Investigating the Factors of Satisfaction/Dissatisfaction on Public Transportation: Policy and Managerial Implications

By

YOO, Jiin

THESIS

Submitted to

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For the Degree of

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Abstract

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YOO, JI IN

The purpose of this study is to provide implications on policy and management in terms of public transportation by exploring the factors of user satisfaction/dissatisfaction, and the current status of demand and perception on government. Research questions applied in this study are following; i) how determinants of satisfaction/dissatisfaction vary among transportation modes, ii) how the citizens' perception on public transportation affects satisfaction/dissatisfaction of the users and perception on government, and iii) how the improvement of public transportation service based on user's demands will affect the level of expected satisfaction and perception on government. This study applies both qualitative and quantitative research to analyze 3 types of public transportation modes including bus, bike, and taxi. For qualitative research, civil opinions were collected from the city website to see the current status of public transportation system. Based on the result of qualitative research, an online survey was distributed randomly to users for quantitative research. A factor analysis and ANOVA test were conducted using the data from survey for the overall satisfaction/dissatisfaction level and its determinants, the existing demand, and the expected future satisfaction and perception on government for the users. The findings of this study could be applied to future strategies towards sustainable development of cities for proper provision and operation of public transportation system by using ICT technology that could increase its efficiency.

Keywords: Public transportation system (PTS), Citizen Relationship Management (CiRM), Intelligent Transport Systems (ITS), Satisfaction, Integrated System, Smart City

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1. Introduction

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 (Vuchic, 2002; Zeng et al., 2014; Viegas, 2001). 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 and caused critical negative consequences, particularly in terms of the environment and safety (Sinha, 2003). The emission of pollutant and greenhouses gases, energy consumption, traffic congestions and accidents are the urban issues that cause significant financial losses and lower the quality of urban life (Al-Sakran, 2015; Bruglieri et al., 2015).

To slow down private car ownership and promote use of public transportation, Citizen Relationship Management(CiRM) and Intelligent Transport Systems (ITS) based on ICT are the key factors to provide the private car owners with comfortable, reliable, and attractive alternatives by discovering citizen's knowledge, behavior patterns, and information of needs and demands which can increase the efficiency of allocating government's resources (Ibrahim, 2003; Sinha, 2003; Matas, 2004; Townsend, 2013). The concepts of Smart City involve a long term vision for sustainability and better quality of life for citizens and smart technology in general and also citizen's active participation and sharing opinions in communities in a broad meaning (Hollands, 2008; Bencardin & Greco, 2014; Benevolo et al., 2016; Mohanty et al., 2016).

The research area targeted for this study is Sejong Special Autonomous City (later referred to as Sejong City) in South Korea, which includes an administrative city located in the city center. As a part of Sejong City, Administrative City is being built with the aim of correcting the side effects of excessive concentration of the metropolitan area and contributing to the development of national balance and strengthening national

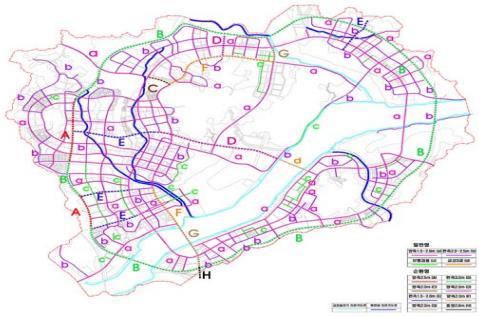
competitiveness (NAACC, 2020). According to National Agency for Administrative City Construction (NAACC) in Korea, the goal of the administrative city (refer to the Table 1) is to strengthen national competitiveness by leading balanced national development and to build a "sustainable model city" by improving urban standards so that our future generations can enjoy a high-quality and rich life and also become a "national administrative hub that drives balanced national development" and a "smart future city that moves toward the world." Master Plan for the Administrative City Construction (2006) plans for the following aims:

Table 1. Transportation Aim for the Administrative City Construction (Master Plan for the Administrative City Construction, 2006)

No	Aim	Statement
1	Public transportation hub	Create a convenient "public transportation hub" for pleasant urban activities and creating a green transportation road network connecting bicycle and pedestrian roads by making the share of public transportation as a mobility mean, including walking and bicycle traffic, account for more than 70% of the total, and the share of cars be within 30%.
2	Connectivity of traffic	Connect urban access roads and urban outer circulation roads to circulate cross-regional traffic from the outside and to curb inner city traffic.
3	Application of new transportation system	Plan a public transportation hub by introducing high-tech BRT, a means of public transportation, as an axis of urban activities.
4	Human-centered traffic information	Implement the Intelligent Transportation System (ITS) for establishment of a state-of-the-art operation system to provide passengers with real-time information on the operation of buses in and out of the city to promote public transportation, to ensure the punctuality of public transportation and to increase operational efficiency in order to create a safe and convenient traffic environment and provide human-centered traffic information.

In this study, Sejong City, the target research area, refers mostly the Administrative City but included other parts in Sejong Special Autonomous City to get overall citizen’s opinions on public transportation which operates across Sejong Special Autonomous City. To achieve the aim of a convenient public transportation hub which could be realized by balanced shares of bike road, pedestrian road, and car road, the public transportation network of bus and bike in Sejong City is being developed according to the initial plans for creating a green transportation road network and promoting the use of public transportation (refer to the Table 2).

Table 2. Plan and Current Images of Public Transportation Network in Sejong City

	
Concept of annular public transport-centered roads (Master Plan for the Administrative City Construction, 2006)	Public bus routes
	
Concept of public bike road network (Master Plan for the Administrative City Construction, 2006)	Public bike road network (Sejong City Transportation Corporation, 2020)

Under the regime of Transportation Oriented Development (TOD) and environmentally friendly and human-centered development, new public transportations that are convenient, eco-friendly and future-oriented such as Bus Rapid Transit (BRT) and electric buses, and public bike and bike roads have been applied to Sejong City (NAACC, 2020). A bus information system is also established at the bus stops to provide real-time traffic information through the Intelligent Transport System (ITS) (NAACC, 2020).

Table 3. BRT and Public Bike in Sejong City

		
Concept of plan for cross-sectional public transport-centered roads (Master Plan for the Administrative City Construction, 2006)	BRT road	Public bike rental system (Sejong City Transportation Corporation, 2020)

A successful fulfillment of aims in Master Plan of Administrative City Construction requires the coordination between necessary infrastructures and effective management. To raise the number of passengers taking public transportation, government needs to deal with the civil opinions and requirements of passengers. Governments should consider the citizen's opinion as a necessary source of information which is required for proper provision and operation of the service of public transportation system. It is important to listen to the users of public transportations, for government to improve the level of sustainability in a city by increasing benefits and productivity. Therefore, this paper aims to explore how services of public transportation system in Sejong City have been provided and utilized through collecting citizen's opinions. This study selected Sejong City since it is a newly developed and planned city as a smart city and green city. Sejong City has applied various infrastructures regarding those aims into the public transportation with advanced vehicles and system, such as BRT. By addressing the user's opinions regarding the current status of public transportation system, the directions for efficiency of future strategies for management and policies could be suggested to policy makers in the city that is still under construction. The construction is planned to be completed in 2030 (NAACC, 2020). The data of knowledge and information of user's satisfaction level can be used to promote the use of public transportation by improving operation of systems and services based on the needs and demands. If the requirements of users are met and satisfaction level increases, public transportations can be chosen not only as alternatives, but also as better mode of mobility in the city.

Although the customer satisfaction area potentially has a lot of practical importance to policy makers and transport service providers, extensive studies in the field of customer service have not applied in the transportation sector (Stradling et al., 2007). According to the survey operated by the Office for Government Policy Coordination on the satisfied level with Sejong City in 2015, there was a discrepancy between the perception of experts and residents. This results reflected that the residents' opinions were not considered in the early development stage of a new town building (Lee & Kwon, 2020). Given that a survey of satisfaction on public transportation in Sejong City has not implemented in recent years, and there has not

been much research on the citizen's perception on public transportation yet in Sejong City which is still under construction, this paper aims to offer suggested answers to three research questions by applying customer satisfaction theories. with an assumption that the types of public transportation are related to determinants of dissatisfaction, this paper will try to find the dissatisfaction on efficiency of operation system, information system, comfortable environment, and safety vary among bus, public bike and taxi, with the following question:

RQ1. Is there relationship between the determinants of satisfaction/dissatisfaction including efficiency of operation system, information system, comfortable environment and safety, and the types of public transportation?

On the basis of the assumption that the attitude of citizens such as satisfaction/dissatisfaction and agreement on government's policies is related to the experience using public transportation system, the paper attempts to address how the citizens' perception on efficiency of operation system, information system, comfortable environment, and safety influences the satisfaction/dissatisfaction of users on bus, public bike and taxi, together with an assumption that the improvement of public transportation service based on user's demands is related to the level of expected satisfaction and perception on government, by answering the following question:

RQ2. How do the citizens' perception on efficiency of operation system, information system, comfortable environment, and safety affect satisfaction/dissatisfaction of users on bus, public bike, and taxi?

RQ3. How does the improvement of public transportation service based on user's demands affect the level of expected satisfaction and perception on government?

The purpose of this paper is to discover the current level of citizen's satisfaction and dissatisfaction, perceptions of citizens, behavior patterns, and the information of demand and barriers on access to public transportation. As Sejong City is still under construction, this approach on investigating current issues on public transportation could be considered as an interim check. The result of this study can be used for

improvement of public transportation policies in Sejong City. And result also provides managerial and policy implications about public transportation in other developed cities.

In the following sections, literatures on Management Information System and Demand-response Transport, Citizen Relationship Management, Public transportation system, Smart Mobility and its definition, evolution, and implementation of different countries are examined in the section 2. Section 3 provides background theories to support the hypotheses which is further developed in the following section 4. Section 5 introduces the methodologies which this paper analyzes the collected data with, and Section 6 presents data analysis. The paper end with the conclusion in Section 7.

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 (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 et al., 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). Transit stands for a basic service and an essential component of all cities since transit provides diversified activities, vitality in economy, socially and environmentally sound conditions (Vuchic, 2002).

2.1.2. Sustainability and Public Transportation System

Urban issues and problems of transport services, such as pullution and greenhouses gases, congestion on roads, accidents, and energy consumption, have considerable impacts on the environment both locally and globally and on the quality of life of urban residents (Bruglieri et al., 2015). Transportation plays a

leading part in sustainable development since recent transportation systems have more pervasive and long-term adverse consequences than earlier transportation developments brought (Sinha, 2003). Not only national governments but also 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 et al., 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). We can be judge the sustainability of an urban transportation system by its contribution to the quality of life in the community, its use of physical and natural resources to ensure the ability of future generations in meeting their transportation and livability needs, the extent which externalities account for, and satisfaction level of current and future demands of diverse segments of society (Sinha, 2003). 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). Environmentally, more efficient public transportation systems could ease the issues regarding of growing pollution levels and traffic congestion in major cities (Barrero et al., 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). Transportation behaviors which are related to air quality and traffic safety also result in health outcome. 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, reduce per capita air pollution and lower the risk of car related accidents (Frank et al., 2006). As a tool of promoting pro-environmental behavior, the strategies on persuasive communication by using information of social norm have become popular (Thøgersen, 2009). Kormos et al. (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 study showed that despite one's previous behavior was still the largest predictor of future behavior, behavior change, particularly commuting behavior was also influenced by social norm information (Kormos et al.,2015). 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. Pulido-Fernández & López-Sánchez (2016) showed that in the tourist sector, high levels of "sustainable intelligence" are related with willingness to pay more to visit a more sustainable tourism destination unless this commitment to sustainability increases the price of product. 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 seems to be important (Thøgersen, 2009). The results of these studies show that social norms such as sustainable intelligence contributes to behavior change toward using public transportation.

