천 거주자 진행]

SQ4. 귀하의 직업은 어떻게 되십니까?

1) 자영업(종업원 9 명 이하 소규모 업장 운영/가족종사자)

2) 판매/서비스직(상점 점원, 세일즈맨 등)

3) 기능/숙련공(운전사, 선반/목공, 숙련공 등)

4) 일반작업직(토목 현장 작업/청소/수위/육체노동 등)

5) 사무/기술직(일반회사 사무직/기술직 등)

6) 경영/관리직(5 급 이상 공무원/기업체 부장 이상 등)

7) 전문/자유직(교사/대학교수/의사/변호사/예술가/종교인 등)

8) 학생

9) 전업주부

10) 기타 (   )

[1~7 번 응답자 조사 진행]

SQ5. 귀하가 사는 지역은 지하철 이용이 가능한 지역인가요?

1) 네   2) 아니오 => 조사 중단

SQ5-1. 귀하는 정기적인 출퇴근을 하시나요?

1) 네   2) 아니오 => 조사 중단

SQ5-2. 통근 시 주로 이용하는 교통수단은 무엇인가요?

1) 자가용 => SQ6-1 로 이동

2) 대중교통(버스 혹은 지하철) => SQ6-2 로 이동

3) 기타 => 조사 중단

[SQ5-2 에서 1 번 응답자]

SQ6-1. 통근 시 자가용 이용을 하는 이유는 무엇인가요? 중요도 순으로 2 개를 선택해 주세요 [2 순위형, 2 순위 필수]

1) 대중교통에 비해 목적지까지 걸리는 소요시간이 적어서

2) 대중교통 접근성이 좋지 않아서

3) 원하는 시간에 맞춰 갈 수 없어서

4) 혼잡하지 않고 편하게 이동할 수 있어서

5) 기타 (______________________)

[SQ5-2 에서 2 번 응답자]

SQ6-2. 통근 시 대중교통 이용을 하며 겪는 불편사항은 무엇인가요? 중요도 순으로 2 개를 선택해 주세요 [2 순위형, 2 순위 필수]

1) 접근성

2) 혼잡함

3) 불편함 (대기시간, 좌석부족)

4) 환승

5) 기타 (______________________)

6) 불편사항 없음

통합모빌리티 서비스(MaaS)의 수용 요인에 대한 연구 설문

안녕하십니까? 먼저 설문에 응해주셔서 대단히 감사합니다.

본 설문은 정기적으로 수도권에서 출퇴근하는 이를 대상으로 **통합 모빌리티 서비스 (MaaS: Mobility as a Service)에 대한 사람들의 선호도를 조사하고자** 작성되었습니다.

여러분의 설문을 통하여 분석된 결과는 중요한 학술자료로 활용될 것이며, 다른 목적으로 사용되거나 외부로 유출되지 않을 것을 약속드립니다.

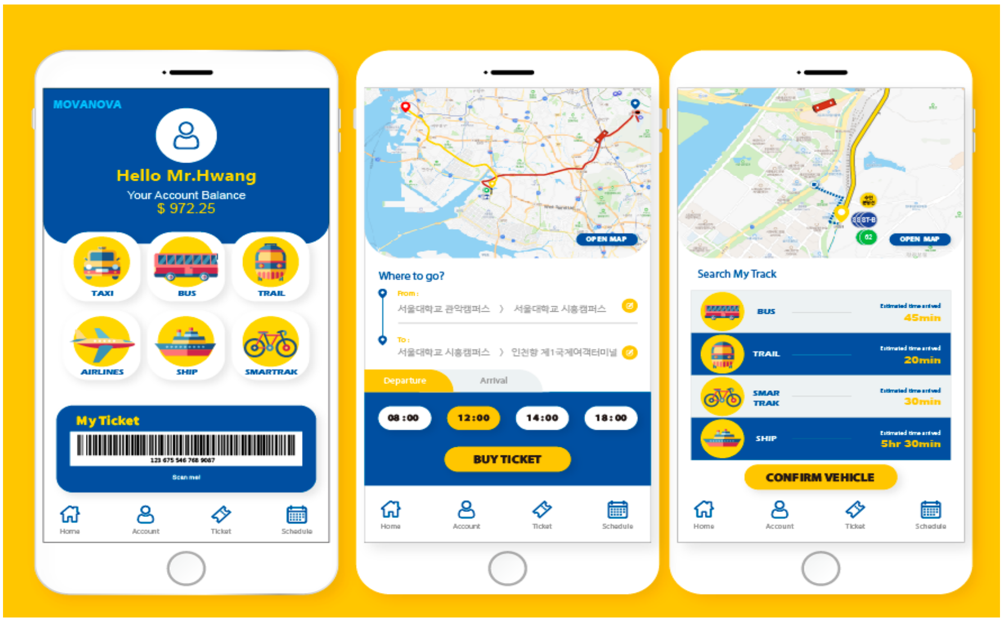
설문의 문항과 보기를 자세히 읽고 응답해 주시기 바랍니다.

