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Investigating the Factors on Public Transportation System for Citizen Relationship and Sustainability

Jiin YOO[1] , Yooncheong CHO[2]

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Abstract

Purpose: The purpose of this paper is to investigate key factors that affect customer dissatisfaction on public transportation system by highlighting the necessity of citizen participation and improved management of advanced technology for sustainability. Research questions applied in this study include following; i) how are factors on dissatisfaction related to types of transportation modes; ii) how do perceived proposed factors affect citizen dissatisfaction; iii) how do the improvement of public transportation service affect the level of expected satisfaction; and iv) how do expected satisfaction affect policy agreement and government trust. **Research design, data and methodology:** For qualitative research, civil opinions were collected and chi-square analysis was applied using keywords. For quantitative research, online survey was collected and factor and multiple regression analyses were applied. 3) **Results:** This study found that efficiency of operation system and safety on dissatisfaction showed significant in all three public transportation modes. This study found that perception of government policy and trust on government will increase as expected satisfaction increases**. Conclusions:** This study provides managerial and policy implications on society and policy makers by addressing necessity of improving strategies for public transportation system with the consideration of citizen relationship management and sustainable development.

Keywords: Public Transportation System, Dissatisfaction, Citizen Relationship, Sustainability

JEL Classification Code: J28, O32, O38

1. Introduction[12]

Public transportation system (PTS) is shared transportation services that all the tax payers who have mobility right can use, which operate on fixed routes and with fixed schedules, including bus, metro and several other modes, which are essential for the general public and social equity (Viegas, 2001; Vuchic, 2002; Zeng, Fu, Arisona, Erath, & Qu, 2014).

The technology, socioeconomic factors, policies on urban growth, and transition of consumer attitudes have made the private automobile the most desirable transportation mode in urban areas, while it caused critical negative consequences, particularly in terms of the environment and safety (Sinha, 2003). The emission of pollutant and greenhouses gases, energy consumption,
that cause significant financial losses and lower the quality of urban life (Al-Sakran, 2015; Bruglieri, Bruschi, Colorni, Luè, Nocerino, & Rana, 2015). Citizen Relationship Management (CiRM) and Intelligent Transport Systems (ITS) based on Information and Communication Technology (ICT) are applied to improve the quality of life and to increase the efficiency of allocating government's resources by discovering citizen's knowledge, behavior patterns, and information based on needs and demands (Ibrahim, 2003; Matas, 2004; Sinha, 2003). With the 4th industrial revolution, the application of smart city plays a key role by adopting smart technology and enhancing

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1 First Author. Doctoral candidate, KDI School of Public Policy and Management, Email: myarina@naver.com
2 Corresponding Author, Professor, KDI School of Public Policy and Management, S. Korea. Email: ycho@kdischool.ac.kr

citizen's active participation in communities for sustainability (Bencardino & Greco, 2014; Benevolo, Dameri, & D'Auria, 2016; Hollands, 2008). This study was performed in newly developed city in South Korea, which aims to be a smart city as the government set up the policy by applying environmentally friendly system.

The purpose of this study is to explore key factors that affect citizen satisfaction/dissatisfaction on public transportation system by addressing the importance of sustainability, necessity of citizen participation, and improved management of advanced technology. This study provides policy and managerial implications regarding public transportation system in line with applications of ICT based systems and CiRM. Although the citizen satisfaction is a critical issue for policy makers and transportation service providers, previous studies have rarely examined the importance of citizen satisfaction in the public transportation sector (Stradling, Anable, & Carreno, 2007). Therefore, this study posits that governments should utilize effective policy instrument by analyzing relevant data that is collected through citizen participation. For innovation and improvement of existing service and systems regarding public transportation in the 4th industrial revolution era, better applications of ITS based systems and management could be considered in the future strategies. By classifying the types of public transportation, this study applied the following research questions: i) how are factors on dissatisfaction related to types of transportation modes; ii) how do proposed factors including efficiency of operation system, information system, comfortable environment and safety affect dissatisfaction; iii) how does the improvement of public transportation service affect the level of expected satisfaction; and iv) how do expected satisfaction affect policy agreement and government trust?