2.1.3. Public Transportation Service in a Smart City: Smart Mobility

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 et al., 2016). A diverse range of Smart City involves information technology, business innovation, governance, communities and sustainability (Hollands, 2008). Smart cities are defined as greener, safer, faster and friendlier cities including various sectors such as infrastructure, transportation, energy, healthcare, and technology (Mohanty et al., 2016). According to the definition of Townsend (2013), smart cities are the places where infrastructure, architecture, everyday objects, and even our bodies are integrated with information technology. Benevolo et al. (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, knowledge city. Information and communication

technology (ICT) are the key factors that enable the transformation of traditional cities to smart cities (Mohanty et al., 2016). Information technology is evidently a big part of how smart city solves the urbanization problems (Townsend, 2013). The concept of Smart City service basically 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 et al., 2016). Nam & Pardo (2011) built the set of multi-dimensional and fundamental components of smart city and divided that into 3 factors: i) technology factor that includes digital city, intelligent city, ubiquitous city, wired city, hybrid city, and information city, ii) human factor that includes creative city, learning city, human city, and knowledge city, and iii) institutional factor that involves smart community and smart growth.

The motorization and urbanization in rapid pace is a global phenomenon and the attraction of private automobiles over public transportation is so overwhelming (Sinha, 2003). As a result of popularity of private motor vehicles which makes urban traffic more crowded, traffic monitoring became one of the important issues regarding smart-city infrastructure in the world (Al-Sakran, 2015). Smart cities could fix current problems such as congestion, global warming, in the world designed by the last century to deal with the next challenges (Townsend, 2013). Smart transportation which is also known as the Intelligent Transport Systems (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 et al., 2016). The real-time passenger information (RTPI) as a passenger information system is a popular passenger request (Beul-Leusmann et al., 2013). 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 et al. (2014), one of the key services for improving public transport attractiveness is providing timely and accurate travel time information of public transport vehicles. Real-time passenger information (RTPI) have been realized as information and communication technologies (ICT), enables information access easily (Beul-Leusmann et al., 2013). In addition, information and communication technologies can play an important role to improve the levels of public

transportation service without spending astronomically high cost (Sinha, 2003).

Further, there can be challenges in building smart cities. Townsend (2013) said 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). Bencardin & Greco (2014) said that definitions of Smart City regarding of ICT infrastructure is limited and 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 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 et al., 2016). Thus, user requirements with regard to attributes of information system have to be detected for success of these systems (Beul-Leusmann et al., 2013).

2.2. Management Information System (MIS) for Public Transport and Demand-response Transport (DRT)

2.2.1. Intelligent Transport Systems (ITS)

Since the concept of Intelligent Transportation Systems (ITS) was emerged in the 1980s, many transportation researchers have also developed incident management models and integrated systems for real-time operations (Ozbay & Kachroo, 1999). Urban traffic problems such as traffic congestion and air pollution could be eased by promoting the use of public transportation and Intelligent Transport Systems (ITS) such as real time mobility management of unexpected events, delays and service disruptions, and improving transit accessibility for each citizen since public transportation services generally have issues on

the provision of poor information to its users (Bruglieri et al., 2015). Intelligent Transportation Systems (ITS) develop on-line incident management strategies by collecting processing 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).

2.2.2. Integrated Multimodal Travel Information (IMTI)

The provision of Integrated Multimodal Travel Information (IMTI) is a core element of the Intelligent Transport Systems (ITS) (Wang et al., 2015). Grotenhuis et al. (2007) expect that integrated multimodal travel information (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 and Lyons, 2003) Many developed countries provide the traveler with a comprehensive information including web portals, traffic radio, Variable Message Sign (VMS), call centers, Short Messaging Service (SMS) platforms (Wang et al., 2015). For example, Japan implemented "Vehicle Information and Communication System (VICS)", Germany "Travel Pilot" (static route guidance system), the United Kingdom "Traffic Master" (real-time traffic and travel information system), and France "SMARTBUS" (public transportation management and information system) (Wang et al., 2015).

2.2.3. Demand-Response Transport (DRT)

According to the definition of the KFH Group (2008), demand-response is a transit mode that operates responding to passengers' or their agents' calls and is dispatched by to the transit operator to pick up and transport passengers to their destinations. Many demand-responsive transportation (DRT) 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 et al., 2015)

2.3. Customer Relationship Management (CRM) and Citizen Relationship Management (CiRM or CzRM)

2.3.1. General Definition of Customer Relationship Management and Citizen Relationship Management

The customer relationship management (CRM) has been demonstrated with various definitions and meanings by experts and theorists that is an on-going concept to develop. There are different points of view that consider CRM. Some define CRM as a customer-centric business strategy that creates and delivers value better than competitors by integrating internal processes and external networks to win and keep customers (Buttle, 2008). CRM is a set of strategic processes related to the creation of shareholder value and development of their plans to implement understanding the required major elements in their own individual context. (Payne, 2006). In a different perspective, CRM is defined as a technology solution particularly with far-ranging technology and customer centric (Payne & Frow, 2005). The technology-based approach is commonly described as "information-enabled relationship marketing" (Ryals & Payne, 2001).

Muscalu writes that (2015), Customer relationship management (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 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)

2.3.2. Citizen Perception with Public Transportation System (PTS)

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. Recently, studying user's perceptions and satisfaction has become increasingly widespread in transportation sector (St-Louis et al., 2014). A framework for knowledge of satisfaction and service performance should be provided to policy makers and operational managers in public transport in order to identify priorities and needs of passengers, to measure their satisfaction level, to assess service determinants, and to demonstrate strategies of improvement. (Nathanail, 2008). Satisfaction plays a pivotal role in understanding public transport from the customer's point of view (Friman & Fellesson, 2009). 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 et al., 2010). The emerging paradigm shifts the customer (passenger) from a user to a co-creator of value in public transport (Vargo and Lusch, 2008).

When aiming to improve the service of public transport, information about most important variables to both actual and potential users is useful for service operators (Dell'Olio et al., 2011). 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 only based on an economical approach and the passengers' feedback had been often ignored. St-Louis et al. (2014) said 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. Elena et al. (2017) analyzed the passenger's satisfaction with existing public transportation in Bucharest 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) suggested that policy makers should consider improving accessibility to transit service as a top priority based on the survey result for user satisfaction with public transportation service especially for high-density metropolitan areas in Korea. Nguyen (2019) explored the satisfaction/dissatisfaction for bus passengers in Ho Chi Minh city in Vietnam, in order to help planners and decision makers improving the service quality and to reduce pollution through reduction of private cars and make the city more sustainable. To provide public transportation system with improved quality in Istanbul, Bilisik et al. (2019) measured the passenger's satisfied level with the public transportation companies based on the result of survey and found out the civil opinions of passengers mostly about crowdedness in buses which can be used as a policy implication suggesting re-optimization of lines.

2.4. Qualitative and Quantitative Research

2.4.1. Qualitative Research using Secondary Data

According to Creswell & Creswell (2018), unstructured or semi-structured observation, interviews, documents, or visual & digital materials from multiple data sources are the natural settings on which the qualitative research is conducted based. The research process of qualitative research generally includes preparing organized data initial reading, coding, thematic analysis, utilizing software packages, making tables, graphs and figures to represent the findings, and then interpreting the findings (Creswell & Creswell, 2018). Among various analytical methods for the qualitative data such as content analysis, case study, cross-case pattern analysis, cross-case thematic analysis, qualitative research in this study applies content analysis to realize the significant relationship between the types of dissatisfaction factors and the types of public transportation in Sejong City.

2.4.2. Quantitative Research using Primary Data

This study investigates whether various factors of public transportation determine the overall dissatisfaction level of citizens and whether the level of satisfaction influence citizen's trust in government. To determine the quality of a transit service and measure the satisfaction of public transport users, surveys are widely used and considered as an useful tool (Imam, 2014). Del Castillo & Benitez (2012) identified the aspects that mostly influence the perception of overall quality of public transport service by measuring various aspects through user survey. A survey was used to find more efficient policies based on the needs and aspirations of existing and potential users by quantifying the effects of future policies (Dell'Olio et al., 2011). Valaskova & Križanova (2008) developed a survey model for evaluating Integrated Public Transport System (IPTS) in order to find information to give policy makers for further development of the system. In addition, Felleson & Friman (2008) revealed that the results of the most important attributes for public transport are varied among transit systems and cities via survey data. St-Louis et al. (2014) compared commuter satisfaction across walking, bicycle, automobile, bus, metro, commuter train by using travel survey to understand determinants of satisfaction and how they vary by transportation modes.

3. Theoretical Background

3.1. Definition of Consumer Satisfaction(CS)

Satisfaction means the state where someone's need or want is fulfilled according to the Webster's dictionary (http://www.webster-dictionary.org/definition/satisfaction). There are many terms and interpretations of satisfaction. Satisfaction can be considered in terms of each events leading up to a consumption outcome and as a comprehensive feeling from these events (Oliver, 1996). The concept of satisfaction can be considered as the outcome resulted from experiences of the buyers when they compare the rewards and purchasing costs in relation to the expected consequences (Churchill & Surprenant, 1982). Consumer satisfaction (CS) has been emphasized with the importance in market by many researches. Consumer satisfaction (CS) focuses on the delivery of satisfaction to consumers and the obtainment of

profits in return as a central marketing concept (Yi, 1990). Hempel (1977) defines consumer satisfaction as the extent of realization of expected benefits from product, which demonstrates a degree of accordance between actual outcomes and expected consequences. The general definition of consumer satisfaction is the responses of customers by evaluating the perceived gap between comparison standards such as expectations and the perceived performance of the product (Yi, 1990). As customer satisfaction theories examine the gap between customer's expectation and perceived actual outcome, this study also measured how citizens perceive public transportation service after the usage and their opinions on satisfaction/dissatisfaction. Further, this study also measured their expected satisfaction when new strategies are applied in public transportation service by applying customer satisfaction theories.

3.2. Theories of Customer Satisfaction (CS)

Theories focusing on product performance include contrast theory, assimilation-contrast theory, dissonance theory, general negativity theory, and hypothesis testing theory. Besides the theories on product performance, other theories that explain expectation-disconfirmation paradigm have been applied such as comparison-level theory, equity theory.

3.2.1. Contrast Theory

Satisfaction may depend not only upon the product itself, but also upon the experience associated with the purchase and use of product (Cardozo, 1965). Disconfirmation can be defined as the disparity between performance and expectation so that disconfirmation becomes positive when performance exceeds expectation (Cardozo, 1965). Contrast theory is a tendency to exaggerate the discrepancy between one's own attitudes and the attitudes of opposing people (Dawes et al, 1972). The lack of communication makes individuals' exaggerated discrepancy larger than the real one (Oliver, 1996). Thus, it is important to know about customer expectation gathered from a variety of sources such as advertising, or other sales promotion methods because these factors are major components of customer behavior (Cardozo, 1965).

