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Digital Amenities of a Smart City

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1. Introduction

Urbanization is essential and necessary to compete with other global cities in a networked world with vague boundaries between countries. A city is a place where creative ideas are exchanged, and, consequently, these ideas blossom a fruit of entrepreneur. Silicon valley is a good example of a melting pot for creative ideas, which was made possible by universities and low rental cost-offices (Glaeser, 2011). However, for already packed cities, it is difficult to provide such an amenity, thus a mechanism must be established by which people can access information and ideas.

One major defect of urbanized society is a lack of community kinship. Human are social and reciprocal in the game of survival (Giddens, 1991). We feel comfortable when we are surrounded by family members and neighbors. A community is necessary from the psychological viewpoint and the manual cooperation as well. In a busy urban life a community tie is very loose or does not exist at all. Strongly digitized time schedule and work labor of modern era prohibit the conglomeration of a community. Connecting people is the first step toward community revitalization in a city.

Deepened urbanization of modern societies, advancement of technology development, and industrial systems have had an impact on social and cultural paradigms from our lifestyles to the way we work (Nei et al., 2007). Especially, development of IT (Information Telecommunication) technology has led to dramatic changes in the urban environment and human activities, and has looked for a way to an integrated model of smart cities where men and environments can interact in a smart way.

A book titled "Creative city" was published in England by Charles Landry. It suggests conditions and objectives in becoming a smart city, where citizens would live in a safer, and securer manner. It also emphasizes the restoration of a community (Landry, 1995). The suggestions were derived from the socio-economical, and political point of view, though there were a few technological ideas for efficiency of administrative and municipal operations.

Researches about a ubiquitous city or a smart city have been undergone recently, actively in Korea. The Korean government granted a big research fund for a national level project. They aimed at conceptualizing and realizing a smart city. Even though the project is in its final stages, the results are insignificant because it failed in figuring out a concrete service framework that supports human activities in a smart city environment. It brought up a

gigantic picture of covering all domains from safety and security to education and health. It remained as a picture, but did not proceed into an elaborate model with detailed execution information.

Fig. 1. Digital amenity. (Uk Kim, ubiquitous amenities lab, Hongik University)

In the urban environment, 'quality of life' is a fundamental requirement for human life. As modernization and urbanization proceeds faster than any previous period since human enlightenment, life has become unpredictable, thus making the sustenance of quality of life the most important goal among architects, planners and urban designers. Recently utilization of IT technology is actively searched in pursuit of smart cities that guarantee in sustaining quality of urban life.

The value of human dignity should not be undermined, and the minimum standard of health and comfort must be secured. Ergo amenity should be considered as the most basic component in providing smart spaces of this purpose (Bell, 2000). Referring to amenity, it includes various factors such as nature, architecture, climate, social character and personal emotion. Thus, amenity should resolve cultural, ecological, political and social conflicts of human needs and provide necessary civil services, individually and collectively. Digitally complemented amenities (figure 1) are suggested here to enhance the services based on digital infra-structure. In this study, essential services of digital amenities are realized using ubiquitous technologies, and are entitled as "u-services" of a smart city (Kim et al., 2009, 2010).

2. History of cultural innovation

Human skills for survival have been embedded into our DNA as intelligence, and they are the resources for the innovation of human culture like social and economical systems. Human instinct and intelligence ignites the development of technologies, which in turn guarantee financial success in a capitalistic society. Thus, it is inevitable for technological innovation, in every aspect of human culture, to explode and continue.

The first step to implement a digital amenity is to find out the required civil services. By reviewing significant footsteps of cultural innovation in human history, the crucial aspects of conception about environment, materials, relationships and commodities can be categorized by the following: time, space, resource and people (Pinker, 1997, 2007).

Along with the invention of tools, time was digitalized in the form of the calendar, and human life has been scheduled far more densely than ever before. Densely scheduled life gives human the opportunity for the development of innovative technology.

Following the invention of the calendar, the invention of the printing press presented human kind with a way to share, reserve, and transmit knowledge to future generations. Such following communication technologies as radio, television, cellular phone and internet allow real time information to be transmitted globally.

As seen in figure 2, there have been four essential factors at the center of the innovation of technology and human culture; time, space, resources and people. Digital amenities will focus on these factors in the development of necessary civil services for the sustainability of a smart city. At the same time, citizens are exposed to life long learnings of innovative technology and evolving culture, which is critical for creative living in a smart city. Therefore, it is needed to collect information, monitor collected data, and broadcast to the public.
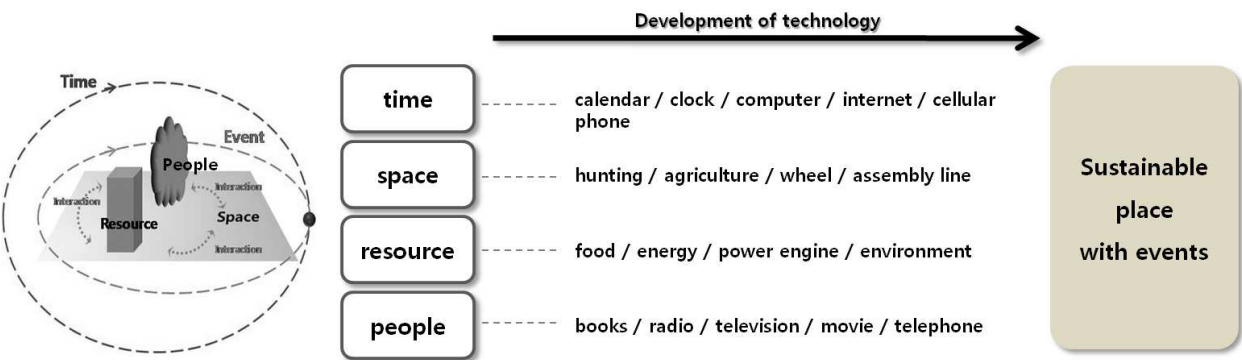
Fig. 2. Time, space, resource and people. (Uk Kim, ubiquitous amenities lab, Hongik University)