2. Literature Review

2.1. Public Transportation System (PTS)

2.1.1. Definition of Public Transportation System

Public transportation is defined as the systems which everyone who pays the fare can use, which operate on fixed routes and with fixed schedules and transit services that provide diversified activities, vitality in economy, socially and environmentally sound conditions (Vuchic, 2002). In modern cities, public transportation system (PTS) is the important provider of shared and massive transportation services that are essential for the general public (Zeng, Fu, Arisona, Erath, & Qu, 2014). Public transportation system pursues social equity so that all the tax payers who has mobility right can get access to a certain amount of mobility (Viegas, 2001).

2.1.2. Sustainability and Public Transportation System

Sustainability issues on transport services, such as pollution and greenhouses gases, congestion on roads, accidents, and energy consumption, have considerable impacts on the environment and the quality of life (Bruglieri et al., 2015; Choi, Kim, & Kim, 2019; Islam, Ahmed, Saifullah, Huda, & Al-Islam, 2017; Nguyen, Duong, Tran, Ha, & Phung, 2020). Sinha (2003) addressed that the sustainability of an urban transportation system can contribute to the quality of life in the community, ensure the ability of future generations in meeting their transportation and livability needs, and increase satisfaction level of current and future demands of diverse segments of society. Both national governments and local authorities are trying to switch people's mobility mode from private vehicle to public transport in order to reduce the inconvenience of congested roads (Grotenhuis, Wiegmans, & Rietveld, 2007). The raised awareness of sustainable development and environmental pollution issues led to a trend towards transport development with large-scale and long-term policies in public sector to provide reasonable alternative options to public car users (Ibrahim, 2003). For sustainability and livability, transit must be given the essential priorities to attain a balanced use of transit, cars, bicycles, and other modes of transportation up to a desirable degree (Vuchic, 2002). What concerns people are traffic congestion and accidents as they usually cause a significant waste of time, damage on property, and polluted environment and eventually lead to financial losses (Al-Sakran, 2015). More efficient public transportation systems could ease the issues regarding of growing pollution levels and traffic congestion in major cities (Barrero, Van Mierlo, & Tackoen, 2008).

A deep understanding of travel behavior and the reason why users choose one mode of transport over another is widely known as attempts to address unsustainable patterns of travel (Anable, 2005). People's transportation choices are shaped by built environment such as pedestrian-centered land use environments, which can improve public health by promoting active forms of transportation (Frank, Kavage, & Litman, 2006). Kormos, Gifford, and Brown (2015) evaluated the impact of social norm information or beliefs by examining the effect on higher pro-environmental behavior, such as transportation use and reduction of private vehicle use. The concept of sustainable intelligence characterized by the level of commitment, attitude, knowledge and/or behavior with regard to sustainability was introduced by Pulido-Fernández and López-Sánchez (2016) to understand the behavior in favor of sustainability and its true economic implications. If the long-term aim is to establish public support for new policies or regulatory intervention to further encourage these changes in behavior, importance of motivating pro-environmental behavior and

building strategies seem to be important (Thøgersen, 2009).

2.1.3. Public Transportation Service in a Smart City

There are many approaches to define and interpret a Smart City. A smart city can be explained as a place where traditional networks and services become more flexible, efficient, and sustainable by using information, digital and telecommunication technologies to increase the benefit of its inhabitant (Mohanty, Choppali, & Kougianos, 2016). A diverse range of smart city involves information technology, business innovation, governance, communities, and sustainability (Hollands, 2008). Townsend (2013) defined that smart cities are the places where infrastructure, architecture, everyday objects, and even our bodies are integrated with information technology. Benevolo, Dameri, and D'Auria (2016) defined a smart city as a complex and long-term vision for better urban areas in the aims of less environmental footprint and better quality of citizen's life which entails ancient urban streams such as digital city, green city, and knowledge city. Bencardino & Greco (2014) defined a smart city as a city which citizens who are aware of the importance of participation in public life, capable of peaceful coexistence, responsible for their choices in life live in, and which can support participatory processes involving citizens in decision-making in public policy as partners. Smart city service includes collection of data regarding urban issues, transmission of collected data to a central decision making process, and improvement of the city with the insights generated (Feder-Levy, Blumenfeld-Liebertal, & Portugali, 2016). Nam and Pardo (2011) built the set of fundamental components of smart city including technology factor, human factor, and institutional factor that involves smart community and growth.