3.2.2. Assimilation-Contrast Theory

According to assimilation-contrast theory, there are scopes of acceptance and rejection in individual's perceptions (Sherif & Hovland, 1961). Oliver (1977) has found that the post-exposure ratings are separately related to expectation and disconfirmation. When the difference of expectation and performance is small enough to be accepted by consumers, the product rating on expectation will tend to be assimilated (Yi, 1990). That is, high expectations about product quality cause much higher ratings, whereas low expectations lead to lower rating if the difference between expectations and performance is neglectable as to fall into the acceptance zone (Yi, 1990). Whereas the contrast theory predicts that raising expectations would harm the perceptions of product performance, the assimilation theory expects that it will strengthen perceived product performance (Yi, 1990).

3.2.3. Dissonance Theory

Festinger (1976) insisted that the dissonance state which is described as a psychologically uncomfortable tension state, may affect a person's perceiving and this state can be created by disconfirmed expectations. According to the cognitive dissonance theory, disconfirmed expectancies result in dissonance state or psychological discomfort (Festinger, 1976). And these mechanisms to lower dissonance include behavior change or selective distortion of perceptions (Festinger, 1976). Calsozo (1965) found that customers who expend little effort rated the product lower than those who made high effort and high expectations are caused by high effort. Yi (1990) posits that the same effect on expectations are predicted by both dissonance theory and assimilation theory. However, Yi (1990) suggested the problem that it is hard to show the arousal of dissonance caused by disconfirmation.

3.2.4. General Negativity Theory

Under the general negativity theory, confirmation will be considered as more pleasant than any disconfirmation of expectations (Carlsmith & Aronson, 1963). If a discrepant performance occurs, consumers will evaluate the product less favorably than in the case of no prior expectations as either positive or negative disconfirmation cause lower evaluation on product (Yi, 1990). Disconfirmation of expectations

by resulting in a negative state generalizes the evaluation of products performance (Carlsmith & Aronson, 1963). The researches by Oliver (1976) and Weaver & Brickman (1974) supported the generalized negativity theory showing that it requires certain conditions to appear, for example, when involvement, commitment and interest are high. If this theory is valid, expectations created by promotion should be consistent with actual product performance (Yi, 1990).

3.2.5. Comparison level Theory

LaTour & Peat (1980) criticized the paradigm which assumes that predictive expectations created by manufacturers, test reporters or unspecified sources primarily determine consumer satisfaction because this assumption ignores other sources of expectation such as consumers' past experience. A modified comparison level theory proposed by LaTour & Peat (1980) consists of three basic determinants: consumers' prior experience with similar products, situationally-produced expectations, and the experience of other consumers who serve as referent persons (Yi, 1990). LaTour & Peat (1980) found that situationally-induced expectations had no significant effect on consumer satisfaction, whereas expectations created by prior experience were the major factor of consumer satisfaction. Swan & Martin (1981) also found that the disconfirmation of the comparison level was more related to satisfaction rather than the disconfirmation of predictive expectations.

3.2.6. Equity Theory

Equity theory has been applied to many studies of consumer satisfaction (Yi, 1990). Equity Theory indicates that individuals compare the ratios of input/output with the ratios of other related people (Adams 1963). The basis of comparison is the consumers' perception level of equity between what they received and what other people received with regard to their respective input (Yi, 1990). It is considered that satisfaction exists when the outcome-to-input ratios are perceived as fair by individuals (Yi, 1990). A test of equity theory in a consumer satisfaction context by Fisk & Young (1985) shows that inequity yields dissatisfaction and reduction of customers' intention to repurchase the product. Swan & Oliver (1991) found that satisfaction was determined not only by inequity but also by disconfirmation.

4. Hypothesis Development

4.1. Effects of Proposed Factors on Citizen's Satisfaction/Dissatisfaction

In travel research methodology and policy interventions, the difference in instrumental, situational and psychological factors that affect decision of travel mode is often overlooked even though different people are motivated by diverse factors and are influenced in different ways by policies (Anable, 2005). St-Louis et al. (2014) compared commuter satisfaction across walking, bicycle, automobile, bus, metro, commuter train to study how levels of satisfaction differ across transportation modes and found that a considerable variation exists among determinants of satisfaction by transportation modes and user's mode preference and perceptions also affect satisfaction. Therefore, this study hypothesizes the relationship between the types of public transportation and the factors of citizen's dissatisfaction in Sejong City.

H1: There is a relationship between types of public transportation and factors of citizen's dissatisfaction.

4.2. Effects of Attributes of Bus, Bike, and Taxi on Satisfaction/Dissatisfaction on Public Transportation

4.2.1. Effects of Efficiency of Operation Service on Satisfaction/Dissatisfaction on Public Transportation

In terms of overall efficiency of using public transportation, time and cost are considered as important factors. Waiting time is always the most weighted variable in the utility functions of a transport mode since users perceive it as lost and irritating (Lirman, 2008). Dell'Olio et al. (2011) shows that waiting time is one of the most valued variables by users in terms of public transport, and waiting time and journey time represent the most important variables that potential users expect from public transport quality. Imam (2014) also showed that the importance of travel cost that contributes to passenger satisfaction.

The research of Le-Klähn, Hall, & Gerike (2014) revealed that ticket price, service frequency, and ease

of use are some of the most important items to visitor satisfaction with public transportation. To present the types of tickets and ticket zones in a clear and succinct way is necessary (Le-Klähn, Hall, & Gerike, 2014). Price of ticket has a main impact on the attractiveness of public transport (Redman et al., 2013). Sharaby & Shiftan (2012) also indicated that fare reduction was a significant factor in attracting transit users. It is observed that a problem of declining ridership in public transport can be eased by active policies such as an integrated fare system realized as low-cost travel cards that permit unlimited travel across the entire network in the case of Madrid (Matas, 2004).

Del Castillo & Benitez (2012) demonstrated that line reliability, bus stop location adequacy, and service frequency belong to the most important aspects. The results of Valaskova & Križanova (2008) shows the importance of following criteria: observance of timetable, price of tickets, accessibility of buying tickets. Thompson & Schofield (2007) highlighted the importance of ease-of-use, which has great influence on satisfaction on public transport's users. According to Le-Klähn, Hall, & Gerike (2014), accessibility is an important criterion since accessible stations and transport vehicles can improve customer penetration.

In the case of public bus, transfer service is an important factor which is related with information system and overall efficiency. According to Tyrinopoulos & Antoniou (2008), providing information at transfer points means the information which is provided to users at the transfer locations about the mixed recommendation of the various lines and modes, and time schedules. Ease of transfers/interchanges is a physical attribute of public transport service quality which is defined as how simple transport connections are, including wasted time while waiting (Redman et al., 2013). The transfer coordination with other means, transfer distance and transfer quality are the dominant factors for satisfaction (Tyrinopoulos & Antoniou, 2008). The impact of fare integration on transit ridership and travel behavior is revealed positive, for example, passenger trips increased by 7.7% resulted from free transfers in Israel (Sharaby & Shiftan, 2012). 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).

The results of these previous studies indicate that efficiency of operation service that contributes most

to the overall satisfaction of users of public transportation in terms of frequency of arrivals, fare, ease of payment, operation time, network coverage, location of station, ease of access, getting transfer information, transfer fare, ease of transfer, total travel time, total travel cost, total waiting time. Therefore, this study hypothesizes the effect of efficiency of operation service on dissatisfaction on public transportation.

H2a: Efficiency of operation service affects satisfaction/dissatisfaction on public bus.

H2b: Efficiency of operation service affects satisfaction/dissatisfaction on public bike.

H2c: Efficiency of operation service affects satisfaction/dissatisfaction on taxi.

4.2.2. Effects of Information System on Satisfaction/Dissatisfaction on Public Transportation

Local public transport users were found to consider real-time information most important (Molin & Timmermans 2006) while tourists have tendency to depend on traditional information sources such as a tourist information center, word-of-mouth, attraction leaflets, the Internet, and hotel reception (Thompson 2004). The research of Le-Klähn, Hall, & Gerike (2014) revealed that information is one of the most important items to visitor satisfaction with public transportation. Caulfield & O'Mahony (2007) examined the public transport information requirements of users. The survey result of Caulfield & O'Mahony (2007) shows that real time location of vehicle, speed of answering, news on disruptions, booklet with bus OR rail timetables, estimated time of arrival are respectively the most important attributes of information provision via Internet, call center, mobile phone, paper-based systems, RTPI (Real-Time Passenger Information) displays. The real-time passenger information (RTPI) as a passenger information system is a popular passenger request (Beul-Leusmann et al., 2013). According to Abidin et al. (2014), one of the key services for improving public transport attractiveness is providing timely and accurate travel time information of public transport vehicles. Real-time passenger information (RTPI) have been realized as information and communication technologies (ICT) allows easy access to information (Beul-Leusmann et al., 2013). The results of these studies show that providing accurate information via various channels and establishment of its system contribute to the overall satisfaction of users of public transportation. Therefore, this study

hypothesizes the effect of information service on dissatisfaction on public transportation.

H3a: Information system affects satisfaction/dissatisfaction on public bus.

H3b: Information system affects satisfaction/dissatisfaction on public bike.

H3c: Information system affects satisfaction/dissatisfaction on taxi.

4.2.3. Effects of Comfortable Environment on Satisfaction/Dissatisfaction on Public Transportation

When improved standards for vehicles or stations are provided, transport suppliers often mention the comfort as a key factor (Redman et al., 2013). as a means of promising emission decrease, it seems to be an important issue for raising ridership the improvement of the perceived comfort of public transportation (Beul-Leusmann et al., 2013). 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 (Fellesson & Friman, 2008). Other works on the same line are those of Imam (2014) and Le-Klähn, Hall, & Gerike (2014). Stradling et al. (2007) found that satisfaction with bus services is affected by various non-instrumental factors such as cleanliness, convenience, stress. It was found that improvements focused on comfort-related issues such as vehicle cleanliness, safety and improved civil opinions handling significantly increased satisfaction of passengers (Foote, 2004). Tyrinopoulos & 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 et al., 2018). The results of these studies show that providing comfortable environment contributes to the overall user perception of public transportation. Therefore, this study hypothesizes the effect of comfortable environment on dissatisfaction on public transportation.

H4a: Comfortable environment affects satisfaction/dissatisfaction on public bus.

H4b: Comfortable environment affects satisfaction/dissatisfaction on public bike.

H4c: Comfortable environment affects satisfaction/dissatisfaction on taxi.

4.2.4. Effects of Safety on satisfaction/dissatisfaction on Public Transportation

The study of Perone & 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). Driving skills are often influenced by road safety, and if passengers find safety conditions poor, they might change transport modes (Van Lierop et al., 2018). The results of these studies show that safety contributes to the overall user satisfaction of public transportation. Therefore, this study hypothesizes the effect of safety on dissatisfaction on public transportation.

H5a: Safety affects satisfaction/dissatisfaction on public bus.

H5b: Safety affects satisfaction/dissatisfaction on public bike.

H5c: Safety affects satisfaction/dissatisfaction on taxi.

4.3. Effect of Advanced Services of Public Transportation on Expected Satisfaction and Perception on Government

4.3.1. Effect of Advanced Services of Public Transportation on Expected Satisfaction

The service-delivery system (SDS) has been transformed into a more interactive way by the development of new technologies and the options that customers can choose are now widened into several different alternatives such as the Internet (Patrício et al., 2003). 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 et al., 2003). Patrício et al. (2003) indicates that service providers should give attention directly to the integrated management of different service delivery systems since customers are satisfied not only with the performance of respective channel, but also with how the overall service are offered by using the different service delivery systems in a complementary way.