감사합니다.

[화면제어 10 초]

<Mobiliy as a Service 의 정의>

Mobiliy as a Service(MaaS)는 이용자가 원하는 목적지까지 모든 교통수단(버스, 지하철, 택시, 카풀, 공유자전거 등등)을 조합하여 실시간으로 이용자의 선호(시간, 가격, 선호수단, 적은 환승 등등)에 맞게 이동 경로 및 수단 등을 추천해주는 앱 서비스입니다. 이는 현재 네이버맵, 카카오맵의 진화 형태라고 이해하시면 됩니다. 또한, 목적지까지 가는데 필요한 모든 수단에 대한 예약과 결제가 통합되어 있어 앱에 미리 등록된 카드로 한 번에 결제가 가능합니다.



[MaaS 애플리케이션]

Q0. [이해도 테스트] 다음 중 MaaS 의 특징으로 옳은 것을 모두 고르세요.

	O	X
다양한 수단이 조합된 경로를 추천		
미리 등록된 카드로 간편하게 결제 가능		
목적지까지 가는 데 가장 저렴한 조합을 우선으로 추천		

[(1) O (2) O (3) X, 정답자만 다음으로 이동, 오답자는 해설을 보여줍니다. (팝업)]

해설(팝업 문구)

(1) MaaS 의 특징은 버스, 지하철, 택시, 카풀, 공유자전거 등 다양한 수단이 조합된 경로를 추천해주는 것입니다. (2) MaaS 는 목적지까지 가는데 필요한 모든 수단에 대한 예약과 결제가 통합되어 있어 앱에 미리 등록된 카드로 한 번에 결제가 가능합니다. (3) 목적지까지 가는 데 이용자의 선호(시간, 가격, 선호 수단, 적은 환승 등등)에 맞게 이동 경로 및 수단 등을 추천해주게 됩니다.

B11. 귀하의 운전 가능 여부는 어떻게 되나요?

1) 가능 2) 불가능(무면허, 장롱 면허, 신체적 불편 등)

[B11 에서 1 번 응답자 질문]

B12. 귀하의 자가용 소유 여부는 어떻게 되나요? (출퇴근 시 본인이 주로 사용하는 가족 차 포함)

1) 유 2) 무

B13. 귀하가 평소 출근할 때 걸리는 시간은 얼마입니까?

1) 30 분 미만 2) 30 분 이상 1 시간 미만

3) 1 시간 이상 1 시간 반 미만 4) 1 시간 반 이상 2 시간 미만

5) 2 시간 이상

B14. 귀하의 집에서 지하철 정거장까지 걸어가는데 소요되는 시간은 얼마입니까?

[1~60] 분

B15. 귀하의 집에서 통근 시 대중교통(버스 및 지하철)을 일주일에 며칠 정도 이용하십니까?

1) 0 일 2) 1 일 3) 2 일 4) 3 일 5) 4 일

6) 5 일 7) 6 일 이상

[B15 에서 2~7 번 응답자 질문]

B16. 귀하의 집에서 통근 시 대중교통(버스 및 지하철)을 이용할 때 평균 환승 횟수는 어떻게 되십니까?

1) 0 회 2) 1 회 3) 2 회 4) 3 회 5) 4 회 이상

B 17. 대중교통 이용 시 정보습득 방법은?

(1) 정보를 확인하지 않음

(2) 출발하기 전 컴퓨터 인터넷을 통해 확인

(3) 출발하기 전이나 이동 중 핸드폰 앱으로 확인

(4) 정류장/역에서 확인

(5) 기타 (____________________)

C. 스마트 모빌리티 수용 요인 조사

[화면제어 20 초]

<스마트 모빌리티의 정의>

스마트 모빌리티란 첨단 정보통신 및 교통 기술의 발전으로 등장한 새로운 교통 서비스로서 공유 자전거, 카셰어링, 라이드 셰어링, 공유 퍼스널 모빌리티 등이 포함됩니다.