3. Computational model of urban spaces

Existing spaces of a city are classified into four classes shown in table 1, in which the necessary services are extracted to meet civil requests in a city. These services are designed in a scenario format that represent realistic patterns of urban life.

The spatial model of the four classes is based on a computational model of life events (Rucker, 2005) for predictability, including Class 01: uniform type, Class 02: queuing type, Class 03: random type, and Class 04: clustered type. The Class 01: uniform type spaces can be found in a structured form, making up a block of a city. The Class 02: queuing type is a linear space that flows in one direction. A plaza or agora can be considered as a Class 03: random type. Further, a random but focused space is classified as a Class 04: clustered type space.
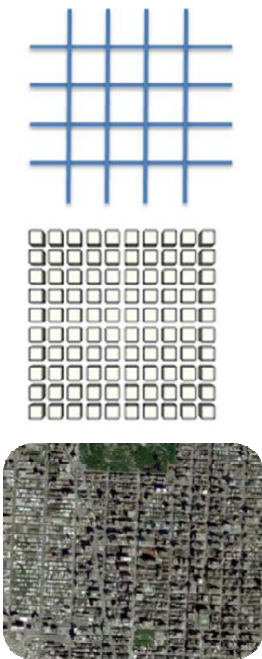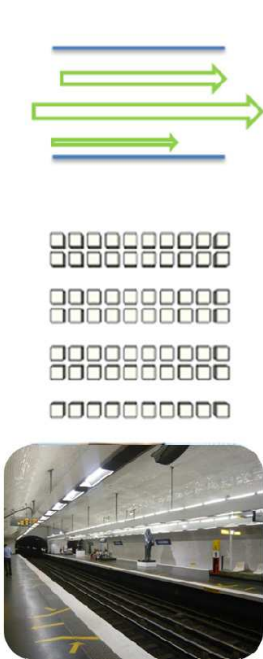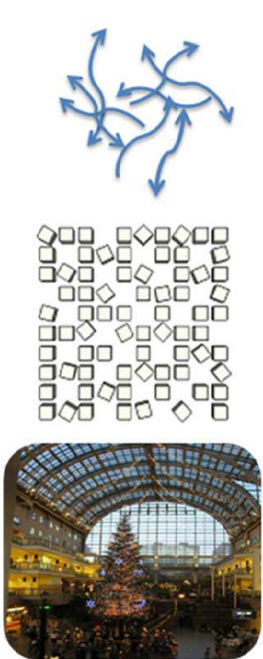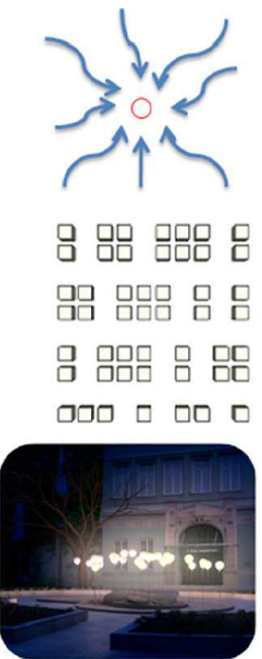
Class 01. Uniform space	Class 02. Queuing space	Class 03. Random space	Class 04. Clustered space
Manhattan, New-york	Subway platform, Paris	Factory shopping mall, Sapporo	Winterwolken, Berlin

Table 1. Urban space classification. (Uk Kim, ubiquitous amenities lab, Hongik University)

Based on the analysis of four urban space types, civil services are studied and organized in a series of events and respective actions. Four factors of figure 2 have been the starting point to conceptualize the digital amenity that provides citizens designed services in a smart city.

4. Service framework and evaluation methods

Digital amenities would provide services that would enhance life values for citizens. These services are gathered, organized in a scenario format, and evaluated through ICT for everyday life, types of a spatial model, and content factors described previously.

The values for citizens can be divided into technological values and psychological values as shown in figure 3. The technological values can be measured by the speed and efficiency of service delivery with the amount of cost and energy. The psychological values ascribe feelings of safety, security, and happiness.