Supplying an integrated and high-quality public transport system has become one of the most favored tools which have been selected to promote public transport use (Matas, 2004). The integration of real-time data which facilitates en-route assistance for passengers is highly interesting (García et al., 2012). The study of Beul-Leusmann et al (2013) revealed through a passenger survey that providing a passenger information system with reliable content is at least a good initial attempt to increase ridership as they are useful to contribute to enhance passenger comfort and user acceptance. Patrício et al. (2003) said that service providers should design a provision tool which is flexible enough to accommodate different customer segments, different operations, and different usage patterns with a strong customer focus due to diversity of customer characteristics. The user-centered approaches, which are followed by human factors researchers, focus on user characteristics and information needs and model passenger information systems (Bae, 1995). Caulfield& O'Mahony (2007) showed that passengers' requirements depend on the user scenario.

It is vital to develop the future public transport to improve customer satisfaction (Le-Klähn, Hall, & Gerike, 2014). Using data from a New York City citizen survey, Van Ryzin (2004) found a fundamental role of the disconfirmation of expectations when satisfaction judgments are formated regarding the quality of urban services. Investment questions raised by operating companies can be answered with knowledge about the desired service quality and the knowledge enables the establishment of future policies designed to encourage more use of public transport based on the needs and expectations of their existing and potential customers (Dell'Olio et al., 2011). Van Ryzin (2004) strongly supported an expectancy disconfirmation model of citizen satisfaction and revealed that satisfaction judgments are determined by a process where consumers compare performance with their prior expectations, not just by product or service performance. Van Ryzin (2004) suggested urban managers to promote not only high-quality services, but also high expectations among citizens.

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

H6b: Integrated information for all types of public transportation affects expected satisfaction on public

transportation.

H6c: Integrated service platform for all types of public transportation affects expected satisfaction on public transportation.

H6d: Quick update of service considering citizen's conveniences affects expected satisfaction on public transportation.

H6e: Better customized service considering individual citizen's usage of public transportation affects expected satisfaction on public transportation.

4.3.2. Effect of Satisfaction with Advanced Services of Public Transportation on Citizen's Perception on Government

Abidin et al. (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 two major features that have to be considered to find a trustworthy opinion. Van de Walle & Bouckaert (2003) studied the performance-trust relation and found that actual performance is not equal to perceived performance; "It is obvious that performance of the public administration has a certain impact on trust in government, but existing levels of trust in government may also have an impact on perceptions of government performance." (Van de Walle & Bouckaert, 2003) If tourist behavior is more investigated and their experience with public transport are more improved, these researches can bring economic returns to a destination as well as contribution to sustainable transport goals (Le-Klähn, Hall, & Gerike, 2014).

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

H7b: Satisfaction with advanced services affects government trust.

5. Methodology

5.1. Methodology for Qualitative Research using Second Data

5.1.1. Research Design

The Qualitative research in this paper applies the content analysis of civil opinions, obtained from the website of Sejong City. It examines frequent words of civil opinions and frequent topics of civil opinions. First, this study intends to find the types of complaint of each public transportation in terms of the main topics of dissatisfaction on public transportation via classifying keywords and descriptions of the experience of users. By investigating the details of reviews in the level of words, this study may find out the key determinants of satisfaction/dissatisfaction via the frequency of words. This study adapts R software which helps to analyzes word frequency, to provide easy recognition of key words and visualization of the civil opinions using bus, public bike and taxi in Sejong City. Second, this research will show if there is the significant relationship between types of public transportation and determinants of satisfaction/dissatisfaction by analyzing the civil opinions of the website of Sejong City. Sejong City has an online platform which contains a volume of civil opinions since 2015. The data of civil opinions on bus and public bike for last 1 year was selected while that of taxi since 2015 was selected due to a low volume of data compared to bus and public bike.

5.1.2. Description of the Data

This content analysis deals with the lexical data of bulletin board for civil opinions on Sejong City website, which listings have been operated from May 2015 to August 2020 and its number of listings during this period is 16,804. Among these listings, to collect recent data, civil opinions from August 2019 to August 2020 have been selected except for those of taxi which have a small volume during the period compared to bus and public bike. For taxi, data operated during the period from May 2015 to August 2020 was selected. This research collects the civil opinions from each type of public transportation with four attributes of dissatisfaction and focuses on 416 civil opinions.

Civil opinions on public transportation in this research are categorized into 4 dissatisfaction types: efficiency of operation system, information system, comfortable environment and safety, because it helps to compare with the survey result of quantitative research. 4 determinants of satisfaction are inspired by

and modified from Seo & Park (2017), Valaskova & Križanova (2008), and Pulido-Fernández and López-Sánchez (2016). Therefore, civil opinions have been classified into efficiency of operation system (187), information system (81), comfortable environment (85) and safety (63). These civil opinions help to interpret the outcome of qualitative research. This research uses 416 civil opinions as shown in Table. Civil opinions on bus service system consist of 125 civil opinions of efficiency of operation system, 63 civil opinions of information system, 69 civil opinions of comfortable environment, and 41 civil opinions of safety. Civil opinions on public bike system consist of 37 civil opinions of efficiency of operation system, 6 civil opinions of information system, 3 civil opinions of comfortable environment, and 18 civil opinions of safety, while civil opinions on taxi service system 125 civil opinions of efficiency of operation system, 63 civil opinions of information system, 69 civil opinions of comfortable environment, and 41 civil opinions of safety. Those opinions on public transportation provide policy and managerial implications how to improve public services to enhance citizen satisfaction. Particularly, various determinants that vary by each transportation mode could be considered by policy makers and operation managers as an important source of information for optimal allocation of resource.

Table 4. The Summary of Sampling: Contingency Table of Civil Opinions by Transportation Type and Determinants of Satisfaction/Dissatisfaction

	Efficiency of Operation System	Information System	Comfortable Environment	Safety	Total
Bus	125	63	69	41	298
Bike	37	6	3	18	64
Taxi	25	12	13	4	54
Total	187	81	85	63	416

By applying qualitative data, this research applies the *chi*-square analysis to identify relationship between types of public transportation and attributes of dissatisfaction from the civil opinions in Table 4.

5.2. Methodology for Quantitative Research using Primary Data

5.2.1. Data Collection

Quantitative research in this paper collects the data via survey and the survey is proposed to investigate the opinions of citizens about public transportation in a city. The constructs used to develop survey questions including satisfaction/dissatisfaction factors were based on previous researches (Van de Walle & Bouckaert, 2003; Foote, 2004; Molin & Timmermans, 2006; Caulfield & O'Mahony, 2007; Fellesson & Friman, 2008; Lirman, 2008; Valaskova & Križanova, 2008; Tyrinopoulos & Antoniou, 2008; Dell'Olio et al., 2011; Sharaby & Shiftan, 2012; Beul-Leusmann et al., 2013; Redman et al., 2013; Abidin et al., 2014; Imam, 2014; Le-Klähn, Hall, & Gerike, 2014; Van Lierop et al., 2018), and the result of qualitative research in this study. Specifically, the study developed variable items modified from the key variables explored by Seo and Park (2017), Valaskova and Križanova (2008), and Pulido-Fernández and López-Sánchez (2016). The types of questions are designed with five-point Likert scales from 1 to 5, 1 being strongly satisfied while 5 being strongly dissatisfied. The survey questionnaire has been pre-tested twice with small groups with eleven individuals for each trial via Qualtrics which is an online survey platform, and feedback about survey questions such as number of questions, definition of wording and proper instruction to performing surveys. The survey was randomly distributed to respondents who have experience of public transportation service in Sejong City, South Korea, through online channel, from mid-August to mid-September 2020. Online survey was conducted based on the platform called Qualtrics, which creates an online link so that the questionnaire can be easily distributed through such means as MNS, SNS, email, and so on. The survey questions are constructed based on the research designs and consist of 73 questions that ask random respondents questions not just regarding public transportation system itself but also about their demographic information including gender, age, education level, occupation and income level.

5.2.2. Description of the Data via Survey

5.2.2.1. Measurement of Factors of Satisfaction/dissatisfaction and Demand

The survey mainly focuses on factors of satisfaction/dissatisfaction and demand on public transportation. The survey includes the expected improvement in the service provided in regards of public transportation system such as a new integrated information system. For determinants of satisfaction/dissatisfaction on public transportation, the questionnaire includes the following attributes based on the result of the qualitative research using civil opinions: i) efficiency of operation system; ii) information system; iii) comfortable environment; iv) safety. In order to check reliability, this study conducted Cronbach's alpha tests.

Table 5. Reliability Test of Variables using Cronbach's Alpha of the Factors of User's Satisfaction/Dissatisfaction

Factors	Transportation modes	Scale items	Data items
Efficiency of operation system	Bus	Frequency of arrivals	Q9-1
		Fare	Q9-2
		Ease of payment	Q9-3
		Operation time	Q9-4
		Network Coverage (route)	Q9-5
		Location of station	Q9-6
		Ease of access	Q9-7
		Getting transfer information	Q9-8
		Transfer fare	Q9-9
		Ease of transfer	Q9-10
		Total travel time	Q9-11
		Total travel cost	Q9-12
		Total waiting time	Q9-13
		(Cronbach's Alpha)	**0.940**
	Bike	Location of station	Q10-1
		Fare	Q10-2
		Ease of payment	Q10-3
		Operation time	Q10-4
		Ease of access	Q10-5
		Total travel time	Q10-6
		Total travel cost	Q10-7
		Total waiting time	Q10-8
		(Cronbach's Alpha)	**0.976**
	Taxi	Frequency of arrivals	Q11-1
		Fare	Q11-2
		Ease of payment	Q11-3
		Location of station	Q11-4
		Ease of access	Q11-5
		Total travel time	Q11-6
		Total travel cost	Q11-7
		Total waiting time	Q11-8
		(Cronbach's Alpha)	**0.907**
Information system	Bus	System of getting information	Q9-13
		Accuracy of information	Q9-14
		Notification about changing policies	Q9-15

		(Cronbach's Alpha)	**0.818**
	Bike	System of getting information Accuracy of information Notification about changing policies (Cronbach's Alpha)	Q10-9 Q10-10 Q10-11 **0.920**
	Taxi	System of getting information Accuracy of information Notification about changing policies (Cronbach's Alpha)	Q11-9 Q11-10 Q11-11 **0.919**
Comfortable environment	Bus	Crowding Cleanness of facility Comfort (noise, scent, temperature) Seat comfort Driver behavior (Cronbach's Alpha)	Q9-17 Q9-18 Q9-19 Q9-20 Q9-21 **0.858**
	Bike	Cleanness of facility Comfort (noise, scent, temperature) Seat comfort (Cronbach's Alpha)	Q10-12 Q10-13 Q10-14 **0.973**
	Taxi	Cleanness of facility Comfort (noise, scent, temperature) Seat comfort Driver behavior (Cronbach's Alpha)	Q11-12 Q11-13 Q11-14 Q11-15 **0.938**
Safety	Bus	Overall safety Safe Driving (Cronbach's Alpha)	Q9-22 Q9-23 **0.888**
	Bike	Safety of vehicle Facilities for safety precaution Safety of bike roads (Cronbach's Alpha)	Q10-15 Q10-16 Q10-17 **0.943**
	Taxi	Overall safety Safe Driving (Cronbach's Alpha)	Q11-16 Q11-17 **0.880**

Further, this study proposed five factors of demand sides to examine better public transportation services that could be expected by citizens in the future: i) an integrated mileage system for all types of public transportation; ii) an integrated information for all types of public transportation (e.g., available for bus, taxi and bike at once); iii) an integrated service platform (online, mobile, etc) for all types of public transportation; iv) quickly updated services by considering citizen's conveniences; v) customized service by considering individual citizen's usage of public transportation.