Smart mobility is a part of smart city which collects citizens' opinions about city's livability or quality of local public transport services for optimization of traffic by citizens' behavior (Benevolo, Dameri, & D'Auria, 2016). Smart transportation which is also known as the ITS includes various types of communication and navigation systems to maximize the utilization of the vehicles and efficiency by using ICT and real-time data processing (Mohanty, Choppali, & Kougianos, 2016). Transit service level can be improved by information and communication technologies, through higher operating efficiency, service reliability, and greater access to real time information (Sinha, 2003). According to Abidin, Kolberg, and Hussain (2014), one of the key services for improving public transport attractiveness includes timely and accurate travel time information of public transport vehicles. Real-time passenger information has been realized as ICT, enables information access easily (Beul-Leusmann, Jakobs, & Ziefle, 2013). Townsend (2013) stated that interlacing integrated aims of smart cities and conflicts is an urgent challenge in terms of participation and transparency. In tech-savvy city, dwellers should be considered as an important factor for the design of intervention which should be open and mutable to realize true benefit, by giving the opportunity for citizen users to identify negative conditions and the potential for improvement based on their experience (Glasmeier & Christopherson, 2015).

2.2. Intelligent Transport Systems (ITS) for Public Transportation

Previous studies on transportation have developed incident management models and integrated systems for real-time operations by applying the concept of ITS (Ozbay & Kachroo, 1999). Urban traffic problems such as traffic congestion and air pollution could be migrated by promoting the use of public transportation and ITS, such as real time mobility management of unexpected delays and service disruptions, and improving transit accessibility for citizen (Bruglieri et al., 2015). ITS developed online incident management strategies by collecting and managing real-time traffic data and created the required infrastructure (Ozbay & Kachroo, 1999). Active Traffic Management, a scheme of ITS which is connected to a regional centralized system with the data center and the traffic control center managing all road-side technology has the effect of carbon offset by improving management of the transport network (Kolosz & Grant-Muller, 2015). The provision of Integrated Multimodal Travel Information (IMTI) is a core element of the ITS (Wang, Shao, Li, Weng, & Ji, 2015). Grotenhuis, Wiegmans, and Rietveld (2007) expect that IMTI could affect passengers' modal choice with better quality of public transport. It is obvious that the information of integrated multimodal data would have the most potential effect to change customers' behavior (Egeler, 2001). The information of various options of transportation modes for a desired travel route in response to a single request could overcome habitual and psychological barriers to consideration of alternative options (Kenyon & Lyons, 2003). Many demand-responsive transportation systems aim to better utilize existing transport infrastructure but are unsuccessful due to poor implementation, planning, and marketing focusing on usually for the interests of the operator, and seldom considering individual's preference and need (Ronald, Thompson, & Winter, 2015)

2.3. Citizen Relationship Management (CiRM) for Public Transportation

Muscalu (2015) addressed that CiRM is a new management approach, a particular form of Customer Relationship Management (CRM) created by particular public organizations which are requested to concentrate on

the institution's impression, confidence in the providing services for the citizens, and the management of the satisfaction of beneficiary. Shan, Panagiotopoulos, Regan, De Brun, Barnett, Wall, McConnon et al. (2015) explain that engagement with the public through two-way communication with interactive processes is a key resource to discover user's attitude, behavior pattern, and information need, which will also improve the services and outcomes. Citizens who can serve the urban space not only as consumers but also as producers continues to influence in broader sectors (Lee & Kwon, 2020). Previous studies also discussed negative side of satisfaction with implications on CRM. Hunt (1977) conceptualized dissatisfactions as trivial in degree or intensity and proposed measurement of dissatisfaction. Cho (2011) addressed the impact of dissatisfaction in online environment by examining different customer behavior based on products/services.

Satisfaction plays a pivotal role in understanding public transport from the customer's point of view (Friman & Fellesson, 2009). Andreassen (1995) claims that the loss of relative market shares and failure to fulfill customer needs of public transportation are resulted by the wrong strategy of mass marketing on the equality-based principle, in contrast to private services which recognize various preferences of customers and accordingly develops products and services. The public-transport operators should include more active participation of customers in their open processes and systems primarily based on the customer relationship management, and share and expand the knowledge of the customers which is gained directly from their customers (Gebauer, Johnson, & Enquist, 2010). The emerging paradigm shifts the customer (passenger) from a user to a co-creator of value in public transport (Vargo & Lusch, 2008). Valaskova and Križanova (2008) supported the approach focused on the passengers' perception of the quality service as many of the public transport problems had been solved mainly based on an economical approach without listening passengers' feedback. St-Louis, Manaugh, van Lierop, and El-Geneidy (2014) stated that for encouraging the involvement of active public transportation, it is necessary to understand the multifaceted issue of satisfaction of transportation users, and its implications for travel behavior. Colesca, Pacesila, Burcea, Ciocoiu, and Bugheanu (2017) analyzed the passenger's satisfaction with existing public transportation to identify the most influencing factors and rank most preferred transport in order to create a methodology for reducing quality gaps between forms of public transport eventually to promote citizen's desire for public transportation rather than personal vehicles. Seo and Park (2017) addressed that policy makers should consider improving accessibility to transit service as a top priority for user satisfaction with public transportation service. A framework for knowledge of satisfaction and service performance should be provided to policy makers and operational managers in public transport to identify priorities and needs of passengers to demonstrate strategies of improvement. (Nathanail, 2008).