To model a smart city with digital amenities, not only are physical spaces required to be based on ICT environments, but they are also required to be incorporated into a conventional internet based data community, say virtual space shown in figure 4. The networking of scattered spaces is also required to uplift life values in terms of content storage and distribution.
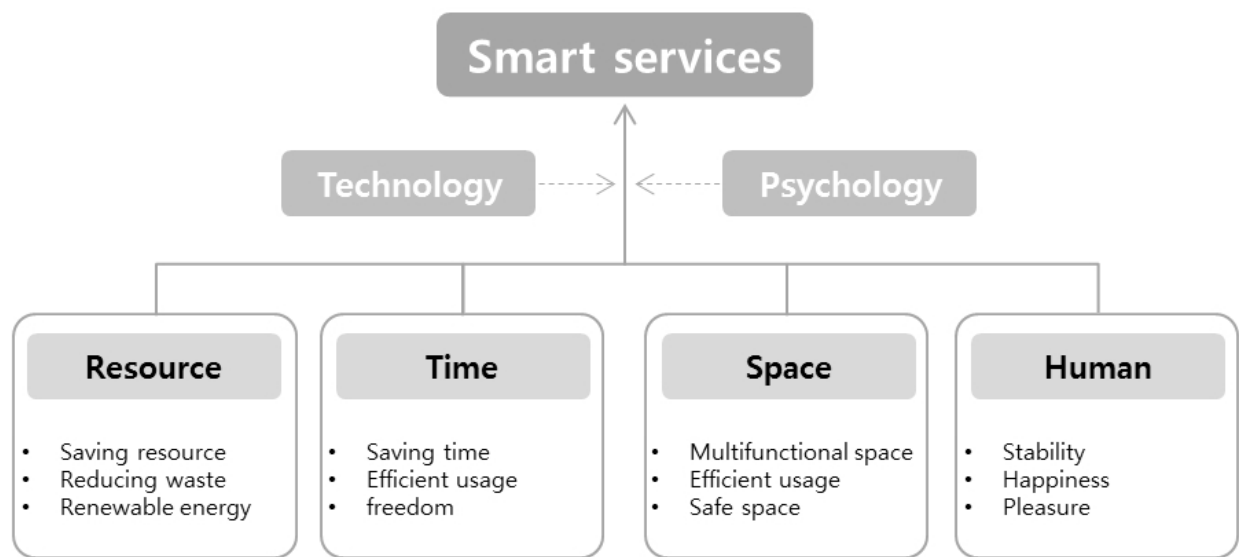
Fig. 3. Smart services with values. (Uk Kim, ubiquitous amenities lab, Hongik University)
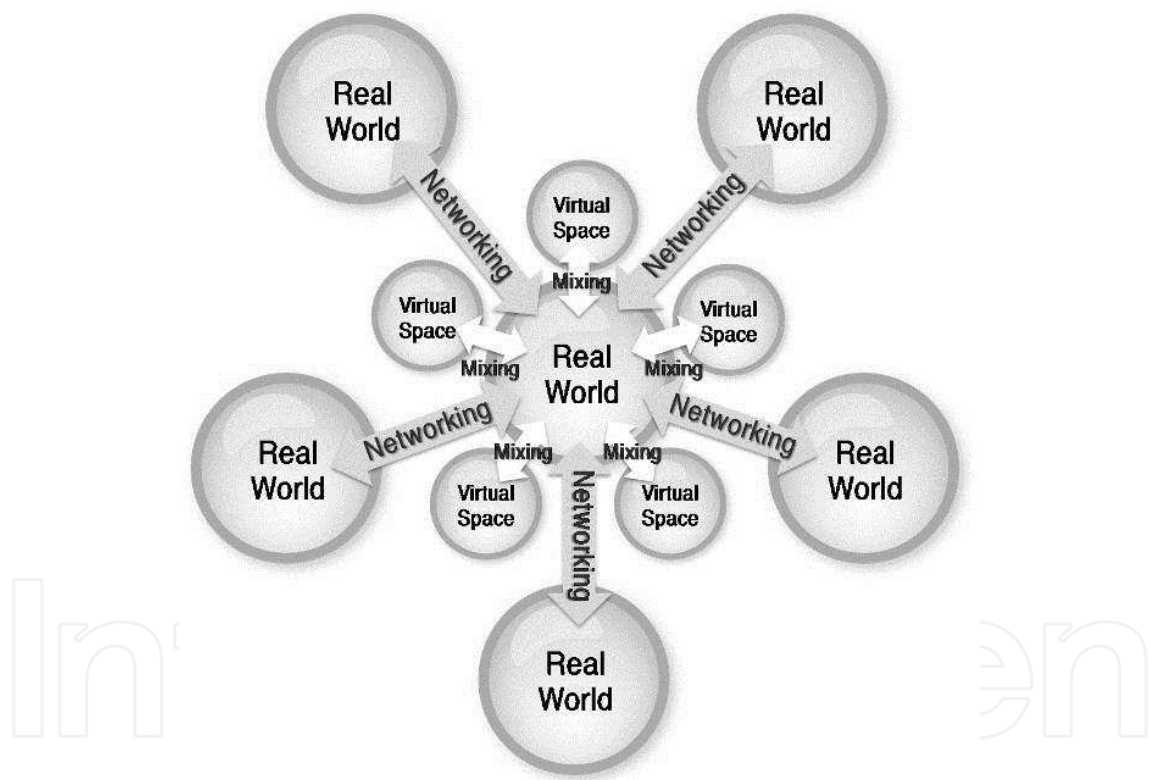