기존 교통수단과의 차이점은 수단별 특성에 따라 편의성, 이동성, 경제성, 안전성을 높일 수 있으며, 이용자의 건강과 환경 개선에 기여할 수도 있습니다.

다음은 국토연구원의 연구에서 발췌해온 스마트 모빌리티의 정의입니다. (박종일, 김광호, 윤태관. 2018. 지방중소도시의 스마트 모빌리티 구축방안 연구)

1	공유 자전거(바이크 쉐어링, 공영자전거, 공공자전거) : 오바이크, 모바이크 등		
개념	▪ 자전거를 단기간 대여하는 서비스		
특징	▪ (이용방법) 스마트폰 앱을 이용하여 주변 자전거를 검색, 예약, 이용 후, 자유롭게 주차 ▪ (이용요금) 30분에 300원, 보증금 없음 (국내 사례) ▪ (이용특성) 일반적인 자전거 평균속도 15km/h 기준으로 30분 이용시 약 7.5km 이동 가능(도보 4km/h) – 우리나라 공유 자전거의 1회 평균 이용 시간은 약 30분 – 단·중거리 통행에 적합		
사진	 [주변 자전거 검색]	 [자전거 발견]	 [대여/반납]

<table>
<tr><td>2</td><td colspan="3">차량 공유 (카쉐어링) : 그린카, 소카 등</td></tr>
</table>

<table>
<tr><td>개념</td><td colspan="3">▪ 회원들에게 차량을 단기간 대여하는 서비스</td></tr>
<tr><td>특징</td><td colspan="3">▪ (이용방법) 스마트폰 앱을 이용하여 주변 전용 주차장 검색, 차량 선택, 예약, 이용 후, 최초 주차장에 주차
▪ (이용요금) 대여요금(10분 당 810원) + 주행요금(1km당 180원) + 보험료
- 30분, 20km 이용 시 약 7,000원 (주중, 아반떼AD 기준, 국내 사례)
▪ (이용특성) 편도 이용 시 요금이 상승함</td></tr>
<tr><td>사진</td><td>
[주변 차량 검색]</td><td>
[스마트폰 기반 차 키]</td><td>

[전용 주차장에서 대여/반납]</td></tr>
</table>

<table>
<tr><td>3</td><td colspan="3">승차 공유 (라이드쉐어링, 카풀) : 카카오 카풀, 풀러스, 럭시, 우버, 리프트 등</td></tr>
</table>

<table>
<tr><td>개념</td><td colspan="3">▪ 출퇴근 시간대에 개인 소유 차량에 요금을 지불하고 탑승하는 서비스로 택시 유사</td></tr>
<tr><td>특징</td><td colspan="3">▪ (이용방법) 스마트폰 앱을 이용하여 자신의 출발지, 탑승시간, 목적지를 입력하고 차량을 배차받아 탑승
▪ (이용요금) 택시 보다 약 30% 이상 저렴(국내 사례)
▪ (이용특성) 운전자는 자신의 차량의 남는 좌석을 공유하여 요금을 받고, 탑승자는 저렴한 비용으로 이용</td></tr>
<tr><td>사진</td><td>
[탑승 요청]</td><td>

[드라이버 매칭]</td><td>

[목적지 도착/ 요금 결제]</td></tr>
</table>

4	공유 퍼스널 모빌리티(공유 전동킥보드, 공유 전기자전거) : 버드, 라임, 점프 등

개념	■ 전기 배터리로 움직이는 1인용 이동수단의 공유 서비스		
특징	■ (이용방법) 스마트폰 앱을 이용하여 주변 전동킥보드나 전기자전거를 검색, 예약, 이용 후, 자유롭게 주차 ■ (이용요금) 공유 전동킥보드 : 30분에 1달러(약 1,200원) (미국 Lime), 공유 전기자전거 : 30분에 2달러(약 2,400원) (미국 Jump) ■ (이용특성) 일반 킥보드, 자전거 대비 덜 힘들게 더 멀리, 더 빠르게 이동 가능 - 타 교통수단 이용 시 보조 수단으로 사용 가능 - 단·중거리 통행 대체 가능 ■ 국내 도입 사례는 아직 없으며, 미국, 유럽에서 활발히 확대 중		
사진	 [전동킥보드, 샤오미]	 [공유 전동 킥보드, 미국 Spin]	 [공유 전기 자전거, 미국 Jump]