3. Hypothesis Development

3.1. Types of Transportation and Dissatisfaction

Anable (2005) addressed that the different effects in instrumental, situational and psychological factors that affect decision of travel mode are often overlooked, while people are motivated by diverse factors and are influenced in different ways due to policies. St-Louis, Manaugh, van Lierop, and El-Geneidy (2014) compared commuter satisfaction across walking, bicycle, automobile, bus, metro, and commuter train to study how levels of satisfaction differ across transportation modes and found that a considerable variation exists among determinants of dissatisfaction by transportation modes and user's mode preference and perceptions that affect satisfaction. Therefore, this study first, hypothesizes the relationship between types of public transportation and the factors that cause citizen dissatisfaction.

H1: There are relationship between types of public transportation and factors that cause citizen dissatisfaction.

3.2. Effects of Factors on Dissatisfaction

3.2.1. Effects of Efficiency of Operation Service on Dissatisfaction

This study considered time and cost related operation services to measure overall efficiency of using public transportation. Waiting time is the most weighted variable in the utility functions of a transport mode since users perceive it as lost and irritating (Lirman, 2008). Dell'Olio, Ibeas, and Cecin (2011) showed that waiting time is one of the most valued variables by users in terms of public transport, and waiting and journey time represent the most important variables that potential users expect from public transport quality. Le-Klähn, Hall, and Gerike (2014) revealed that ticket price, service frequency, and ease of use are important items for satisfaction of public transportation. Price of ticket has a main impact on the attractiveness of public transport (Redman, Friman, Gärling, & Hartig, 2013). Sharaby and Shiftan (2012) also indicated that fare reduction is a significant factor in attracting transit users. Del Castillo and Benitez (2012) demonstrated that line reliability, bus stop location adequacy, and service frequency belong to the most important aspects. Valaskova and Križanova (2008) showed the importance of criteria including observance of timetable, price of tickets, and accessibility of buying tickets.

Thompson and Schofield (2007) highlighted the importance of ease-of-use, which has great influence on satisfaction for public transport's users. According to Le-Klähn, Hall, and Gerike (2014), accessibility is an important criterion since accessible stations and transport vehicles can improve customer penetration. Ease of transfers/interchanges, as a physical attribute of public transport service quality, is defined as how simple transport connections are, including wasted time (Redman, Friman, Gärling, & Hartig, 2013). Fare integration can encourage travelers to shift from private cars or taxi to buses and offer options for better routes to choose (Sharaby & Shiftan, 2012). Based on consideration, this study hypothesizes the effect of efficiency of operation service on dissatisfaction on public transportation. This study hypothesizes "a" for the case of public bus, "b" for public bike, and "c" for taxi.

H2a~c: Efficiency of operation service affects dissatisfaction.

3.2.2. Effects of Information System on Dissatisfaction

Public transport users were found to consider real-time information as the most important factor (Molin & Timmermans, 2006). Le-Klähn, Hall, and Gerike (2014) revealed that information is one of the most important items to user satisfaction with public transportation. Caulfield and O'Mahony (2007) examined the public transport information requirements of users by showing that real time location of vehicle, speed of answering, news on disruptions, booklet with bus timetables, estimated time of arrival are respectively most important attributes of information provision. According to Abidin, Kolberg, and Hussain (2014), one of the key services for improving public transport attractiveness is providing timely and accurate travel time information of public transport vehicles. RTPI has been realized as ICT allows easy access to information (Beul-Leusmann, Jakobs, & Ziefle, 2013). This study hypothesizes the effect of information service on dissatisfaction on public transportation.

H3a~c: Information system affects dissatisfaction.