5.2.2.2. Measurement of Citizen's Perception on Government

The study continues to measure trust-building. This study mainly focuses on approach for policies and management to improve trust in government's providing and operating the public transportation system. In order to investigate the relationship between the satisfaction level on public transportation and the perception on government including agreement with policies and trust in government, the questionnaire items include future level of agreement with policies and trust in government if the public transportation system is improved based on the user's demand on 5 factors above.

5.2.2.3. Measurement of Effect of Attitudes towards Sustainability on the Use of Public Transportation

This study also measures the effect of individual attitudes towards environment-friendly vehicles on the use of public transportation. The attitude toward sustainability of a city is measured based on the attitudes towards environment-friendly vehicles and willingness to use public transportation. In order to investigate the potential growth of use of public transportation, questionnaire items include the level of willingness to use more environment-friendly vehicles and perception on public transportation as an environment-friendly vehicle.

5.2.3. Analytical Method

This study applied Factor Analysis (EFA) and regression analyses as methodology and SPSS as analysis program. By using factor analysis, 4 factors are selected from many variables. 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. And by using the derived factor scores, multiple regression analysis was conducted to see the relationship between dependent variables such as level of satisfaction/dissatisfaction on public transportation and selected factors as independent variables, and the strength of the relationship. A significant level was mostly applied as alpha 0.01(1%) and 0.05(5%).

6. Data Analysis

6.1. Data Analysis for Qualitative Research

6.1.1. Visualization of key words of civil opinions and shared topics

The result shows that the words in civil opinions on bus have frequently related to bus station, bus route, time, bus driver and transfer, while civil opinions on public bike are associated with installation of bike rack, issues regarding return, bike road and station, and those on taxi with taxi driver, taxi station, fare, call taxi and refusing ride. In this research, contents of civil opinions are classified into 4 categories based on key words, which vary by bus, bike and taxi. Based on the classified data of civil opinions on public transportation in Sejong City by 4 determinants of dissatisfaction, this research visualized the words that appear most frequently using R software to see main topics of dissatisfaction factors by 3 types of public transportation: bus, public bike and taxi.

Table 6. Frequency of Words in Civil Opinions on Bus, Bike and Taxi in Sejong City.

Type	**Bus**		**Bike**		**Taxi**	
Rank	**Word**	**Frequency**	**Word**	**Frequency**	**Word**	**Frequency**
1	bus station	211	install	41	taxi driver	38
2	bus route	173	Rack	24	taxi station	19
3	Time	115	Return	16	fare	17
4	bus driver	98	Toad	13	call taxi	18
5	transfer	53	station	12	refusing ride	17
6	terminal	65	storage	11	distance	8
7	install	40	Time	11	install	8
8	alight	36	rental station	10	service	7
9	vehicle	35	weed control	9	matching	6
10	Drive	30	location	8	time	6
11	intervals	25	Safety	7	call	6
12	traffic light	25	Call	7	safety	5
13	notification	25	management	6	application	5
14	Change	24	dangerous	6	integration	5
15	distance	23	Place	6	road	4

Figure 1. Wordcloud for Civil Opinions on Bus in Sejong City

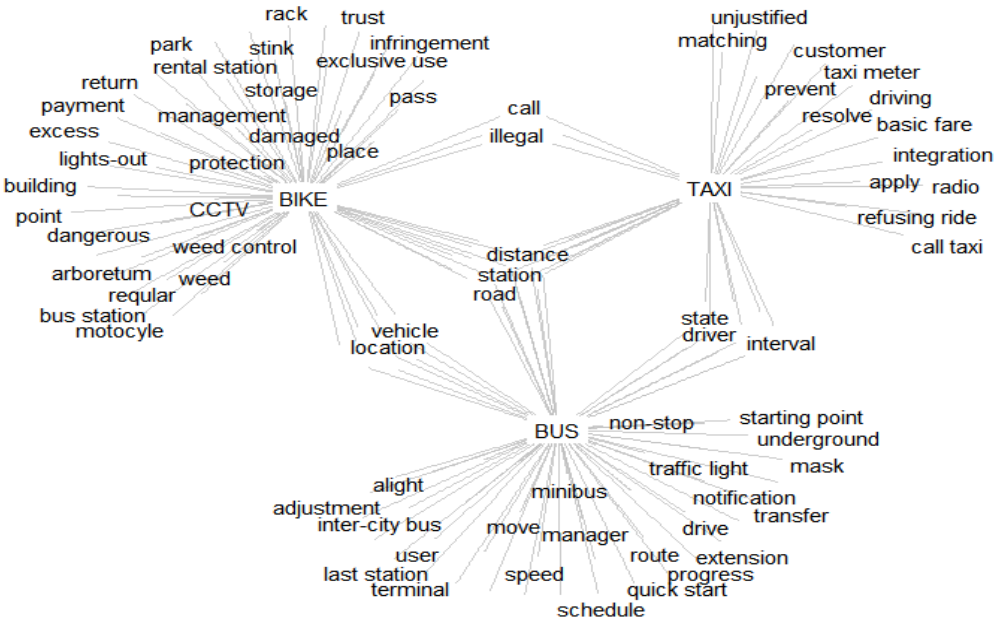
Figure 2. Wordcloud for Civil Opinions on Public Bike in Sejong City

Figure 3. Wordcloud for Civil Opinions on Taxi in Sejong City

In addition, based on the keywords of civil opinions for each transportation mode, this research also

visualized shared topics that appear at the same time by using R software to see how much topics of civil opinions vary among bus, public bike and taxi. Although there are several common topics that are related to not only one transportation mode but more than 2 different modes, it is generally observed that each mode of transportation has its own different kinds of topics. Most of keywords regarding bus, public bike, and taxi are different.

Figure 4. The connection of keywords in civil opinions on public transportation in Sejong City



6.1.2. *Chi*-square Test

The contingency table below provides the following information: the observed cell totals, (the expected cell totals) and [the chi-square statistic for each cell]. The chi-square statistic, p-value and statement of significance appear beneath the table. A chi-square test of independence was performed to examine the relationship between the type of public transportation and the 4 determinants of dissatisfaction. The relation between these variables was significant, X2(6, N=416), p = .000243. This research concludes the alternative hypothesis 1 is accepted at significant level of 0.01. The determinants of satisfaction/dissatisfaction vary by bus, bike and taxi in Sejong City.

Table 7. Result of *Chi*-square Test

	Efficiency of operation system	Information system	Comfortable environment	Safety	Row Totals
Bus	125 (133.96) [0.60]	63 (58.02) [0.43]	69 (60.89) [1.08]	41 (45.13) [0.38]	298
Bike	37 (28.77) [2.35]	6 (12.46) [3.35]	3 (13.08) [7.77]	18 (9.69) [7.12]	64
Taxi	25 (24.27) [0.02]	12 (10.51) [0.21]	13 (11.03) [0.35]	4 (8.18) [2.13]	54
Column Totals	187	81	85	63	**416 (Grand Total)**

The chi-square statistic is 25.7915. The p-value is .000243. The result is significant at $p < .01$.

6.2. Data Analysis for Quantitative Research

6.2.1. Demographics

Out of 207 respondents in total, 107 completed the survey with 51.6% of response rate. Among them, 43.93% were female and 56.07% were male. By age groups, 0.93% were under 20 years old, 22.43% were 20-29 years old, 35.51% were 30-39 years old, 22.43% were 40-49 years old, 15.89% were 50-59 years old and 2.8% were 60-69 years old. With regard to their education level, 3.74% had high school degree or less, 3.74% had 2-year associate degree, 44.86% had bachelor's degree, 38.32% had master's degree and 9.35% had Ph.D. degree. or more. Occupation-wise, students were 17.76%, government officers were 17.76%, workers in academic sector were 4.67%, workers in public-sector corporation were 19.63%, workers in private-sector corporation were 17.76%, personal business owners were 3.74%, housewives were 7.48%, workers in other occupations were 9.35%, and not available took up 1.87%. In terms of income, 18.87% were not applicable, possibly because those respondents were students and still not in the job market, 9.43% had annual incomes between $20,001 and $30,000, 26.42% had annual incomes between $30,001 and $50,000, and 10.38% reported their annual incomes between $50,001 and $70,000. 21.70% said they had annual incomes equal to $70,001 or more, while 13.21% had annual incomes equal to $20,000 or less.

Table 8. Sample Demographic Characteristics of Respondents

Characteristics		Number	%
Gender	Male	60	56.07%
	Female	47	43.93%
Age	Under 20	1	0.93%
	20-29	24	22.43%

	30-39	38	35.51%
	40-39	24	22.43%
	50-59	17	15.89%
	60-69	3	2.80%
	70 or more	0	0.00%
Education	High school or less	4	3.74%
	2-year associate degree	4	3.74%
	Bachelor's degree	48	44.86%
	Master's degree	41	38.32%
	Doctoral degree or more	10	9.35%
Occupation	Student	19	17.76%
	Own a personal business	4	3.74%
	Corporation-private sector	19	17.76%
	Corporation-public sector	21	19.63%
	Government officer	19	17.76%
	Academic sector	5	4.67%
	Housewife	8	7.48%
	Other	10	9.35%
	Not available	2	1.87%
Income	Not available	20	18.87%
	$20000 or less	14	13.21%
	$20001-$30000	10	9.43%
	$30001-$50000	28	26.42%
	$50001-$70000	11	10.38%
	$70001 or more	23	21.70%
Total		**107**	**100%**

6.2.2. Data Analysis and Hypothesis Testing

Table 9 summarized the result of factor analysis for factors that determine bus user's satisfaction/dissatisfaction: efficiency of operation system, information system, comfortable environment and safety.

Table 9. Component Matrix: Determinants of Satisfaction/Dissatisfaction of Bus Users (efficiency of operation system, information system, comfortable environment and safety)

Items		**Components**			
Factors	**Scale items**	**1**	**2**	**3**	**4**
Efficiency of operation system	Total waiting time	0.860			
	Location of station	0.849			
	Total travel time	0.847			
	Network coverage(route)	0.830			
	Ease of transfer	0.796			
	Frequency of arrivals	0.764			
	Operation Time	0.762			
	Total travel cost	0.759			
	Fare	0.746			
	Ease of access	0.738			
	Ease of payment	0.662			

	Getting transfer information	0.651			
	Transfer fare	0.642			
Information system	Accuracy of information		0.901		
	System of getting information		0.861		
	Notification about changing policies		0.811		
Comfortable environment	Comfort(noise, scent, temperature)			0.911	
	Cleanness of facility			0.883	
	Seat comfort			0.859	
	Driver behavior			0.786	
	Crowding			0.594	
Safety	Safe driving				0.949
	Overall safety				0.949

Table 10 summarized the result of factor analysis for factors that determine bike user's satisfaction/dissatisfaction: efficiency of operation system, information system, comfortable environment and safety.