Fig. 4. Mixing and networking using ICT. (Uk Kim, ubiquitous amenities lab, Hongik University)

By analyzing the unit service models defined from the ubiquitous city research, the services that satisfy the needs of a target city are derived, in which they are evaluated and articulated for further implementation of a platform and rule engine. For the evaluation of services, the QFD(Quality Function Deployment) and SVD(Service Value Deployment) methods (figure 5) are utilized in order to prioritize the services based on space classes, customer requirements and technology properties.
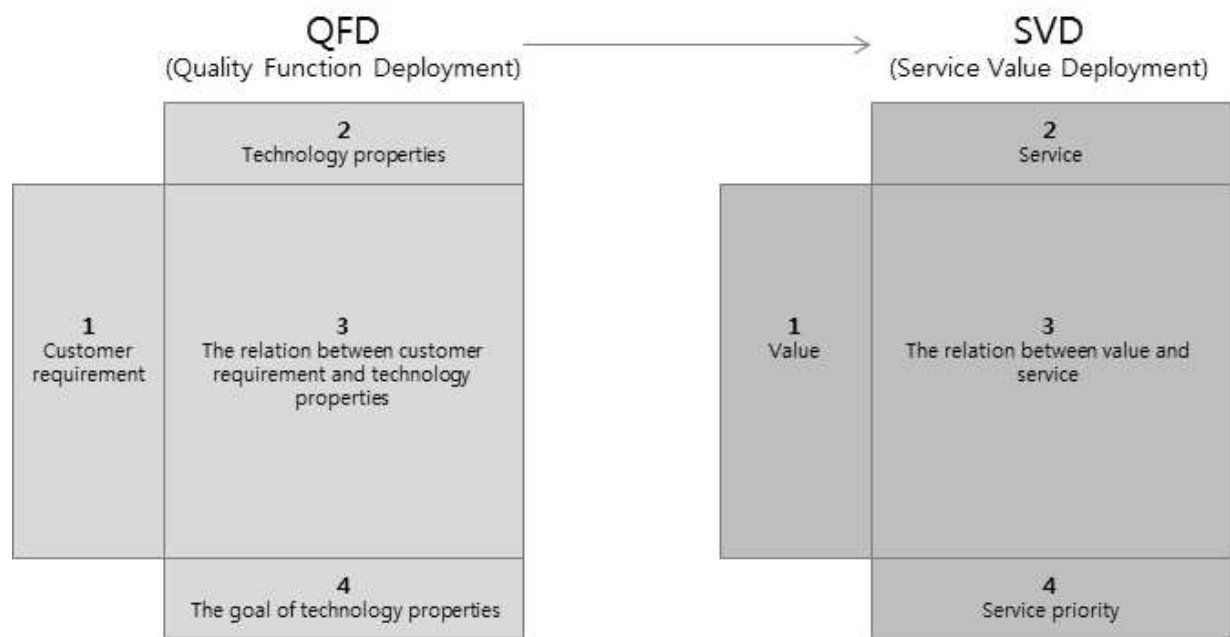
Fig. 5. Evaluation methods of services. . (Uk Kim, ubiquitous amenities lab, Hongik University and Seung Sik Yoon, UBIDUS Co.)

5. Service scenarios and device images

Evaluated and articulated services are used in turn to prepare service scenarios. Firstly, content factors of a city are analyzed according to their correlations along with their interfaces. Secondly, various personas are employed to document plausible events that constitute ordinary urban life patterns. Following tables illustrate service scenarios realized for the project.

Scenario 1			
Name	Sex	Age	Job
Hee-sun, Kim	female	35 age	office worker
Characteristics	Passes the Street Light on way home		
Purpose of Activity	Check village notifications and other information through local information browsing		
It is inconvenient to check village information, since it is too late in the evening. Before returing to home, we use the Street Light located on the street to check on village notifications.			

   ①   Walk towards the Street Light located near the local mart.
   ②   Check for village information and notifications using the Street Light
   ③   Check the results for the recent polling event

Table 2. Scenario 1. (Uk Kim, ubiquitous amenities lab, Hongik University)

Scenario 2			
Name	Sex	Age	Job
Young-ha, Park	male	45 age	researcher of urban
Characteristics	Use the Street light frequently for retrieving information		
Purpose of Activity	Need information for passing-by population		

Mr. Park, who is a researcher for city planning, wishes to gather information about passing by population of Hong-Ik university during weekdays and weekends.

① Input setting parameters to the Street light where the research is to be conducted.

② Gather information about passing by population through Street lights.

③ Continue research using data gathered from Street lights.