C1-1. 귀하는 스마트 모빌리티(공유 자전거, 카셰어링, 라이드 셰어링, 공유 퍼스널 모빌리티)를 알고 계십니까? 해당하는 곳에 체크해주세요

교통 수단명 : 도입 사례 또는 서비스 업체명	몰랐다	알고 있지만, 이용하지 않았다	이용해 봤다
(1) 공유 자전거 (공영 자전거) : 따릉이, 카카오 T 바이크 등 			
(2) 차량 공유 (카 쉐어링) : 쏘카, 그린카 등 			
(3) 승차 공유 (라이드 쉐어링, 카풀) : 풀러스, 우버, 카카오 카풀 등 			
(4) 공유 퍼스널 모빌리티(전동킥보드) : 버드, 라임, 씽씽이 등 			

[C1-1 에서 이용해 봤다 응답 모빌리티만 제시]

C1-2. 귀하께서 이용해보신 스마트 모빌리티(공유 자전거, 카셰어링, 라이드 셰어링, 공유 퍼스널 모빌리티)의 만족도를 표시해주세요.

교통 수단명 : 도입 사례 또는 서비스 업체명	매우 불만족 브	불만족	보통	만족	매우 만족
(1) 공유 자전거 (공영 자전거) : 따릉이, 카카오 T 바이크 등 					
(2) 차량 공유 (카 쉐어링) : 쏘카, 그린카 등 					
(3) 승차 공유 (라이드 쉐어링, 카풀) : 풀러스, 우버, 카카오 카풀 등 					
(4) 공유 퍼스널 모빌리티(전동킥보드) : 버드, 라임, 씽씽이 등 					

C1-3. 스마트 모빌리티(공유 자전거, 카셰어링, 라이드 셰어링, 공유 퍼스널 모빌리티)를 향후에 사용해볼 의향이 있으십니까? 해당하는 곳에 체크해주시기 바랍니다.

교통 수단명 : 도입 사례 또는 서비스 업체명	앞으로 이용할 의향 있다	앞으로 이용할 의향 없다
(1) 공유 자전거 (공영 자전거) : 따릉이, 카카오 T 바이크 등 		
(2) 차량 공유 (카 쉐어링) : 쏘카, 그린카 등 		
(3) 승차 공유 (라이드 쉐어링, 카풀) : 풀러스, 우버, 카카오 카풀 등 		
(4) 공유 퍼스널 모빌리티(전동킥보드) : 버드, 라임, 씽씽이 등 		

C2. 본인이 통근 시 대중교통(지하철 및 버스)을 보완 및 대체할 수 있는 교통수단은 뭐라고 생각하십니까? 중요도 순으로 3개를 선택해 주세요 [3순위형, 3순위 필수]

1) 공유 자전거 (공공 자전거)
2) 택시
3) 차량 공유 (카쉐어링)
4) 승차 공유 (라이드쉐어링, 카풀)
5) 공유 퍼스널 모빌리티 (전동킥보드)
6) 없음 → C5로 이동

[C2 응답값 상단 제시]

C3. 위와 같이 답변하신 이유는 무엇입니까? 중요도 순으로 3개를 선택해 주세요.

[3순위형, 3순위 필수]

1) 이동의 편리
2) 이동 시간의 단축
3) 교통비 절약
(4) 안전한 이동
5) 신체적인 건강
6) 환경 개선에 기여
7) 기타 (   )

C4. 위에서 선택하신 스마트 모빌리티 교통수단과 대중교통이 연계된 MaaS 서비스가 잘 상용화된다면 통근 시 일주일에 며칠이나 사용하시겠습니까?

1) 0 일
2) 1 일
3) 2 일
4) 3 일
5) 4 일
6) 5 일
7) 6 일 이상

[응답 후, D 챕터로 이동]

[C2에서 6번 응답자]

C5. 스마트 모빌리티를 이용하지 않으실 이유는 무엇입니까? 중요도 순으로 3개를 선

택해 주세요.

[3순위형, 3순위 필수]

1) 이용의 어려움

2) 신체적인 힘듦

3) 비싼 비용

4) 안전하지 않을 것 같음

5) 기존의 수단에 비해 적은 장점

6) 기존 수단에 이미 지출한 비용이 아까움

7) 나의 통행패턴과 적합하지 않음

8) 기타(   )

C6. 다음과 같은 통행의 목적을 갖고 이동 시, MaaS를 얼마나 사용하시겠습니까?

