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CITIZENS' PERCEPTION FOR THE SENSIBLE SMART CITY SERVICES

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Abstract. *Number of mega-cities with more than population of 10 million is expected to increase by 2025, due to the rapid increase of urban residence rate. Due to this prospect, ICT-based smart cities are being actively built. Smart city is evaluated as an alternative to urban problems such as traffic congestion, crime and disaster, and energy depletion caused by the rapid increase of urban population and to improve urban competitiveness. This study analyzed the citizens' perception for the Busan smart city test-bed project and sensible smart city services through two questionnaires. The usability, convenience, economic efficiency, urgency, diffusiveness, and publicness which are represented citizens' perception of smart city service, were measured and analyzed. As a result, citizens recognized that smart city projects are useful for their lives, but it should be built as public work. In addition, since the willingness to use smart city services with a fee is low, it is necessary to develop a service that is economically valuable.*
Keywords: Smart city, Busan smart city test-bed project, Citizens' perception, Sensible smart city services

1. **Introduction.** Smart city is a city with advanced intelligence that utilizes ICT (Information and Communication Technology) and information processing capabilities. Smart city can be defined as city that improves citizens' life quality through efficiency and intelligence of city function. Smart city can build a variety of services that match the characteristics and images of cities by utilizing ICT.

Smart cities are being actively developed around the world; number of population who are benefited from smart city is currently more than 10 million. Furthermore, the number of operating smart cities which is 13 in 2013, is expected to increase to 37 cities by 2025. Busan Metropolitan City also implemented smart city test-bed project in 2015-2017 to improve the quality of life of citizens. In order for smart city to be successful, active participation of citizen and building of smart city services in accordance with the city environment are required. In other words, citizens' perception of smart city services is related to the spread of the services and affects the continuous use.

In this study, we deducted several smart city services which can directly benefit from the smart city services provided in the smart city test-bed project and measured the perception of the citizen. This study suggested methods and implications for successful introduction and diffusion of smart city services by analyzing citizens' perception about smart city services.

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This study is organized as the following. Section 2 presents an overview of the Busan smart city test-bed project and the services implemented in the project. Section 3 presents the best cases of smart city around the world. Section 4, we analyze the citizens' perception for the sensible smart city services. The conclusion of this study is described in Section 5.

2. **Busan Smart City Test-Bed Project.** Smart city can be defined as ICT-affiliated city infrastructure, solving city problems through delivering surrounding situation information to the citizen, and enhancing the overall quality of life by providing convenience and timely and economic advantages. Busan smart city test-bed project demonstrated 30 smart city services in three areas of welfare, transportation and energy as shown in Table 1.

TABLE 1. 30 smart city service on the Busan smart city test-bed project

Area	**Smart City Services**
Welfare (17)	Smart streetlight service, Safety service for the disadvantaged, Missing child prevention service, Smart maritime safety service, Context-aware evacuation service, Beacon-based marketing supporting service for small business, Pedestrian-responsive smart direction sign service, Smart access control service of ventilating opening on subway, Environmental sensor-linked fine misty spraying service, Context-aware smart home service, Smart disaster prevention service, Streetlight-linked smart safety location management service, Smart mirror-based social care service, Wireless IoT sensor-based smart ship service, Marine leisure service using IoT-based weather information collecting device, Visitor access control and observation service, Subway intelligent safety platform service
Transportation (9)	Smart parking service, CCTV image analysis-based traffic detour guidance service, CCTV video analysis/detection sensor-based walker safety service on school zone, Parking image analysis-based parking lot management service, Safety driving alert service in rain, Smart traffic information service, Traffic information collection and analysis service, Pedestrian safety services in pedestrian crossing section, Smart crosswalk service
Energy (4)	EV parking and charge management service, Smart store energy management service, Smart building energy saving service, Urban energy-independent typed smart farm service

3. **Best Cases of Smart City.** Barcelona has an established reputation as a pioneering European smart city. The city's initiatives are focused on inclusive, citizen-centered urban technological innovation, geared to improve public space quality, urban renewal and cultural heritage protection and promotion. The Barcelona Smart City consists of WiFi, Open Access Data, Smart Mobility, Smart Water Management System, Smart Lighting System, Smart Waste Management System and Smart Allotment for improving quality of life to citizen [1,2]. Helsinki Smart City [3] aims to advance economic competitiveness, service innovation, and 'quadruple helix' innovation in a climate of openness, experimentation, democracy, and inclusivity. The vision for Helsinki is the city's transformation into a functional, world-class, business, and innovation hub. Open, user-driven innovation, and living lab approaches are key to this strategy. In this sense, all aspects of soft infrastructure are leveraged and promoted towards the goal of economic prosperity and both hard and soft infrastructure seek to support high quality urban innovation [1].