Table 3. Scenario 2. (Uk Kim, ubiquitous amenities lab, Hongik University)

Scenario 3			
Name	Sex	Age	Job
Su-ji, Choi	female	27 age	office worker
Characteristics	Fashion mania. Uses her car frequently		
Purpose of Activity	Goes to Dongdaemun using her car, searches for nearby parking spaces		

She is planning to drive to Dongdaemun fashion mall to purchase some clothes. Dongdaemun is a crowded area, and searches for the nearest parking space.

① Search for Parking spaces prior to visiting Dongdaemun.

② System searches for empty parking spaces, and delivers the directions.

③ Park in the parking area, and continue shopping.

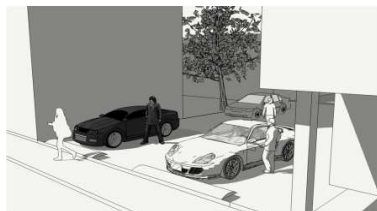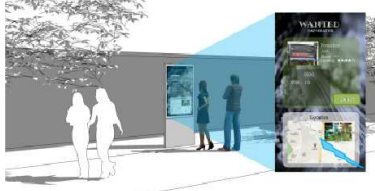Table 4. Scenario 3. (Uk Kim, ubiquitous amenities lab, Hongik University)

Scenario 4			
Name	Sex	Age	Job
Dong-jin, Seo	male	48 age	shop owner
Characteristics	Cannot leave his store		
Purpose of Activity	Wishes to gather part-time workers for his shop		

He owns a local shop, and wishes to hire a part-time worker. He uses the Media board to post a hiring ad to reach local communities.

①   Use his own notebook to register an ad on the Media board.

②   People of the local community look up the wanted information using the local Media board.

③   People of the local community can access information about the shop using the Media board.

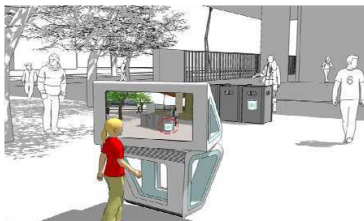Table 5. Scenario 4. (Uk Kim, ubiquitous amenities lab, Hongik University)

Scenario 5			
Name	Sex	Age	Job
Jin-seok, Park	male	33 age	government employee
Characteristics	Officer of the Mapogu Office. In charge of developing tourist attractions in the Hongdae area		
Purpose of Activity	Survey and Polling		

He, who works for the Mapogu office, is in charge of developing tourist attractions for the Hongdae area. He acquires information through polling and surveying using the Media board.

①   Post polls and surveys using the internet.

②   Citizen A uploads the realtime image and location information.

③   Citizen B posts an opinion.

Table 6. Scenario 5. (Uk Kim, ubiquitous amenities lab, Hongik University)

Scenario 6			
Name	Sex	Age	Job
Young-su, Kim	male	33 age	office worker
Characteristics	Uses the Smart device very well. Interested in the Gangnam province.		
Purpose of Activity	Upload realtime information of Gangnam area, and share it with other people.		

He, who is interested in the Gangnam area uses various smart devices at his office, home, bus, and other places to upload and share information about the Gangnam area using a virtual space called USL World.

① After his date in Gangnam area, he accesses the USL world using his smart phone.
② Upload pictures taken in Gangnam area to the USL World.
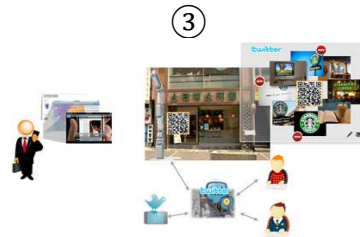③ Using realtime social networking services, he posts comments on other peoples photos.

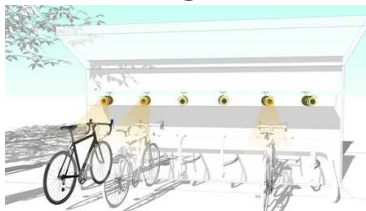Table 7. Scenario 6. (Sung Ah Kim, Sung Kyun Kwan University)

Scenario 7			
Name	Sex	Age	Job
Jae-won, choi	male	31 age	worker
Characteristics	Uses the Smart device and public bicycle very well. Interested in the bicycle road of Hangang river.		
Purpose of Activity	Upload realtime environmental information of bicycle road of Hangang river, and share it with other people.		

He, who is interested in bicycling, uses various smart devices and public bicycles at the bicycle road of Hangang river to upload and share information about integrated urban platform.

① After his date at the bicycle road of Hangang river, he accesses the integrated urban platform using his smart phone and devices.
② Upload pictures taken in the bicycle road of Hangang river to the integrated urban platform.
③ Using realtime social networking services, he posts comments on other peoples photos.

Table 8. Scenario 7. (Uk Kim, ubiquitous amenities lab, Hongik University)

The ICT devices and display forms that can be used in the services are designed according to technical feasibilities. Their images are captured in table 9.

Street light	Community board	Adaptive media display
- Life information service - Exercise information service - Personal exercise management base on smart key - Emergency call service	- Local information service - Life information service - Augmented reality service - Interactive community service - Emergency call service	- Construction guide service - Construction information service - Roundabout way guide service - Environment information service

Table 9. Examples of smart device implementation. (Uk Kim, ubiquitous amenities lab, Hongik University and Seung Sik Yoon, UBIDUS Co.)