Table 10. Component Matrix: Determinants of Satisfaction/Dissatisfaction of Bike Users (efficiency of operation system, information system, comfortable environment and safety)

Items		**Components**			
Factors	**Scale items**	**1**	**2**	**3**	**4**
Efficiency of operation system	Total travel cost	0.961			
	Operation time	0.953			
	Total travel time	0.945			
	Total waiting time	0.934			
	Ease of access	0.928			
	Ease of payment	0.912			
	Fare	0.893			
	Location of station	0.866			
Information system	Accuracy of information		0.938		
	Notification about changing policies		0.936		
	System of getting information		0.919		
Comfortable environment	Comfort (noise, scent, temperature)			0.987	
	Seat comfort			0.971	
	Cleanness of facility			0.965	
	Facilities for safety precaution				0.962
Safety	Safety of vehicle				0.961
	Safety of bike roads				0.924

Table 11 summarized the result of factor analysis for factors that determine taxi user's satisfaction/dissatisfaction: efficiency of operation system, information system, comfortable environment and safety.

Table 11. Component Matrix: Determinants of Satisfaction/Dissatisfaction of Taxi Users (efficiency of operation system, information system, comfortable environment and safety)

Items		Components			
Factors	**Scale items**	**1**	**2**	**3**	**4**
Efficiency of operation system	Total travel cost	0.844			
	Total travel time	0.841			
	Frequency of arrivals	0.832			
	Location of station	0.815			
	Ease of access	0.812			
	Total waiting time	0.792			
	Fare	0.694			
	Ease of payment	0.578			
Information system	Accuracy of information		0.961		
	System of getting information		0.943		
	Notification about changing policies		0.881		
Comfortable environment	Comfort (noise, scent, temperature)			0.949	
	Seat comfort			0.948	
	Cleanness of facility			0.918	
	Driver behavior			0.859	
Safety	Safe driving				0.946
	Overall safety				0.946

To test how significant the factors affecting the four determinants of user's satisfaction/dissatisfaction level, this study applied factor scores for regression analyses.

Table 12 represents the results of multiple regression analysis for factors that determine bus user's satisfaction/dissatisfaction level. Overall, the ANOVA analysis showed that the models was significant at 0.000 level with $F = 48.125$(*r-square* = .658). Given the Table 12, the findings indicate that hypothesis 2a, 3a, and 5a are accepted, but not the hypothesis 4a. In other words, efficiency of operation system, information system, and safety affect bus user's satisfaction/dissatisfaction level as independent variables.

Table 12. Effects of Determinants of Satisfaction/Dissatisfaction of Bus Users

Variable (Independent → dependent)	Standardized Coefficient (t-value-Sig)
efficiency of operation system → satisfaction/dissatisfaction on bus (H2a)	0.535 (7.359***)
information system → satisfaction/dissatisfaction on bus (H3a)	0.220 (2.737***)
comfortable environment → satisfaction/dissatisfaction on bus (H4a)	-0.124 (-1.071)
safety → satisfaction/dissatisfaction on bus (H5a)	0.307 (2.567**)

*** p < 0.01, ** p <0.05, * p < 0.1 denotes statistical significance

Table 13 represents the results of multiple regression analysis for factors that determine bike user's

satisfaction/dissatisfaction level. Overall, the ANOVA analysis showed that the models was significant at 0.000 level with F =28.879(*r-square* = .767). Given the Table 9, the findings indicate that hypothesis 2b and 5b are accepted, but not the hypothesis 3b and 4b. In other words, efficiency of operation system, and safety affect bike user's satisfaction/dissatisfaction level as independent variables.

Table 13. Effects of Determinants of Satisfaction/Dissatisfaction of Bike Users

Variable (Independent → dependent)	Standardized Coefficient (t-value-Sig)
efficiency of operation system → satisfaction/dissatisfaction on bike (H2b)	0.672 (4.662***)
information system → satisfaction/dissatisfaction on bike (H3b)	0.154 (0.940)
comfortable environment → satisfaction/dissatisfaction on bike (H4b)	-0.204 (-1.541)
safety → satisfaction/dissatisfaction on bike (H5b)	0.305 (2.410**)

*** p < 0.01, ** p <0.05, * p < 0.1 denotes statistical significance

Table 14 represents the results of multiple regression analysis for factors that determine taxi user's satisfaction/dissatisfaction level. Overall, the ANOVA analysis showed that the models was significant at 0.000 level with F =28.381(*r-square* = .666). Given the Table 10, the findings indicate that hypothesis 2c, 4c, and 5c are accepted, but not the hypothesis 3c. In other words, efficiency of operation system, comfortable environment and safety affect taxi user's satisfaction/dissatisfaction level as independent variables.

Table 14. Effects of Determinants of Satisfaction/Dissatisfaction of Taxi Users

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
efficiency of operation system → satisfaction/dissatisfaction on taxi (H2c)	0.578 (6.029***)
information system → satisfaction/dissatisfaction on taxi (H3c)	-0.066 (-0.608)
comfortable environment → satisfaction/dissatisfaction on taxi (H4c)	0.273 (2.205**)
safety → satisfaction/dissatisfaction on taxi (H5c)	0.197 (1.917*)

*** p < 0.01, ** p <0.05, * p < 0.1 denotes statistical significance

To test the effect of improvement based on user's demand on future satisfaction/dissatisfaction, the ANOVA shows the model is significant at 0.1 level with F = 1.976(*r-square* = 0.089). In general, the

findings indicate that hypothesis 6c and 6d is accepted according to the result summarized in Table 15.

Table 15. Effects of Improvement based on Demand on Future Satisfaction/Dissatisfaction

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
Integrated mileage system → future satisfaction/dissatisfaction (H6a)	0.120 (0.851)
Integrated information system → future satisfaction/dissatisfaction (H6b)	0.303 (1.249)
comfortable environment → future satisfaction/dissatisfaction (H6c)	-0.587 (-2.473**)
Quick update of service → future satisfaction/dissatisfaction (H6d)	0.411 (1.703*)
Customized service → future satisfaction/dissatisfaction (H6e)	-1.106 (-0.604)

*** p < 0.01, ** p <0.05, * p < 0.1 denotes statistical significance

Table 16 represent the results of regression analysis based on factor analysis for each item of the variables to test the effect of future satisfaction with advanced services on agreement on government policies. According to the ANOVA, it finds the model is significant at 0.01 level with $F = 54.287$ (*r-square* = 0.341). Based on the finding, hypothesis 7a is accepted. In other words, future satisfaction with advanced services of public transportation system affects user's agreement on government policies as an independent variable.

Table 16. Effects of Future Satisfaction/Dissatisfaction on Agreement on Government Policies

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
future satisfaction/dissatisfaction → agreement on government policies (H7a)	0.584 (7.368***)

*** p < 0.01, ** p <0.05, * p < 0.1 denotes statistical significance

To test the effect of future satisfaction with advanced services on trust in government, the ANOVA shows the model is significant at 0.01 level with $F = 49.245$(*r-square* = 0.319). In general, the findings indicate that hypothesis 7b is accepted according to the result summarized in Table 17.

Table 17. Effects of Future Satisfaction/Dissatisfaction on Trust on Government

Variable (Independent → dependent)	Standardized Coefficient (*t*-value-Sig)
future satisfaction/dissatisfaction → trust on government (H7b)	0.565 (7.017***)

*** p < 0.01, ** p <0.05, * p < 0.1 denotes statistical significance

In conclusion, the result of hypotheses testing of determinants of user's satisfaction/dissatisfaction on public transportation in Sejong City is summarized in Table 18.

Table 18. Summary of Determinants of Satisfaction/Dissatisfaction Hypotheses Testing

Determinant	Hypothesis Testing	Result
efficiency of operation system	efficiency of operation system → satisfaction/dissatisfaction on bus (H2a)	Accepted
	efficiency of operation system → satisfaction/dissatisfaction on bike (H2b)	Accepted
	efficiency of operation system → satisfaction/dissatisfaction on taxi (H2c)	Accepted
information system	information system → satisfaction/dissatisfaction on bus (H3a)	Accepted
	information system → satisfaction/dissatisfaction on bike (H3b)	Rejected
	information system → satisfaction/dissatisfaction on taxi (H3c)	Rejected
comfortable environment	comfortable environment → satisfaction/dissatisfaction on bus (H4a)	Rejected
	comfortable environment → satisfaction/dissatisfaction on bike (H4b)	Rejected
	comfortable environment → satisfaction/dissatisfaction on taxi (H4c)	Accepted
safety	Safety → satisfaction/dissatisfaction on bus (H5a)	Accepted
	Safety → satisfaction/dissatisfaction on bike (H5b)	Accepted
	Safety → satisfaction/dissatisfaction on taxi (H5c)	Accepted

Secondly, the result of hypotheses testing of improvement of service based on user's demand on satisfaction/dissatisfaction with public transportation in Sejong City is summarized in Table 19.

Table 19. Summary of Improvement based on Demand on Future Satisfaction/Dissatisfaction

Group	Hypothesis Testing	Result
Improvement of service	Integrated mileage system → future satisfaction/dissatisfaction (H6a)	Rejected
	Integrated information system → future satisfaction/dissatisfaction (H6b)	Rejected
	Integrated service platform → future satisfaction/dissatisfaction (H6c)	Accepted
	Quick update of service → future satisfaction/dissatisfaction (H6d)	Accepted
	Customized service → future satisfaction/dissatisfaction (H6e)	Rejected

Lastly, the results of hypothesis testing from the impact of satisfaction/dissatisfaction toward agreement on government policies and on trust in government are summarized in Table 20.

Table 20. Summary of Effects of Future Satisfaction/Dissatisfaction on Perception on Government

Group	Hypothesis Testing	Result
Perception on Government	future satisfaction/dissatisfaction → agreement on government policies (H7a)	Accepted
	future satisfaction/dissatisfaction → trust on government (H7b)	Accepted

7. Conclusion

7.1. Findings

This study aimed to analyze the determinants of citizen's satisfaction/dissatisfaction in relation to public transportation system. The determinants are selected based on literature review which citizens can be satisfied or dissatisfied with based on individual experience of using public transportation. Especially, what this study mainly measured are the factors that affect satisfaction/dissatisfaction level of users and the impact of satisfaction/dissatisfaction level on perception on government.

As a result of the qualitative research in this study, H1 were accepted that effects of proposed factors as determinants of satisfaction/dissatisfaction were different for each transportation mode: bus, public bike, and taxi. This qualitative research using civil opinions in Sejong City is distinguished from previous study that investigated the overall civil opinions with public transportation system in general through text-mining (Lee & Kwon, 2020) by examining keywords for each transit system, not the overall public transport system.

It was meaningful result that user's satisfaction/dissatisfaction with services of bus, public bike, and taxi are affected by different factors. It was found that strategies for promoting the use of public transportation should focus on different factors by transportation mode. In the previous study using civil complaints, civil opinions from Sejong City were analyzed in comprehensive sectors including education, bad smell, traffic. This study reviewed specifically public transportation sector, in the case of Sejong City, bus, public bike,

and taxi in general. The overall frequency analysis of civil opinions collected from Sejong City website showed that terms regarding the operation system including installation, station, and driver were found to be common and high-ranking. This implies that there are high demands for the installation of facilities regarding public transportation and the improvement of attitude of drivers in the case of bus and taxi.