Amsterdam Smart City is a broad, open partnership among businesses, authorities, research institutions, and the citizens of Amsterdam to improve the environmental and social sustainability of the city. The primarily environmental orientation of the program targets energy efficiency with regards to public services [4]. Stockholm Smart City applies information technology to a wide range of urban infrastructures to create an ecosystem that includes citizens, industry, and public sectors and to boost the economy. This strategy is citizen-centered and focuses on providing improved e-government services to citizens [5].

The best cases of smart city project are being developed as public work for improving quality of life to citizens, and active participation of citizens is regarded as a success factor [1,2,5].

4. Analysis of the Citizen's Perception for the Sensible Smart City Services.

4.1. Analysis process.

The purpose of this study is to select sensible smart city services among the smart city services developed by Busan Metropolitan City and to analyze citizens' perception of them. As the smart city service is a new information technology based service, we defined 6 perception variables based on information technology acceptance. In order to analyze the perception of smart city service, we performed two step survey and analysis. For step 1, we interviewed experts aware of the Busan's smart city development project, and selected 13 sensible smart city services among the Busan's 30 smart city services. In step 2, we measured the perception of the overall Busan smart city test-bed project and also the perception of selected 13 sensible smart city services from step 1 to the citizen in Busan.

4.2. Defining the citizen's perception variables for the sensible smart city services.

4.2.1. *The need for citizen participation in smart city services design.* Khayoun and Zeadally [6] analyzed the 14 smart city projects that have been globally promoted, and set technical issues for successful smart city implementation. They emphasized that it is important for the smart city to be connected with the citizen in every location such as public, public transportation, home, and also to be built with function to share information and experiences of the citizen. Granier and Kudo [7] emphasized that it is important to reflect the opinions of citizen in the design of smart city services through an interview survey of citizen in 4 smart cities in Japan. Jeong add Lee [8] pointed out that the citizens' perception for U-city services is different according to the demographic characteristics, suggesting it is necessary to design U-City service considering the distribution of residents. Giffinger et al. [9] argued that satisfaction of public services is a significant factor affecting enhancement of citizens' quality of life. Therefore, since the smart city service is a public service, the satisfaction of the smart city service is related to the quality of life of the citizen.

4.2.2. *Definition of perception variables.* Perception is the activity of consciousness wanting to grasp the object, and the attitude can change depending on how the object is recognized and accepted. The goal of smart city service is to have the citizen fully perceived with the value of smart city services and to actively use services.

Davis [10] defined that the two factors of information technology acceptance are perceived usefulness and perceived ease of use, which can be a major determinant of attitudes toward the audience and behavioral intentions. Perceived usefulness is defined as 'the degree to which a particular system is expected to improve work performance', and perceived usability is defined as 'the degree of feeling that it is not difficult to use a particular system'. The convenience of using smart city service can be most advantageous when the

service can be used anytime and anywhere. Citizen will perceive it as highly useful when they are provided with services when they need it.

Economic efficiency can be defined as the cost of using information technology services and it is suggested to be a major factor in Internet banking [11], mobile technology in the life insurance industry [12], and clouding computing [13].

Venkatesh et al. [14] proposed a social influence as a variable on the acceptance of technology. The social influence can be defined as the degree to which the user is perceived by the social environment as the necessity and urgency to spread the new information technology. In particular, since the smart city service is a public service, it is necessary to measure the diffusion and urgency that the citizen perceives in public concept.

Smart city services are built by public institutions as part of public services. Therefore, measuring the perception of publicness is important in establishing the smart city service proliferation policy. King et al. [15] argued that government policies and roles should be considered as essential elements in the proliferation of public services, and Rogers [16] argued that government's consistent support and policies have a positive impact on technology adoption and diffusion.

Therefore, we defined the smart city service perception variables as shown in Table 2.