3.2.3. Effects of Comfortable Environment on Dissatisfaction

Redman, Friman, Gärling, and Hartig (2013) addressed the comfort as a key factor to improve standards for vehicles or stations. Fellesson and Friman (2008) stated that traveling comfort is an important service attribute for passenger satisfaction including the requirements for space, cleanliness and seat availability of vehicles as well as stations. As a means of promising emission decrease, it seems to be an important issue for raising improvement of the perceived comfort of public transportation (Beul-Leusmann, Jakobs, & Ziefle, 2013). Stradling, Anable, and Carreno (2007) found that satisfaction with bus services is affected by various non-instrumental factors such as cleanliness, convenience, and stress. Foote (2004) stated that improvements focused on comfort-related issues such as vehicle cleanliness, safety and civil opinions handling significantly increased satisfaction of passengers. Tyrinopoulos and Antoniou (2008) revealed that preference of courtesy, especially for female users, customer service such as interaction with a public transport agency's bus drivers and personnel is a key attribute which derives customers' overall satisfaction with public transport (Van Lierop, Badami, & El-Geneidy, 2018). This study hypothesizes the effect of comfortable environment on dissatisfaction on public transportation.

H4a~c: Comfortable environment affects dissatisfaction.

3.2.4. Effects of Safety on Dissatisfaction

Perone and Volinski (2003) noted that safety seems to be more important than free travel as free fare not only encourages increase of ridership but also increase of disruptive riders which lead to return to a previous payment system. Imam (2014) showed that the importance of safety in the vehicle, personal security that contributes to public bus user satisfaction. A rail system that offers significant transportation service rather than a frequent service leads to a higher perception of passenger safety (Tyrinopoulos & Antoniou, 2008). This study hypothesizes the effect of safety on dissatisfaction on public transportation.

H5a~c: Safety affects dissatisfaction.

3.3. Effect of Advanced Services on Expected Satisfaction and Perception on Government

Patrício, Fisk, and Cunha (2003) indicated that service providers should give attention directly to the integrated management of different service delivery systems that has been transformed into a more interactive way by developing new technologies and designing a provision tool with consideration of different usage patterns, customer focus, and characteristics. The objective of multichannel service providers is considered to distribute resources across the combination of channel options in order to satisfy customers and maximize profits (Montoya-Weiss, Voss, & Grewal, 2003). Supplying an integrated and high-quality public transport system have become one of the most favored tools which also help promote public transport usage (Matas, 2004). The integration of real-time data which facilitates route assistance for passengers is highly interesting (García, Candela, Ginory, Quesada-Arencibia, & Alayón, 2012). Therefore, it is vital to develop future public transport to improve customer satisfaction (Le-Klähn, Hall, & Gerike, 2014). Van Ryzin (2004) found a fundamental role of the disconfirmation of expectations when citizen satisfaction judgments are formatted regarding the quality of urban

services. Operating companies should consider better service quality and the establishment of future policies to encourage more use of public transport based on the needs and expectations of existing and potential customers (Dell'Olio, Ibeas, & Cecin, 2011). Based on consideration, this study hypothesizes advanced services such as integrated mileage system, integrated service platform, and promptly updated service affect expected satisfaction.

H6a: Integrated mileage system of all types of public transportation affects expected satisfaction.

H6b: Integrated service platform for all types of public transportation affects expected satisfaction.

H6c: Promptly updated service considering citizen's conveniences affects expected satisfaction.

Abidin, Kolberg, and Hussain (2014) showed the role of trust when implementing policy measures, saying that it is crucial for receivers of road traffic messages to trust the sender of messages since relationship and experience are major features that have to be considered to find a trustworthy opinion. Van de Walle and Bouckaert (2003) addressed that there is an obvious impact of performance of the public administration on people's trust in government and vice versa. This study hypothesizes effects of expected satisfaction with advanced services on policy agreements and government trust.

H7a: Expected Satisfaction with advanced services affects policy agreements on public transportation.

H7b: Expected satisfaction with advanced services affects government trust.

4. Methodology

4.1. Methodology for Qualitative Research

This study collected civil opinions from an official website operated by public institution with the permission. Among total of 16,804 listings, 416 opinions were applied in this research. This study examined frequent words with major topics on public transportation. By investigating user experiences, this study classified categories of satisfaction/dissatisfaction by counting keywords based on different public transportation modes. Categories applied in this study include efficiency of operation system, information system, comfortable environment and safety. This study adapted R software to analyze word frequency, recognition of key words, and visualization of the civil opinions for three transportation modes.