The unique aspect of this study is that all the types of current public transportation in the target city are selected, this study tries to figure out what and how much factors of each mode significantly influence user's satisfaction/dissatisfaction level, and perception on government. In all types of three public transportation modes, efficiency of operation system and safety appeared to affect satisfaction/dissatisfaction that H2a, H2b, H2C, H4a, H4b, and H4c are all accepted. At the same time, there were distinctive differences in factors that affect user's satisfied level according to each type of public transportation. Regarding information system, only bus was significantly affected by that factor, while comfortable environment significantly affected only taxi. H3a and H4c were accepted while H3b, H3c, H4a, and H4b were rejected. For the users of bus, efficiency of operation system and information system were the most effective determinant of satisfaction/dissatisfaction. For the users of public bike, efficiency of operation system was the most effective determinant of satisfaction/dissatisfaction, while efficiency of operation system affected taxi user's satisfaction level the most.

In terms of proposed factors on demand for future improvement, this study demonstrates that integrated service platform and quickly updated service significantly affect future satisfaction as H6c and H6d were accepted. This might reflect the fact that there are customized service platforms for bus, public bike, and taxi based on different needs in the target city. This implies that there might be a potential demand for the establishment of an integrated service platform. About hypotheses that have not been accepted in terms of proposed demands, further research is needed on what kind of demands and expectations have significant impacts on future satisfaction by improvement on that information. The examples of proposed demands presented in the survey may not have effectively demonstrated user's needs and expectations within the contents. In addition, for the potential improvement of citizen's perception on government in the future,

H7a and H7b were accepted with implications that future satisfaction based on user's demand and expectation significantly affect agreement on government policies and trust on government. This result also support that government should consider citizen's satisfaction as an important factor for the image of governments, the agreement on policies, and the trust on government of citizens to be improved.

Regarding information system, bus users are found to consider it as an effective factor for their satisfaction. This result might be due to the characteristics of bus, particularly, the fixed operation schedule, that lead users to need accurate information when they transfer and access to bus station. In terms of the factor, comfortable environment, it may not be necessary for the users of bus and public bike, however, the taxi users are found to consider the cleanness, comfort, and taxi driver's behavior as important factors for their satisfaction. This result of taxi user's satisfaction factors seems to be consistent with previous results of qualitative research on taxi user's opinions. Taxi driver, refusing ride, and service were ranked in top 10 frequent key words in the civil opinions on taxi. In the case of taxi, the higher expectation of service quality as a reward of higher price of service might have affected the overall satisfaction level of passengers.

7.2. Additional Findings

To find out whether willingness to use more environment-friendly vehicles varies based on assessment on public transportation in Sejong City regarding environmental friendliness, this study additionally conducted the ANOVA test. For participants who answered that they think public transportation in Sejong City is environment-friendly, the survey asked how much they are willing to use more environment-friendly vehicles. As the study applied the analysis of the ANOVA which is significant at 0.025 level with $F = 5.160$, it indicates that based on user's assessment on public transportation regarding the concept of environmental friendliness, user's willingness to use more environment-friendly vehicles varies. This implies that provision of the environment-friendly public transportation such as electric bus might play a role to promote the use of more public transportation for citizens who care about the traffic and air pollution and are aware of the positive impacts on them of choosing public vehicles rather than private cars. To insist that public

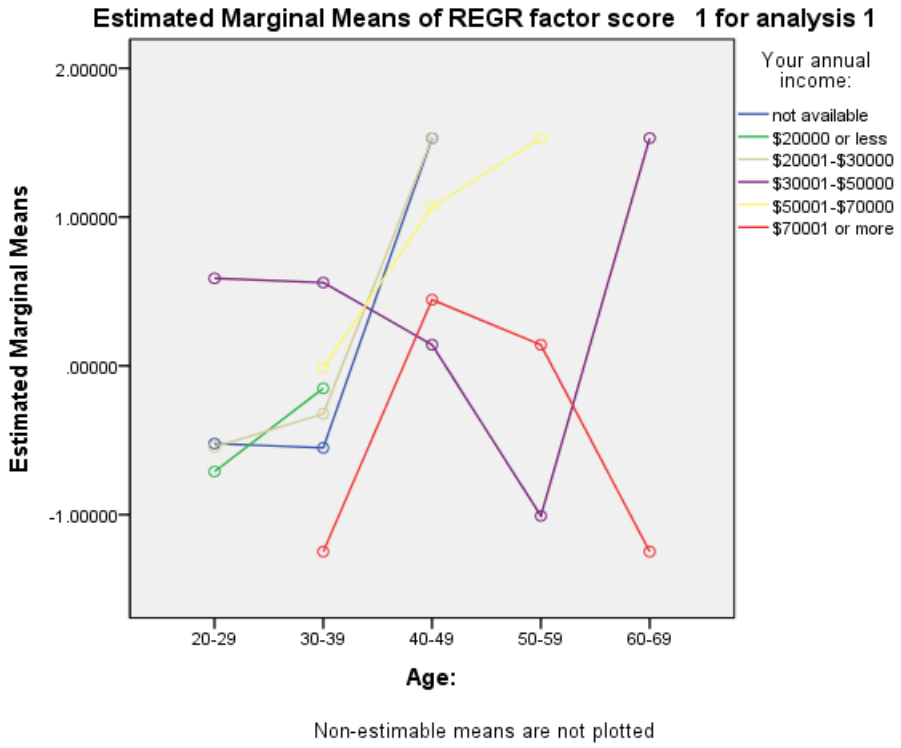
transportation could bring positive effects and to achieve true aims including reduction of air pollution, the shift from existing (mostly fossil-fueled) public vehicles into efficient and environment-friendly vehicles should be considered.

Another ANOVA analyses on participants' demographics showed that there is no difference in dissatisfaction level by gender that is significant at 0.701 level with $F = 0.688$. On the other hand, means of dissatisfaction level differs based on occupation groups with the ANOVA analysis that is significant at 0.038 level with F = 2.460. In particular, to find out whether means of overall satisfied level varies based on frequency of using and annual income level, this study conducted the two-way ANOVA test. For those who responded that they are less than 70 years old and have experienced the service of public transportation in Sejong City, the survey asked how much they are satisfied with public transportation system in Sejong City with the criteria categorized with frequency of using and age: for frequency of using, 1-2 times per year, 1-2 times per month, more than twice-less than 5 times per month, or more than 5 times per month, and for age, under 20 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, 60-69 years. The analysis of the two-way ANOVA shows that the significance level is 0.044 with F =2.564 for frequency of using, 0.071 with F = 2.123 for age, and 0.215 with F = 1.326 for interaction effect of frequency of using and age. It indicates that there is difference between means of satisfaction/dissatisfaction level of respondents regarding the frequency of using and age, but no significant interaction effect of 2 independent variables on satisfaction/dissatisfaction. This result implies that the frequency of using and passenger's age could be a determinant of satisfaction level. Policy makers and operation agents of public transportation in Sejong City should consider the variation of determinants by age and frequency of using.

In addition, the result of the two-way ANOVA analysis (refer to the Figure 5) to see whether there is an interaction effect of age and income on satisfaction/dissatisfaction on taxi service shows significant at 0.1 level with $F = 2.052$. It indicates that both annual income and age affect user's satisfied level with taxi at the same time. This result might imply that the passengers whose income level and age are various have different expectations, demands, and determinants of satisfaction/dissatisfaction for taxi service.

Particularly, the users at the age between 30 and 39 has the greatest variation in income level, and those who have the highest income level among them are found to have lowest satisfaction level in average.

Figure 5. The Effect of User's Annual Income and Age on Satisfaction/Dissatisfaction on Taxi



7.3. Managerial and Policy Implications

This study indicates the managerial and policy concerns of public transportation from both qualitative and quantitative data analyses and investigates how societies can establish strategies for management and policies in order to realize sustainable development and livability and reduce adverse effects such as traffic and congestion. This study also finds the impact of user's satisfaction of public transportation on citizen's agreement on policies and trust in government and the effect of citizen's assessment on public vehicles in regard of environmental-friendliness on potential willingness to use. This study provides the managerial and policy implications for policy makers and operators of public transportation system.

Realizing true benefits from integrated aims of smart cities, open and mutable intervention based on citizen's opinions can be considered to deal with challenges in terms of participation and transparency (Townsend, 2013; Glasmeier & Christopherson, 2015). Regarding the claims that smart cities are undemocratic, discriminatory and cannot significantly improve citizen's quality of life, the active participation of citizens in the process can play a role to make values created by everyone in the "well-informed city" which is a decentralized, self-organizing smart city service (Feder-Levy et al., 2016). Jane Jacobs (1961) said that the realization of capability of cities that provides something for everybody requires a condition that it is created by everybody. Citizen relationship management (CiRM) is a new management approach that focuses on the institution's confidence in the providing services for the citizens, and the management of the citizen's satisfaction with the aim of providing the highest quality services at the lowest cost to citizens through the best way of allocating government's resources for tax payers (Muscalu, 2015). The engagement with the public who want to actively participate in the public governance through two-way communication is a key resource to meet citizen's increasing expectations with service improvement based on the discovered information behavior patterns and needs (Shan et al., 2015). The paradigm that shifts the customer (passenger) from a user to a co-creator of value in public transport is emerging, research has been actively conducted on the role of the active participation of citizens who policy makers and operational managers could cooperate with in their processes and systems in order to promote the use of public transportation (Nathanail, 2008; Vargo & Lusch, 2008; Gebauer et al., 2010). As it becomes more important to identify and understand the passenger's perspective, satisfaction, priorities, and needs to indicate measures of improvement, the importance of strategically encouraging citizen's participation is highlighted (Nathanail, 2008; Friman & Fellesson, 2009; St-Louis et al., 2014).

In the instance that smart city policies are not extensively covered in literature mainly due to infancy of the field, researchers should provide guidance for public and private decision-making (Yigitcanlar et al., 2018). The results of data analysis in this study demonstrated that factors such as efficiency of operational system and safety are significant determinants when considering passenger's satisfaction and dissatisfaction,

commonly in bus, public bike, and taxi. The other two factors, information system and comfortable environment, have impacts on bus and taxi, each. In addition, it indicates that proposed determinants including an integrated service platform and a quickly updated service were found to have a significant impact on future satisfaction with improvement based on demands. The result in this study also shows that citizen's agreement on policies and trust in government can be improved by improvement based on identified demands and expectations. The finding posits that citizen's satisfaction is effective to build agreement on public policies and trust in government. Further, the result of positive causal impact of the citizen's assessment on public transportation vehicles in regard of sustainability, which was asked in the survey with questions of environmental friendliness, on willingness to use more public transportation implies that innovation of physical infrastructure, for example, by adapting new vehicles and replacing old vehicles that are not environment-friendly or energy-efficient, might contribute to the behavior change of citizens. In addition, not only these physical improvements but also raising citizen's understanding on the importance of using public transportation and trust in government could be implemented simultaneously. Policies that can raise the perception on the positive effects of public transportation use, such as a promotion campaign, can be considered by government to increase the frequency.

The finding posits that governments should utilize effective policy instrument by using relevant data that is 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 systems and management could be considered in the future strategies. For instance, in order to provide the advanced service, Big Data analysis could be applied to analyze the patterns of consumers' behavior for the provision of higher-quality service of public transportation system. Further, proper policies should be prepared as necessary means of establishing the demands on advanced services and realizing the fundamental aims of government and local authorities such as improving the quality of life. Based on the analyses of data collected from users, governments would establish policies to motivate the use of public transportation by improving service of the system based on actual demands and

needs, transition of existing vehicles into environment-friendly ones, integrated system, quick feedback to the civil opinions, and building trust on government. Particularly, the establishment of an integrated service platform for all modes of public transportation is highly recommended as one of the possible strategies for the user's future satisfaction which could lead to the improvement of citizen's agreement and trust on governance. Although public transportation modes are provided in individual service platform such as platform for public bike which offers information to only public bike users, an integrated service platform for getting information of all transportation modes have not been established yet.