Table 2. Definition of smart city service perception variables

Perception Variables	**Definition**
Usability	Smart city services will be readily available.
Convenience	Smart city services will make our life convenient.
Economic Efficiency	Smart city services are worth the money to pay.
Urgency	Smart city services need to be provided quickly.
Diffusiveness	Smart city services need to spread to other areas as well.
Publicness	Smart city services need to be provided as public services.

4.3. **Selection of the sensible smart city services.** We selected 13 sensible smart city services, which are thought to be necessary in daily life among the 30 smart city services, through an interview survey of 32 experts who are aware of Busan's smart city development project. They indicated a level of perceived need for daily life for the smart city services by a five-point Likert scale ranging from (1) strongly not needed to (5) strongly needed in daily life. Table 3 shows the top 13 sensible smart city services, with 5 in welfare, 7 in transportation, and 1 in energy.

4.4. **Citizens' perception of the Busan smart city test-bed project.** Total of 155 responses were collected from citizen in Busan, Korea. Of the 155 responses collected during one month of August 2017, the 141 responses were valid. The demographics of the sample are shown in Table 4. The measurement scales in the survey used a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree.

In order to investigate the citizens' perception of the Busan smart city test-bed project, the following five questions were asked to the citizen; 1) I know the Busan smart city test-bed project (Awareness), I think the smart city services will help our life (Usefulness), 3) I think that it is necessary to build smart city service as public work (Necessity as public works), 4) I think it is necessary to expand smart city services (Necessity to expand), 5) I am willing to pay for smart city services (Intention to pay). Figure 1 shows the results of the citizen's perception of the Busan smart city test-bed project.

The awareness of the Busan smart city project was 2.62. It can be interpreted that only 40.5% of the citizen are aware of the Busan smart city, indicating low perception. The intention to pay for the smart city service was 2.63, it indicated that 40.75% of the citizen are willing to use the smart city service for a fee. It means that although the smart city

Table 3. Selected 13 sensible smart city services

Smart City Service Name	Rank	Point	Area
Smart streetlight service	1	4.22	Welfare
Smart crosswalk service	2	4.16	Transportation
Security service for the disadvantaged	3	4.13	Welfare
Smart parking service	3	4.13	Transportation
Pedestrian safety services in pedestrian crossing section	3	4.13	Transportation
Missing child prevention service	6	4.09	Welfare
Streetlight-linked smart safety location management service	6	4.09	Welfare
Safety driving alert service in rain	8	4.06	Transportation
Smart mirror-based social care service	9	4.00	Welfare
Parking image analysis-based parking lot management service	10	3.97	Transportation
Smart traffic information service	11	3.94	Transportation
CCTV video analysis/detection sensor-based walker safety service on school zone	12	3.88	Transportation
EV parking and charge management service	12	3.88	Energy

Table 4. Demographics of sample data

Sex	Man	106 (75%)
	Woman	35 (25%)
Age Group	Under 30	49 (35%)
	30∼39	72 (51%)
	Over 40	20 (14%)

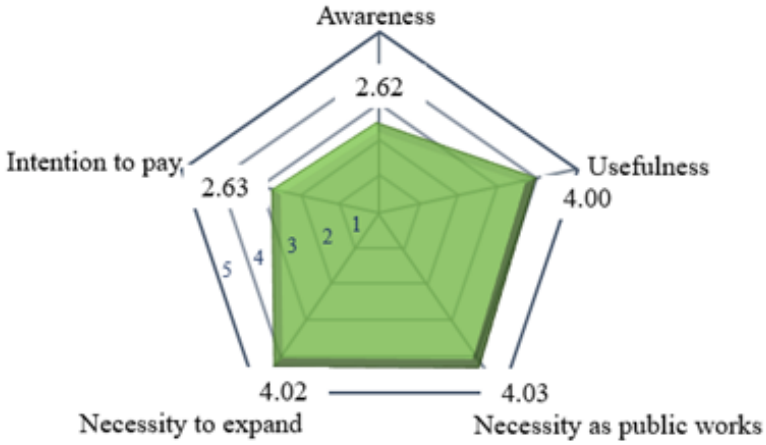

Figure 1. The citizens' perception of the Busan smart city test-bed project

service is a service that helps living, welfare and transportation, citizens are less willing to pay for using the service at this stage. As the usefulness of the smart city service was 4.00, 75% of the citizen perceived that smart city service will be useful. The necessity to extend of the smart city service was 4.02, indicating that 75.5% of the citizen expected to expand the smart city service. The necessity as public works of the smart city service was 4.03, indicating 75.75% of the citizen perceived it appropriate to develop the smart city project as public work.