Table 1: The Summary of Civil Opinions by Transportation Type

	Bus	Bike	Taxi	Total
Efficiency of Operation System	125	37	25	187
Information System	63	6	12	81
Comfortable Environment	69	3	13	85
Safety	41	18	4	63

Frequencies of civil opinions were classified into efficiency of operation system (187), information system (81), comfortable environment (85) and safety (63). Table 1 summarized types of civil opinions by transportation type. Further, this research applied the *chi*-square analysis to identify relationship between types of public transportation and satisfaction/dissatisfaction to test H1.

4.2. Methodology for Quantitative Research

This study conducted online survey in the new city. Survey was distributed via MNS, SNS, email, etc. Questionnaire items were developed based on results of qualitative research and previous researches (Seo & Park, 2017; Pulido-Fernández & López-Sánchez, 2016; Valaskova & Križanova, 2008). Major questionnaire items were designed with five-point Likert scales from 1 (strongly satisfied) to 5 (strongly dissatisfied). The survey questionnaire has been pre-tested twice and modified based on feedbacks. Further, this study proposed factors to examine better public transportation services that could be expected by citizen for public transportation including an integrated mileage system, an integrated information, an integrated service platform, and promptly updated services by considering better usage of public transportation. This study conducted reliability test. In the case of bus, Cronbach's alpha was 0.94 for efficiency of operating system, 0.82 for information system, 0.86 for comfortable environment, and 0.89 for safety. In the case of bike, Cronbach's alpha was 0.98 for efficiency of operating system, 0.92 for information system, 0.97 for comfortable environment, and 0.94 for safety. In the case of taxi, Cronbach's alpha was 0.91 for efficiency of operating system, 0.92 for information system, 0.94 for comfortable environment, and 0.88 for safety.

5. Data Analysis

5.1. Data Analysis for Qualitative Research

The results of qualitative research showed that keywords in civil opinions on bus have frequently related to bus station, bus route, time, bus driver and transfer, civil opinions on public bike associated with installation of bike rack, issues

regarding return, bike road and station, and those on taxi related to taxi driver, taxi station, fare, call taxi and refusing ride. Based on the classified data of civil opinions by categories of satisfaction/dissatisfaction, this research visualized the words that appear most frequently based on types of public transportation. Figure 1 showed each mode of transportation with different perceptions. Further, the *chi*-square results for the relationship between types of public transportation and categories of satisfaction/dissatisfaction showed significant at 0.01 level. Therefore, H1 was accepted.

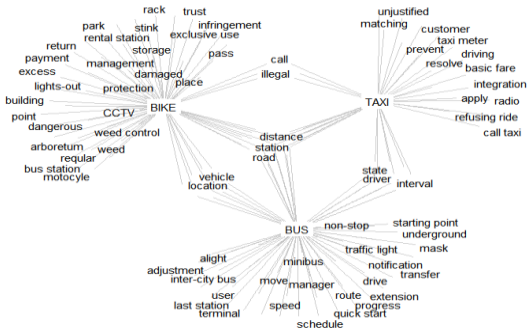

Figure 1: The Visualization of Keywords on Public Transportation

5.2. Data Analysis for Quantitative Research

5.2.1. Demographics

Out of 207 respondents in total, 108 completed the survey with 52.1% of response rate. Among them, 44.4% were female and 55.6% were male. By age groups, 22.2% were 20-29 years old, 36.1% were 30-39 years old, 22.2% were 40-49 years old, 15.7% were 50-59 years old and 2.8% were 60-69 years old. With regard to education level, 3.7% were high school graduates, 3.7% were 2-year associate degree, 44.4% were bachelor's degree, 38.9% were master's degree, and 9.3% were Ph.D. degree. With regard to employment, students were 17.6%, government officers were 18.5%, workers in academic sector were 4.6%, workers in public-sector were 19.4%, workers in private-sector were 17.6%, personal business owners were 3.7%, housewives were 7.4%, and workers in other occupation field were 9.3%. In terms of income, 9.3% had annual incomes between $20,001 and $30,000, 25.9% had annual incomes between $30,001 and $50,000, and 10.2% had annual incomes between $50,001 and $70,000, and 22.2% had annual incomes $70,001 or more.