사용 목적	사용하지 않는다	드물게	때때로	자주	항상
통근					
쇼핑					
개인일상					
업무					
레저 및 여행					

D. 통합모빌리티 서비스(MaaS)의 수용 요인 조사

지금부터 MaaS 에 대한 여러분들의 생각에 대하여 질문할 것입니다. 만약 여러분들께서 MaaS 사용 경험이 없으시다면 앞서 기술된 MaaS 를 생각을 하시면서 예상되는 답변에 체크해주시면 됩니다. 사용 경험이 있으시다면 실제 사용 경험을 바탕으로 다음의 질문에 응답해주세요.

다음을 읽고 귀하께서 느끼시는 바에 그럴수록 매우 그렇다(5), 아닐수록 매우 아니다(1)에 가까운 숫자에 표기해주세요.

D1. 다음은 MaaS의 <u>성과에 대한 기대</u> 면에서 사용자가 느끼는 정도에 관한 질문입니다.

성과에 대한 기대	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
MaaS를 이용하면 이동에 대한 비용이 절약될 것이다.					
MaaS를 이용하면 이동 시간을 절약해줄 것이다.					
MaaS를 이용하면 이동의 편리를 가져다줄 것이다.					
MaaS를 이용하면 좀 더 안전한 이동을 하는 데 도움을 줄 것이다.					
MaaS를 이용하면 다양한 교통수단을 단일 플랫폼에서 경험해 볼 수 있어 편리할 것이다					
MaaS를 이용하면 다양한 교통수단들의 실					

시간 정보를 확인할 수 있어 편리할 것이다.					
MaaS를 이용하면 단일 플랫폼(인터페이스) 내에서 통합 예약 및 결제를 할 수 있어 편리할 것이다.					
MaaS를 이용하면 나만의 취향 및 요구 사항이 반영된 다양한 대안을 추천해주기에 편리할 것이다.					

[동일척도 응답 시, 경고창 1회 제시]

D2. 다음은 MaaS의 노력에 대한 기대 면에서 사용자가 느끼는 정도에 관한 질문입니다.

노력에 대한 기대	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나는 MaaS 이용 방법을 쉽게 배울 수 있을 것이다					
나는 MaaS 이용 방법을 빠르게 배울 수 있을 것이다.					
나는 MaaS 이용에 쉽게 능숙해질 수 있을 것이다					
나는 MaaS 이용에 있어 어려움을 느끼지 않을 것이다.					
나는 MaaS 이용을 위해서 큰 노력이 필요하지 않을 것이다					

[동일척도 응답 시, 경고창 1회 제시]

D3. 다음은 MaaS의 사회적 영향 면에서 사용자가 느끼는 정도에 관한 질문입니다.

사회적 영향	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나의 주변인들은 나에게 MaaS 이용을 권장할 것이다.					
나의 주변인들은 내가 MaaS를 이용하는 것을 긍정적으로 생각할 것이다.					
나의 주변인들은 내가 MaaS를 사용하는 것을 바람직하다고 생각할 것이다.					
나의 주변인들은 내가 MaaS를 많이 사용하기를 기대할 것이다.					
나의 주변인들은 내가 MaaS를 사용한다면 MaaS를 이용해 볼 의향을 가질 것이다.					

[동일척도 응답 시, 경고창 1회 제시]

D4. 다음은 MaaS의 촉진 조건 면에서 사용자가 느끼는 정도에 관한 질문입니다.

촉진 조건	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나는 MaaS 사용에 있어 모바일 예약 및 결제에 필요한 지식을 가지고 있다고 생각한다.					
나는 MaaS 사용에 있어 이동하면서 인터넷을 사용하는 데 어려움이 없을 것이다.					
나는 MaaS 사용에 있어 모바일 서비스를 이용하는데 필요한 정보 및 가이드라인을 쉽게 찾을 수 있을 것이다.					
나는 MaaS 사용에 있어 모바일 사용에 대한 어려움이 없을 것이다.					
나는 MaaS 사용에 있어 모바일 결제 서비스를 손쉽게 이용할 것이다.					

[동일척도 응답 시, 경고창 1회 제시]

D5. 다음은 MaaS의 혁신 행동 면에서 사용자가 느끼는 정도에 관한 질문입니다.