6. Service rules and platform

The integrated service management and monitoring environment for smart services is suggested. The unit smart services construct an information architecture (figure 6) that gathers the 'Event' generated by citizens, and relates them to the 'Action' that should be taken by the digital devices/artifacts, while managing these two elements using service 'Rules'.

The u-service (or services based on ubiquitous technology) can be abstracted to a series of 'Events' occurring according to the'Actions' evoked by a user or the environment. Often times, the environment encapsulates various sensors and input devices based on IT technology, and output devices such as a computer, smart-phone, digital signage, and/or large sized information displays

The 'Event' that triggers an 'Action' of a smart space can be an input signal, actively or passively, created by a user of the system, or an event that is automatically generated by the system, such as a timed event, or an output signal from a nested procedure of the smart space. The 'Action' can be classified as a triggering of contents, applications, or mechanical outputs of a smart space.

The series of 'Events' that provoke 'Actions' of a smart space can be modeled so that the interactions of a user to a given smart space can be normalized and systemized. If we define a u-service as a series of 'Actions' caused by a single, or a series of events within a smart space, we can couple the relations of corresponding 'Actions' caused by appropriate 'Events', and call it a 'Rule'.

The input data from the citizens' behaviors are modeled into 'Events', which are mapped to one or more 'Actions' that is to be performed by the digital devices that provide smart services (or u-services). 'Events' and 'Actions' are bound through 'Rules', thus enabling a platform to manage services through those specified 'Rules'.
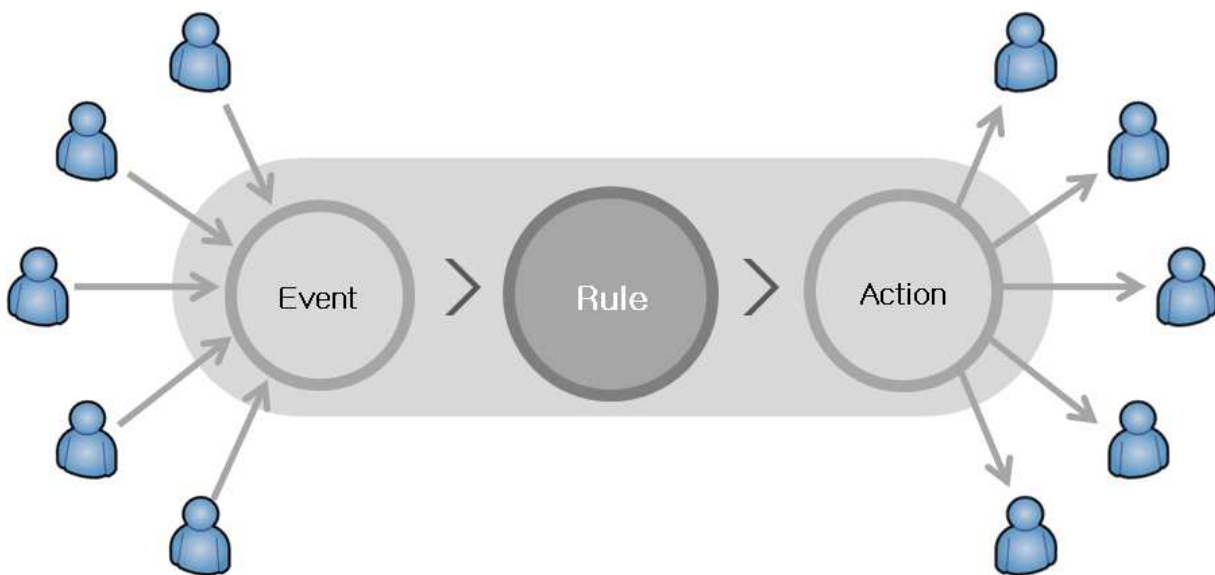

Fig. 6. Information architecture. (Uk Kim, ubiquitous amenities lab, Hongik University)

By associating 'Actions' to 'Events' using 'Rules' in a smart space, it is possible to normalize & systemize a u-service. If we can conceive the concept of a 'u-service' as delivering needed contents to a needed user, using appropriated devices & networks through associated applications, the coupling of 'Actions', 'Events', and 'Rules' to define a 'u-service' can provide a method to normalize u-services.

The 'Rules' can be archived and modified according to the needs of the associated u-service given a specific time frame, thus provide a platform in which u-services can be modeled,

authored, and managed. A customizable integrated platform model (figure 7) is framed so that it provides adequate information for appropriate devices. The Platform detects and processes the citizens' needs based on various ICT (Information Community Technology) environments.