5.2.2. Data Analysis and Hypothesis Testing

This study applied Factor Analyses. For an extraction method, Principal Component Analysis (PCA) was used and for a rotation method, Varimax with Kaiser Normalization was applied. Factors whose Eigenvalues are over 1.00 were selected. Factor scores were applied for multiple regression analysis. Table 2 summarized the result of factor analysis in the case of bus.

Table 2: Component Matrix in the Case of Bus

Items	Components			
Factors	**1**	**2**	**3**	**4**
Efficiency of operation system	0.847			
	0.831			
	0.789			
	0.789			
	0.780			
	0.772			
	0.690			
	0.607			
Information system		0.905		
		0.866		
		0.818		
Comfortable environment			0.916	
			0.891	
			0.866	
			0.797	
			0.620	
Safety				0.952
				0.952

Table 3 showed the results of multiple regression analysis in the case of bus. Overall, the ANOVA results found that the model was significant at 0.01 level with F = 51.003 (*r-square* = .669). The results also showed that effects of efficiency of operating system and information system on dissatisfaction found significant at 0.01 level, while the effect of safety on dissatisfaction found significant at 0.05 level. Therefore, H2a, 3a, and 5a were accepted.

Table 3: Effects of Determinants of Dissatisfaction of Bus Users

Variable (Independent → dependent)	Standardized Coefficient (t-value-Sig)
Efficiency of operation system → dissatisfaction on bus (H2a)	0.528 (7.448***)
Information system → dissatisfaction on bus (H3a)	0.226 (2.812***)
Comfortable environment → dissatisfaction on bus (H4a)	-0.116 (-0.997)
Safety → dissatisfaction on bus (H5a)	0.312 (2.587**)

*** p < 0.01, ** p <0.05

Table 4 showed the results of multiple regression analysis in the case of bike. Overall, the ANOVA results

found that the model was significant at 0.01 level with F =28.879 (*r-square* = .767). The results also showed that effects of efficiency of operating system on dissatisfaction found significant at 0.01 level, while the effect of safety on dissatisfaction found significant at 0.05 level. Therefore, H2b and 5b were accepted.

Table 4: Effects of Determinants of Dissatisfaction of Bike Users

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Efficiency of operation system → dissatisfaction on bike (H2b)	0.672 (4.662***)
Information system → dissatisfaction on bike (H3b)	0.154 (0.940)
Comfortable environment → dissatisfaction on bike (H4b)	-0.204 (-1.541)
Safety → dissatisfaction on bike (H5b)	0.305 (2.410**)

*** $p < 0.01$, ** $p < 0.05$

Table 5: Effects of Determinants of Dissatisfaction of Taxi Users

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Efficiency of operation system → dissatisfaction on taxi (H2c)	0.753 (6.279***)
Information system → dissatisfaction on taxi (H3c)	-0.089 (-0.828)
Comfortable environment → dissatisfaction on taxi (H4c)	0.025 (0.187)
Safety → dissatisfaction on taxi (H5c)	0.202 (1.970*)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5 showed the results of multiple regression analysis in the case of taxi. Overall, the ANOVA results found that the model was significant at 0.01 level with F =34.403(*r-square* = .703). The results also showed that effects of efficiency of operating system on dissatisfaction found significant at 0.01 level, and the effect of safety found significant at 0.1 level. Therefore, H2c and 5c were accepted.

Table 6 showed the results of effects of advanced services on expected satisfaction. Overall, the ANOVA results found that the model was significant at 0.1 level with F = 2.161 (*r-square* = 0.096). The results also showed that effects of integrated service platform on expected satisfaction found negatively significant at 0.01 level, while the effect of promptly updated service on expected satisfaction found positively significant at 0.1 level.

Table 6: Effects of Improvement based on Demand on Expected Satisfaction

Variable (Independent → dependent)	Coefficient (*t*-value-Sig)
Integrated mileage system → Expected satisfaction (H6a)	0.127 (0.902)
Integrated service platform → Expected satisfaction (H6b)	-0.591 (-2.468**)
Promptly updated service → Expected satisfaction (H6c)	0.428 (1.757*)

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7 showed the results of effects on agreement on government policies and trust on government. Overall, the ANOVA results found that the model was significant at 0.01 level with F = 54.182 (*r-square* = 0.338) and F = 52.844(*r-square* = 0.333). The results also showed that both effects on perceived government policies and trust on government found significant at 0.01 level. Therefore, H7a and 7b were accepted.