혁신 행동	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나는 다른 사람들보다 MaaS와 같은 신서비스/제품을 빨리 사용하거나 구매하는 편이다.					
나는 MaaS와 같은 신서비스/제품에 대한 사용법을 배우려고 노력하는 편이다.					
나는 MaaS와 같은 신서비스/제품에 대한 정보를 찾는 데 관심이 있는 편이다.					
나는 MaaS와 같은 신서비스/제품을 이용하는 것에 두려움이 없는 편이다.					
나는 MaaS와 같은 신서비스/제품을 실험해보는 것을 좋아하는 편이다.					

[동일척도 응답 시, 경고창 1회 제시]

D6. 다음은 MaaS의 환경 고민 면에서 사용자가 느끼는 정도에 관한 질문입니다.

사용 의도	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나는 MaaS가 지구 온난화를 줄이는 데 도움이 되리라 생각한다.					
나는 MaaS를 통해 에너지 절약을 실천할 수 있다고 생각한다.					
나는 MaaS 사용으로 대기오염을 일부 줄일 수 있다고 생각한다.					
나는 MaaS 사용이 나의 기존 이동방식보다 환경친화적이라고 생각한다.					
나는 MaaS가 친환경 모빌리티 생태계 활					

성화에 기여할 것으로 생각한다.					

[동일척도 응답 시, 경고창 1회 제시]

D7. 다음은 MaaS의 인지된 위험 면에서 사용자가 느끼는 정도에 관한 질문입니다.

인지된 위험	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나는 MaaS를 이용하면 데이터 프라이버시 및 보안이 걱정된다.					
나는 MaaS 이용으로 인해 이동 관련 지출이 증가할 것 같아 걱정된다.					
나는 앱에서 추천하는 경로나 수단에 대한 신뢰도가 낮기에 MaaS 이용이 걱정된다.					
나는 MaaS 에 포함된 이동수단 이용 방법이 복잡할 것 같아 걱정된다.					
나는 MaaS 앱 이용 방법이 복잡할 것 같아 걱정된다.					

[동일척도 응답 시, 경고창 1회 제시]

D8. 다음은 MaaS의 사용 태도 면에서 사용자가 느끼는 정도에 관한 질문입니다.

사용 태도	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나는 MaaS가 훌륭하다고 생각한다.					
나는 MaaS 사용에 긍정적이다.					
나는 MaaS는 사용할 가치가 있다고 생각한다.					
나는 MaaS는 이동하는 데 도움이 많이 될 것으로 생각한다.					
나는 MaaS 사용은 나에게 많은 이득을 줄					

것이라고 생각한다.					

[동일척도 응답 시, 경고창 1회 제시]

D9. 다음은 MaaS의 사용 의도 면에서 사용자가 느끼는 정도에 관한 질문입니다.

사용 의도	매우 아니다	아니다	보통이다	그렇다	매우 그렇다
나는 MaaS를 사용해볼 의향이 있다.					
나는 MaaS를 사용할 계획이 있다.					
나는 MaaS를 통해 이동과 관련된 정보를 탐색할 의향이 있다.					
내가 필요로 할 때 MaaS를 언제든 사용할 의향이 있다.					
나는 MaaS를 주변인들에게 추천할 의향이 있다.					

[동일척도 응답 시, 경고창 1회 제시]

DQ1. 귀하의 현재 월평균 수입은 얼마나 되십니까?

1) 150 만 원 미만

2) 150 만 원 이상 300 만 원 미만

3) 300 만 원 이상 500 만 원 이하

4) 500 만 원 이상

DQ2. 귀하의 최종 학력은 어떻게 되십니까?

1) 중학교 졸업 이하

2) 고등학교 졸업

3) 대학교 재학

4) 대학교 졸업

5) 대학원 재학 이상

DQ4. 귀하의 평균 출근 시간과 퇴근 시간을 적어주세요. (30 분 단위로 기입 바랍니다.)