In addition, in the cases of Sejong City, the public transportation system is operated and managed not only by the local government in Sejong City, but also by some private corporations and the local government in Daejeon Metropolitan City. Some bus routes and roads are co-managed by those operational and managerial agents. The complexity of operation and management also relies on the cooperation system of those agents in order to obtain feedback from users and achieve the agreement on modifying related policies and systems in a faster and more efficient way. Thus, more systematic and integrated management information system (MIS) could help the diverse operation agents to manage public transportation system.

In conclusion, to achieve the fundamental aims of cities such as sustainable development and better quality of life, the government and local authorities should not only listen to citizen's opinion but also involve them into the process and system of governance as a partner through two-way communication to increase the efficiency of resource allocation, management, and operation, and the adaption of ICT is highly recommended as it could potentially lower the time, cost and effort by utilizing data and network.

7.4. Limitations and Future Research

Although the study employed various data and analysis tools, there are still some limitations in the study. The small size of the sample compared to the ratio with its population is one of the limitations. A survey with larger sample size could provide more reliable analytical results and have opportunities to identify more significant relationships. For instance, the quantitative research in this study has limited respondents

who have experience at least once and willingness to respond the survey and civil opinions on city website was not sufficient to represent the entire population well. In particular, due to the characteristics of target city as a newly constructed administrative city which many public officers live in, the result might be biased by political and social perspectives of respondents. In addition, since the data collection is developed and distributed in the form of online survey, it would have more opportunity to have more and diverse participants rather than mobile and online participants only.

This study investigates the determinants of citizen's satisfaction/dissatisfaction on public transportation to suggest a strategy for shifting private car users to public vehicle users through improvement based on existing and future demands and emphasizes the mutual understanding and cooperation mainly among the citizens and local authorities. Further researches may need to be supported by in-depth qualitative research to analyze the factors that determine passenger's satisfaction and dissatisfaction. If there are any differences in the criteria of determinants, the measurement will be different. There can be some omitted necessary variables that might significantly affect the result. Particularly, by targeting those who have experience of all the 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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Appendix

1. Have you ever lived in Sejong City?

Yes () No ()

2. Have you lived in Sejong City for more than 1 month?

Yes () No ()

3. Approximately, how long have you lived in Sejong City?

() Less than 3 months () 3 months - less than 6 months () 6months - less than 1 year () More than 1 year - less than 3 years () More than 3 years

4. Have you ever used public transportation in Sejong city? (if not, stop here)

() None ()1 - 2 times per year ()1 - 2 times per month () More than twice- less than 5 times per month () More than 5 times per month

5. How often do you use the following types of public transportation?
(1-never, 5-always) (you may choose n/a if it is not applicable)

() Non-BRT bus within Sejong City 1 2 3 4 5 n/a

() BRT bus 1 2 3 4 5 n/a

() Non-BRT inter-city bus (e.g., Sejong to Ohsong) 1 2 3 4 5 n/a

() Public bike operated by Sejong city 1 2 3 4 5 n/a

() Taxi 1 2 3 4 5 n/a

() Other public transportation 1 2 3 4 5 n/a

6. Have you ever dissatisfied with public transportation in Sejong City?

() Yes () No

7. Overall, how much are you satisfied with public transportation applied in Sejong City?

Strongly satisfied 1 2 3 4 5 strongly dissatisfied

7-1. How much do you agree with government policies related to public transportation system applied in Sejong city? (e.g., provision of public transport, operation of information system)

Strongly agree 1 2 3 4 5 strongly disagree

7-2. How much do you have confidence in government regarding public transportation system in Sejong city?

A great deal 1 2 3 4 5 not at all.

8. Please answer the following for your satisfied level with public transportation applied in Sejong City. (1-strongly satisfied, 5-strongly dissatisfied) (you may choose n/a if it is not applicable)

() Non-BRT bus within Sejong City 1 2 3 4 5 n/a

() BRT bus 1 2 3 4 5 n/a

() Non-BRT inter-city bus (e.g., Sejong to Ohsong) 1 2 3 4 5 n/a

() Public bike operated by Sejong city 1 2 3 4 5 n/a

() Taxi 1 2 3 4 5 n/a

() Other public transportation 1 2 3 4 5 n/a

9. Please rate how much you are satisfied with '**public bus**' in Sejong City about the following:
(1-strongly satisfied, 5-strongly dissatisfied) (you may choose n/a if it is not applicable)

1	Efficiency of Operation System	Frequency of arrivals	1 2 3 4 5 n/a
2		Fare	1 2 3 4 5 n/a
3		Ease of payment	1 2 3 4 5 n/a
4		Operation time	1 2 3 4 5 n/a
5		Network Coverage (route)	1 2 3 4 5 n/a
6		Location of station	1 2 3 4 5 n/a
7		Ease of access	1 2 3 4 5 n/a
8		Getting transfer information	1 2 3 4 5 n/a
9		Transfer fare	1 2 3 4 5 n/a
10		Ease of transfer	1 2 3 4 5 n/a
11		Total travel time	1 2 3 4 5 n/a
12		Total travel cost	1 2 3 4 5 n/a
13		Total waiting time	1 2 3 4 5 n/a

14	Information System	System of getting information	1 2 3 4 5 n/a
15		Accuracy of information	1 2 3 4 5 n/a
16		Notification about changing policies	1 2 3 4 5 n/a
17	Comfortable Environment	Crowding	1 2 3 4 5 n/a
18		Cleanness of facility	1 2 3 4 5 n/a
19		Comfort (noise, scent, temperature)	1 2 3 4 5 n/a
20		Seat comfort	1 2 3 4 5 n/a
21		Driver behavior	1 2 3 4 5 n/a
22	Safety	Overall safety	1 2 3 4 5 n/a
23		Safe Driving	1 2 3 4 5 n/a
24	Overall, how much are you satisfied or dissatisfied with public bus service in Sejong City?		1 2 3 4 5 n/a
25	Are you satisfied or dissatisfied with public bus service in Sejong City compared to other cities?		1 2 3 4 5 n/a

10. Please rate how much you are satisfied with **'public bike (Eoulling and New Eoulling)'** in Sejong City about the following? (1-strongly satisfied, 5-strongly dissatisfied) (you may choose n/a if it is not applicable)

1	Efficiency of Operation System	Location of station	1 2 3 4 5 n/a
2		Fare	1 2 3 4 5 n/a
3		Ease of payment	1 2 3 4 5 n/a
4		Operation time	1 2 3 4 5 n/a
5		Ease of access	1 2 3 4 5 n/a
6		Total travel time	1 2 3 4 5 n/a
7		Total travel cost	1 2 3 4 5 n/a
8		Total waiting time	1 2 3 4 5 n/a
9	Information System	System of getting information	1 2 3 4 5 n/a

10		Accuracy of information	1 2 3 4 5 n/a
11		Notification about changing policies	1 2 3 4 5 n/a
12	Comfortable Environment	Cleanness of facility	1 2 3 4 5 n/a
13		Comfort (noise, scent, temperature)	1 2 3 4 5 n/a
14		Seat comfort	1 2 3 4 5 n/a
15	Safety	Safety of vehicle	1 2 3 4 5 n/a
16		Facilities for safety precaution	1 2 3 4 5 n/a
17		Safety of bike roads	1 2 3 4 5 n/a
18	Overall, how much are you satisfied or dissatisfied with public bike service in Sejong City?		1 2 3 4 5 n/a
19	Are you satisfied or dissatisfied with public bike service in Sejong City compared to other cities?		1 2 3 4 5 n/a

11. Please rate how much you are satisfied with **'taxi'** in Sejong City about the following?

(1-strongly satisfied, 5-strongly dissatisfied) (you may choose n/a if it is not applicable)

1	Efficiency of Operation System	Frequency of arrivals	1 2 3 4 5 n/a
2		Fare	1 2 3 4 5 n/a
3		Ease of payment	1 2 3 4 5 n/a
4		Location of station	1 2 3 4 5 n/a
5		Ease of access	1 2 3 4 5 n/a
6		Total travel time	1 2 3 4 5 n/a
7		Total travel cost	1 2 3 4 5 n/a
8		Total waiting time	1 2 3 4 5 n/a
9	Information System	System of getting information	1 2 3 4 5 n/a
10		Accuracy of information	1 2 3 4 5 n/a
11		Notification about changing policies	1 2 3 4 5 n/a

12	Comfortable Environment	Cleanness of facility	1 2 3 4 5 n/a
13		Comfort (noise, scent, temperature)	1 2 3 4 5 n/a
14		Seat comfort	1 2 3 4 5 n/a
15		Driver behavior	1 2 3 4 5 n/a
16	Safety	Overall safety	1 2 3 4 5 n/a
17		Safe Driving	1 2 3 4 5 n/a
18	Overall, how much are you satisfied or dissatisfied with taxi service in Sejong City?		1 2 3 4 5 n/a
19	Are you satisfied or dissatisfied with taxi service in Sejong City compared to other cities?		1 2 3 4 5 n/a

12. Please rate your opinions about service improvement you expect based on the experience for public transportation in Sejong City.

(1-strongly disagree, 5-strongly agree) (you may choose n/a if it is not applicable)

I wish to have integrated mileage system for all types of public transportation.	1 2 3 4 5 n/a
I wish to have integrated information for all types of public transportation (e.g., available for bus, taxi and bike at once).	1 2 3 4 5 n/a
I wish to have an integrated service platform (online, mobile, etc) for all types of public transportation.	1 2 3 4 5 n/a
I hope that services are quickly updated by considering citizen's conveniences.	1 2 3 4 5 n/a
I wish to have customized service by considering individual citizen's usage of public transportation.	1 2 3 4 5 n/a

13. If services related to public transportation are improved based on your expectations above, how much will you be satisfied?

(1- strongly dissatisfied, 5-strongly satisfied) 1 2 3 4 5 n/a

13-1. If services related to public transportation are improved based on your expectations above, how much will your agreement in government policies be improved?

(1-none at all, 5-a great deal) 1 2 3 4 5 n/a

13-2. If services related to public transportation are improved based on your expectations above, how much will your trust in government be improved?

(1-none at all, 5-a great deal) 1 2 3 4 5 n/a

14. I think that public transportation in Sejong City is environment-friendly.

(1-strongly disagree, 5-strongly agree) 1 2 3 4 5 n/a

14-1. I am willing to use more environment-friendly vehicles.

(1-strongly disagree, 5-strongly agree) 1 2 3 4 5 n/a

Demographic information

15. What is your gender?

() Female () Male

16. How old are you?

() Under 20 () 20-29 () 30-39 () 40-49 () 50-59 () 60-69 () 70 or more

17. Please indicate the highest level of education completed.

() High school or less () 2-year associate degree () Bachelor's degree () Master's degree

() Doctoral degree or more

18. Please indicate your occupation (optional).

() Student () Own a personal business () Corporation-private sector () Corporation-public sector () Government officer () Academic sector () Housewife () Other

19. Please indicate your annual income (optional).

() not available () $20000 or less () $20001-$30000 () $30001-$50000

() $50001-$70000

() $70001 or more