The service offered to the citizens using ICT environments can be modified /adapted /expanded according to the unit space, and individual context of the space.
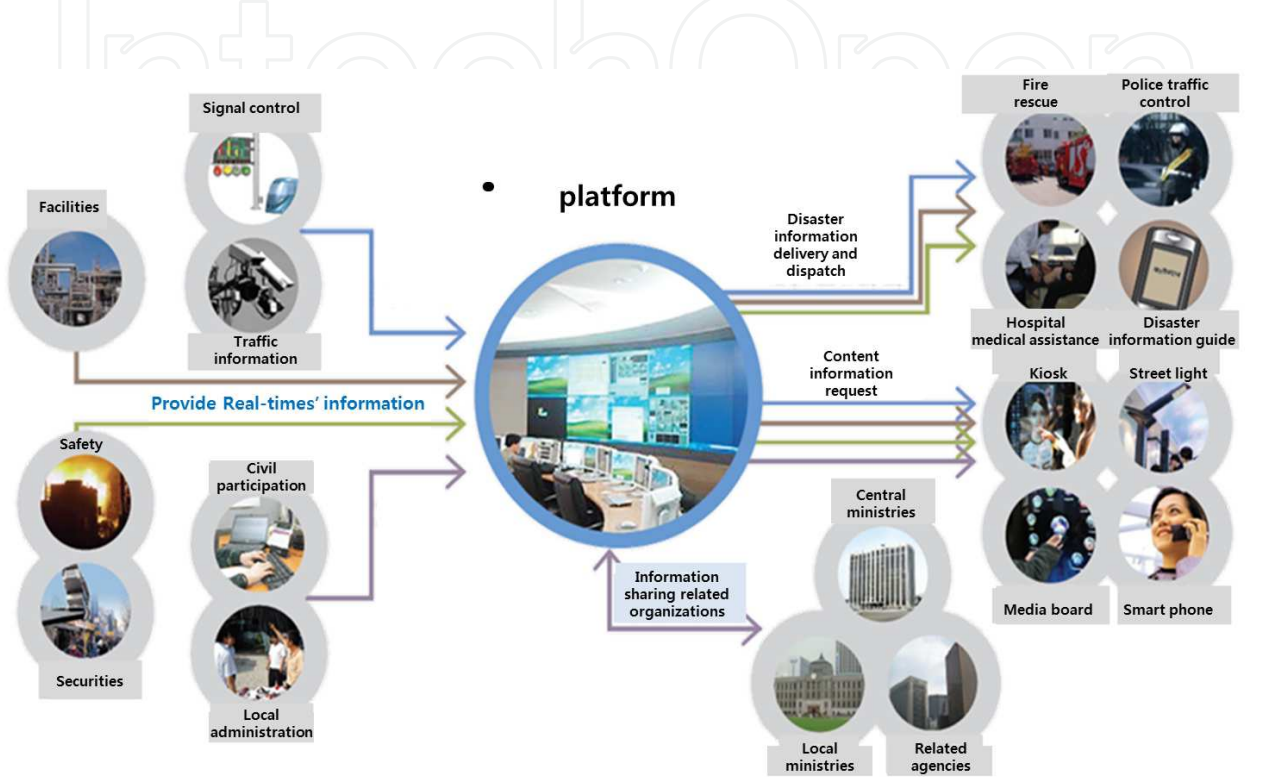

Fig. 7. Smart service platform. (Uk Kim, ubiquitous amenities lab, Hongik University and Seung Sik Yoon, UBIDUS Co.)

Prototypes of SDK (Standard Development Kit), API's and Simulators that are needed to integrate the unit smart service to the platform is also provided, and Service Management Rules are developed to provide maximum benefit and efficiency.

To ensure the successful management of services, a "Business Ecology" is suggested to the Government and Private sector business partners.

7. Implementations

The methodology of evaluating the feasibility and usability of implemented u-services include the user response analysis (usability, value analysis), surveys of citizen groups, and technical analysis (technical efficiency, technical robustness)