출근 시간: ( )시 ( )분

퇴근 시간: ( )시 ( )분

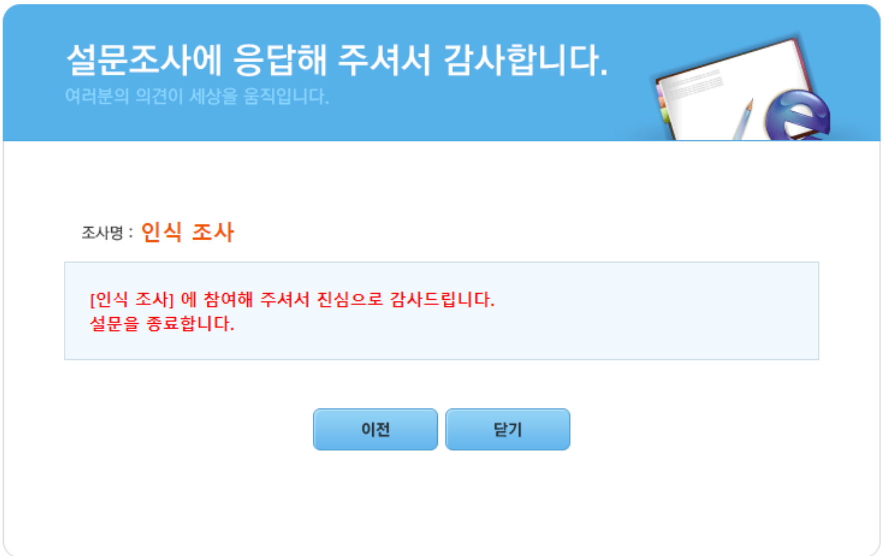
DQ5. 귀하의 회사(또는 출근 기관)의 지각에 대한 규정은 어떠한가요?

1) 늦어도 상관없음 2) 눈치가 보이지만 용인되는 범주

3) 늦으면 매우 곤란함

DQ6. 귀하의 회사(또는 출근 기관)에서 주로 입는 복장은 무엇인가요?

1) 정장 2) 비즈니스캐쥬얼 3) 자유 복장



Abstract (Korean)

자동차, 버스, 지하철, 자전거, 퍼스널 모빌리티와 같은 다양한 교통수단을 하나의 플랫폼에 통합하는 서비스를 통합모빌리티서비스(Maas) 라고 한다. MaaS는 모든 교통 정보를 하나의 앱으로 받아 볼 수 있는 편리함은 물론, 예약과 결제를 한 번에 할 수 있어 사용자들에게 더 많은 관심을 받고 있다. 또한, Maas가 도시화와 자동차의 급격한 증가로 인한 교통 문제를 해결하기 위한 대안이 될 수 있다는 점에서 부각되고 있으며 관련 연구 및 시범 프로그램이 유럽에서 널리 추진되고 운영되고 있다. 그러나 국내에서는 MaaS의 개념과 도입을 위한 정성적 연구가 미흡하다. 따라서 본 연구에서는 국내의 대중교통과 스마트 모빌리티 서비스를 통합하기 위해 초기 사용자의 MaaS 수용도를 분석하였다.

본 연구는 통합기술수용이론(UTAUT)을 활용하여 결과를 실증적으로 분석하고 도출하여 서울에서 MaaS를 지속적으로 사용하려는 사용자의 의도를 알아냈다. 독립 변수로는, 성과 기대, 노력 기대, 사회적 영향, 개인 혁신, 환경

관심 등을 선정하여 연구를 진행하였다. 설문 대상자는 통근 특성에 기반하여 우리나라 수도권에서 자가용이나 대중교통을 이용하여 정기적으로 출퇴근하는 사람들을 대상으로 제한하였고, 총 529명의 참가자가 설문 조사에 참여하였다. 그 결과 성능 기대, 사회적 영향, 개인 혁신, 환경 문제가 MaaS 사용의도에 긍정적인 영향을 미치는 것으로 나타났다. 또한 자동차 소유 여부, 주요 교통 수단, 대중교통 사용 일수, 스마트 모빌리티 경험 여부 등의 항목으로 그룹을 구분하여 다중 그룹 분석을 수행하였다. 영향 요인과 그룹 분석을 통해 도움이 되는 잠재 사용자를 식별함으로써, MaaS 운영자에게 도움이 될 수 있는 홍보 전략 및 정책을 제안하였다. MaaS 구현은 아직 미성숙한 단계이기 때문에 이번 연구는 한국 상황에 적합한 MaaS 시스템 구축을 위한 청사진을 제공할 수 있으리라 판단한다.

주요어 : 통합모빌리티서비스(MaaS), 사용자 수용도, 통합기술수용이론(UTAUT), 다중 그룹 분석, 통근 특성, 스마트 모빌리티
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