Table 7: Effects on Agreement on Government Policies and Trust on Government

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Expected satisfaction → Perceived government policies (H7a)	0.582 (7.361***)
Expected satisfaction → Trust on government (H7b)	0.577 (7.269***)

*** $p < 0.01$

6. Conclusion

6.1. Findings

The purpose of this study is to explore determinants of citizen's dissatisfaction in relation to public transportation system by conducting qualitative and quantitative researches. The results of qualitative research confirmed that factors of dissatisfaction are related to different transportation modes. Therefore, there were differences in perceptions on dissatisfaction based on type of public transportation. From the quantitative research, this study investigates effects of proposed determinants including efficiency of operation system, information system, comfortable environment and safety on dissatisfaction, effects of advanced public transportation service on expected satisfaction, and effects of expected satisfaction on perceived government policies and trust on government. The results of this study showed that effects of efficiency of operation system and safety on dissatisfaction were significant in the case of three public transportation modes. Further, effect size of efficiency of operation system were higher than other effects for all types of public transportation. In terms of proposed factors on demand for future

improvement, effects of integrated service platform and promptly updated service on expected satisfaction showed significant negatively and positively each. The results implied that integrated service platform might cause inconvenience as citizen's expectations on public transportations are different. Integrated service platform correlates negatively with expectation satisfaction probably due to the citizens' reluctance to one platform covering too many services or the lack of experience and information on similar types of public transportation integration platforms. This study also found that perception of government policy and trust on government will increase as expected satisfaction increases. The results also implied that government should apply better policies on transportation system to improve citizen's satisfaction and trust on government.

Additionally, this study found that overall dissatisfaction level differs based on types of public transportation. The results showed that satisfaction levels on bus and public bike were relatively higher than taxi. This study also conducted the ANOVA to check different dissatisfaction level based on demographics. The results showed that there was no difference based on gender, while means of dissatisfaction level differ based on occupation at 0.05 level. The result of the two-way ANOVA showed that there is an interaction effect of education level and length of residence on satisfaction level. Means of dissatisfaction level of citizens who have more than 2-year associate degree tend to be higher with the length of residency exceeds 3 years. The result of the MANOVA showed that there is a significant difference between means of overall satisfaction on public transportation and levels of dissatisfaction of bus, bike, and taxi based on the occupation according to Roy's Largest Root.

6.2. Managerial and Policy Implications

This study provides managerial and policy implications on society and policy makers by addressing necessity of improving strategies for public transportation with the consideration of citizen relationship and sustainable development. This study confirmed that the impact of citizen satisfaction of public transportation improves citizen's agreement on policies and trust in government. This study stressed that governments should utilize effective policy instrument by using relevant data collected through citizen participation and adaption of advanced technology. For innovation and efficiency of existing service and systems regarding public transportation in the 4th industrial revolution era, better applications of ICT based management systems such as ITS and CiRM could be utilized in the future strategies. For instance, in order to provide the advanced service, Big Data analysis could be applied to analyze the patterns of citizen behavior for the provision of higher-quality service of public transportation system. With increasing concerns on sustainability, public transportations that consider more environmental friendly and energy efficiency should be applied. Further, proper policies need to be prepared as necessary means of establishing the demands for better quality of life. Governments should establish policies to motivate the use of public transportation by considering transition of existing vehicles into environment-friendly ones and applying civil opinions. Technology enabled strategies for all modes of public transportation could be developed for the future satisfaction that might also lead to the improvement of citizen's agreement and trust on governance. Although perceived integrated service platform for all public transportation modes didn't show significant, developing and promoting better services will improve citizen satisfaction.

In the case of Sejong City, the public transportation system is operated and managed by the local government in Sejong City, private corporations, and the local government in adjacent cities. Some bus routes and roads are co-managed by operational and managerial agents. The complexity of operation and management relies on the cooperation system of those agents by obtaining feedback from users and by achieving the agreement on modification of related policies and systems in more efficient way. Thus, applying advanced management information system could help integrate for better management of PTS. To achieve the fundamental aims of cities such as sustainable development, policy makers and managers should listen citizen's opinion and involve them into the process and system of governance through interactive communication for the efficient use of resource allocation, management, and operation, and the adaption of ICT.

6.3. Limitations and Future Research

This study has limitations. The small size of the sample compared to the ratio with its population is one of the limitations. For future studies, larger sample size could be considered. Future studies might also consider to apply in other city cases. By targeting those who have experienced all transportation modes, further study can examine whether an integrate system or service may be an effective factor that consists of demands and determines user's satisfaction.

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