To enhance the credibility of the service analysis, we cooperated with the test-bed implementation, evaluation and maintenance task defined in a smart city. We perform a recursive service model evaluation process (figure 8) by evaluating and revising the service models through 2 stage test bed implementations.
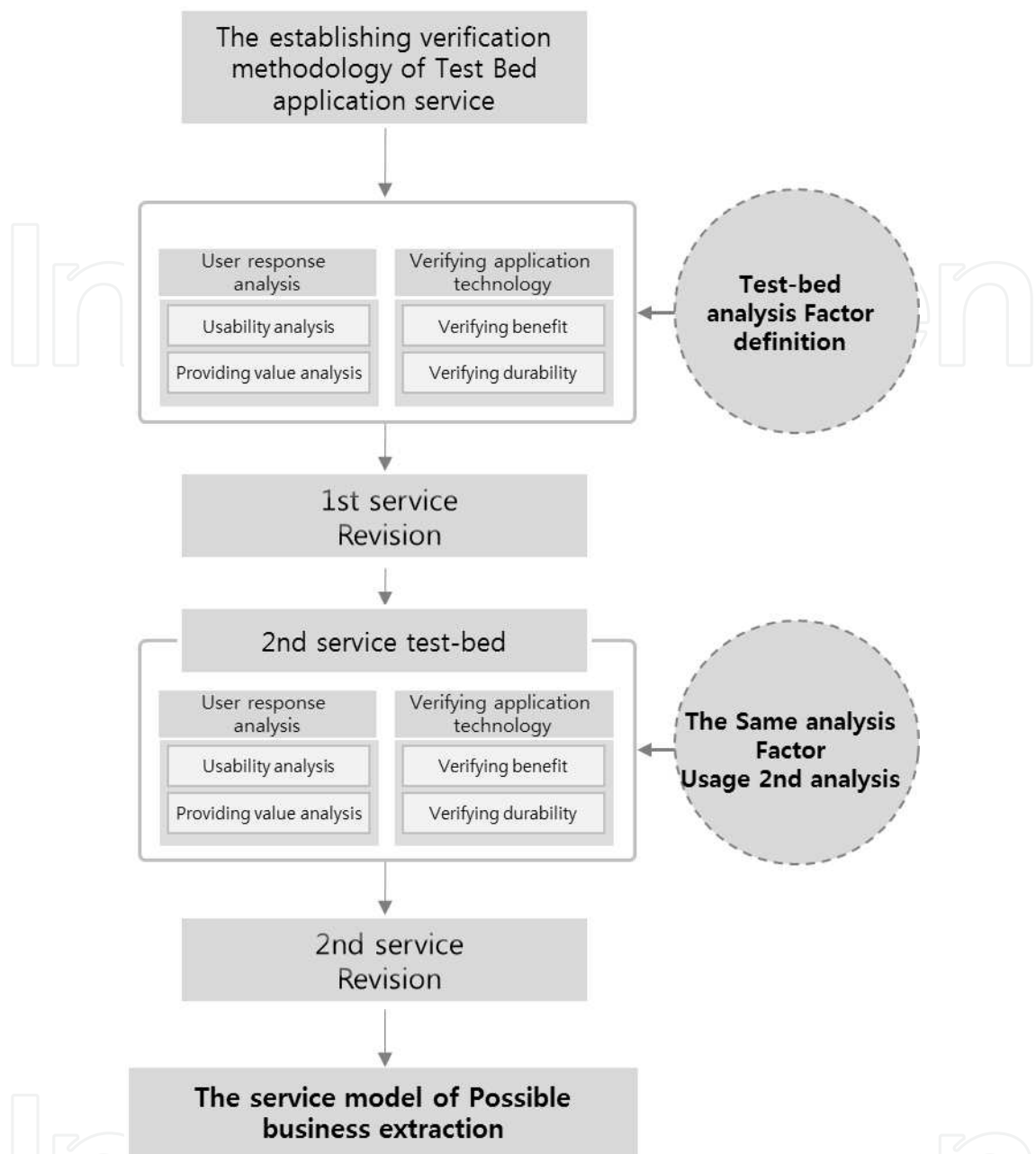
Fig. 8. Service model evaluation process using test-beds. (Uk Kim, ubiquitous amenities lab, Hongik University and Seung Sik Yoon, UBIDUS Co.)

The 1st stage test-bed will evaluate the user response according to the usability and values provided, which is based on the data gathered from the implementation of the service test-bed. As for the 1st stage of technical evaluation in the test-bed, factors such as the efficiency of the technology implemented, and durability of the technology under field environment are examined.

During the 2nd stage of the test-bed, the usability and technical evaluation results from the 1st stage are used to upgrade the system and service models. The revised system and service models are tested in the 2nd step test-bed, according to the same evaluation factors used in the 1st stage.

8. Conclusion

Ubiquitous technologies are being adapted here to create new value to urban amenities for better human environment. Through u-services of digital amenities, not only will the quality of human life be improved, but traditional functions of a community will also be restored by connecting members geographically, and networking them socially.

A great amount of money is required to facilitate digital amenities. Although digital amenities are in principle, the infra-structure of digital environment, the investment should be allotted for people, for the objective of implementing a smart city is to increase human capital for sustainability of the city.

A sustainable business model that will increase the life value of citizens while building up a successful business ecology will be derived as a result.

9. Acknowledgment

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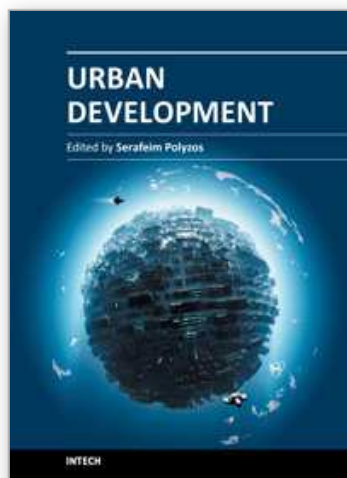
Urban Development

Edited by Dr. Serafeim Polyzos

Cities are growing as never before and nowadays, it is estimated that at least 50% of the world's population lives in urban areas. This trend is expected to continue and simultaneously the problems in urban areas are anticipated to have an increase. Urbanization constitutes a complex process involving problems with social, economic, environmental and spatial dimensions that need appropriate solutions. This book highlights some of these problems and discusses possible solutions in terms of organisation, planning and management. The purpose of the book is to present selected chapters, of great importance for understanding the urban development issues, written by renowned authors in this scientific field. All the chapters have been thoroughly reviewed and they cover some basic aspects concerning urban sustainability, urban sprawl, urban planning, urban environment, housing and land uses. The editor gratefully acknowledges the assistance of Dr Marius Minea in reviewing two chapters.

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