4.5. **Citizens' perception for the sensible smart city services.** The results of the analysis of the citizens' perception for the sensible smart city services are shown in Table 5. The most preferred service for usability and diffusiveness is missing child prevention service (4.21) among the 13 sensible smart city services. The smart parking service is the most preferred service for convenience (4.23) and economic efficiency (3.64). The safety for the disadvantaged (4.13) and the smart streetlight (4.30) were the most preferred smart city services in terms of urgency and publicness, respectively.

The average of six citizens' perception variables for 13 sensible smart city services were 3.89 for publicness, 3.82 for diffusiveness, 3.80 for usability, 3.80 for convenience, and 3.64 for urgency, respectively. It indicates that the citizen recognized that the sensible smart city services should also be built and spread to public works, although they are useful for living. In other words, the willingness to pay for smart city services was very low. However, the economic efficiency was 3.05, which is very low. Therefore, it is necessary to consider economic value creation in smart city service planning and design.

TABLE 5. Results of the analysis of the citizens' perception for the sensible smart city services

Service Name	Usability	Convenience	Economic Efficiency	Urgency	Diffusiveness	Publicness	Mean
Missing child prevention service	4.21	4.18	3.55	4.02	4.20	4.23	**4.07**
Safety service for the disadvantaged	4.16	4.14	3.45	4.13	4.18	4.25	**4.05**
Smart parking	4.19	4.23	3.64	3.98	4.18	4.05	**4.04**
Smart streetlight	4.11	4.14	3.13	3.91	4.10	4.30	**3.95**
Smart traffic information	3.90	3.86	3.11	3.67	3.84	3.90	**3.71**
EV parking and charge management	3.71	3.75	3.38	3.52	3.79	3.80	**3.66**
Walker safety service on school zone	3.71	3.65	2.67	3.61	3.77	3.87	**3.55**
Pedestrian safety	3.65	3.65	2.79	3.58	3.70	3.84	**3.54**
Smart crosswalk	3.67	3.67	2.54	3.53	3.74	4.04	**3.53**
Parking lot management	3.70	3.77	3.09	3.41	3.63	3.59	**3.53**
Smart safety location management	3.59	3.56	2.86	3.56	3.73	3.81	**3.52**
Safety driving alert	3.45	3.50	2.57	3.35	3.56	3.76	**3.37**
Social care	3.35	3.35	2.85	3.07	3.25	3.18	**3.18**
Mean	**3.80**	**3.80**	**3.05**	**3.64**	**3.82**	**3.89**	

5. **Conclusions.** Smart cities using ICT are being built due to the prospect that the number of mega-cities with a population of 10 million or more will increase to 37 in 2025 with the rapid increase in the urban residence rate. Smart city is evaluated as an alternative to urban problems such as traffic congestion, crime and disaster, and energy depletion caused by the rapid increase of urban population and to improve urban competitiveness.

This study analyzed the citizens' perception for the Busan smart city test-bed project and sensible smart city services through two stage surveys. The usability, convenience, economic efficiency, urgency, diffusiveness, and publicness which represented citizens' perception of smart city service, were measured and analyzed.

The usefulness of the Busan smart city test-bed project is highly perceived by the citizen and is in need to extend as public works. However, as the intention to use the service with a fee is low, it is necessary to develop the smart city service necessary for real life by reflecting the citizen's requirements. The awareness is also very low, so it is necessary to promote the smart city project.

The average of six citizens' perception variables for 13 sensible smart city services was 3.89 for publicness, 3.82 for diffusiveness, 3.80 for usability, 3.80 for convenience, and 3.64 for urgency, respectively. It indicates that the citizen recognized that the sensible smart city services should also be built and spread to public works, though they are useful for living. The economic efficiency is 3.05, which is very low. Therefore, it is necessary to consider economic value creation in smart city service planning and design.

In the future, various smart city projects will be developed, and smart city services will be implemented. The results of this study can be used to plan smart city project and design its services. However, only limited smart city services in the Busan smart city project were analyzed in this study. Therefore, it is necessary to derive success factors by analyzing successful smart city services in future study.

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