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Procedia Environmental Sciences 22 (2014) 89 – 100

Procedia Environmental Sciences

12th International Conference on Design and Decision Support Systems in Architecture and Urban Planning, DDSS 2014

Linking Data and Converging Systems for Smarter Urban Services: Two Cases of U-City Service in Korea

Yountaik Leem[a]*, Sang Ho Lee[a], Jungho Yoon[b]

[a]*Hanbat National University, 125 Dongseo-Daero, Yuseong-Gu, Daejeon, 305-719, Korea*
[b]*Anyang Municipal Office, 235 Simin-Daero, Dongan-gu, Anyang-Si,Gyenggi-do 431-728 Korea*

Abstract

To overcome many difficulties in sustaining the satisfying quality of life for a large population[1], urban spaces are evolving toward more efficient spaces by combination with ICTs (information and communication technologies) and raising the possibility to provide improved urban services which can enrich the quality of life of the citizen. In many cities over the world, a good number of public and private services in transportation, environment, urban safety from crime or disaster, health and other fields are designed and implemented with IT infrastructure. In spite of the expectation of cost-effective urban services based on the linkage between data and systems, obstructions in administrative and technical domains have made it difficult to be implemented. In this study, two advanced ICTs based urban services, which were developed by linkage and convergence of urban information and systems of Korea were introduced and analysed. The structural design of system convergence and data sharing scheme of Carbon Emission Monitoring System (CEMS) in Sejong City uses UIS (Urban Information System for local authorities), GIS data and other data provided by the public agencies, such as Korea Meteorological Administration for the monitoring and analysing the characteristics of the energy consumption of household[2]. Another system, Urban Integrated CCTV Control System (ICCS) in Anyang City, shows integrated CCTV networks for crime prevention, traffic control and public facility management to provide extended urban services, such as disaster prevention, police investigation and others. Qualitative and Quantitative effects analyses with technical and policy directions were suggested for the development and improvement of future urban services for a liveable city.

Peer-review under responsibility of the Eindhoven University of Technology, Faculty of the Built Environment, Urban Planning Group

*Keywords:*System Convergence, Data Linkage, Carbon EmissionMonitoring System, Integrated CCTV Control System

* Corresponding author. Tel.: +82-42-821-1193; fax: +82-42-821-1185.
*E-mail address:*ytleem@hanbat.ac.kr

Peer-review under responsibility of the Eindhoven University of Technology, Faculty of the Built Environment, Urban Planning Group
doi:10.1016/j.proenv.2014.11.009

1. Introduction

The rapid growth of urban areas has introduced severe problems in the sustainment of the satisfactory quality of the existing city life all around the globe[1]. The primary solution to such "unhealthy" urbanization is to raise social consensus that the cities of today have limitations in growing any further, and that a new design of a smart(er) city is needed. Recently, urbanization is evolving with a more efficient space through combination with ICTs and raising the possibility to provide improved urban services, which can enrich the quality of life of the citizen. They call these kinds of cities as ‘Intelligent City’, ‘Pervasive Space’, ‘Smart(er) City’ and ‘Ubiquitous City’. In many cities over the world, a good number of public and private services in transportation, environment, urban safety from crime or disaster, health and other fields have been designed and implemented based on an advanced IT infrastructure. In spite of the expectation for achieving cost-effective urban services that are based on the linkage between data and systems, certain obstructions in the administrative and the technical domains have made them quite difficult to be implemented.

In this study, two advanced ICTs based urban services, which were developed by linkage and convergence of urban information and systems of Korea, were introduced and analyzed. The structural design of system convergence and data sharing scheme of Carbon Emission Monitoring System (CEMS) in Sejong City uses UIS (Urban Information System for local authorities), GIS data and other data provided by public agencies, such as Korea Meteorological Administration for monitoring and analyzing the characteristics of households’ energy consumption by their housing or household structure[2]. Another system, the Urban Integrated CCTV Control System (ICCS) in Anyang City[3], Korea has integrated CCTV networks for crime prevention, traffic control and public facility management to provide effective urban services, such as disaster prevention, police investigation and others. Furthermore, qualitative and quantitative effects analyses with technical and policy directions were suggested for the development or improvement of future urban services for a livable city.

2. Ubiquitous City and its Services

2.1. Ubiquitous City and Similar Concepts

The concept of U-City has originated from Korea and there are a number of similar ideas, such as cyber city, e-city, smart(er) city, etc. U-City is defined as an urban space where ICTs are embedded in physical spaces to collect a variety of information, and process them to provide U-Service, helpful to enhance the quality of the daily life of the citizens. ICTs are hidden but exist ubiquitously and are responsible for the improvement in the efficiency of the urban space. Table 1 lists other city concepts that are similar to the U-City.

Table 1.Similar concepts of U-city.

Name	Meaning	Implementation
Cyber City	In the future city built in web, space can be expanded infinitely. Distance will be disappeared. Imitation of real space	Cyber space
e-City	Even connected by electronic devices, graphic or network, it is an extension of real world. A kind of media city constituted by symbols and image to store and convey information	Information infrastructure
Smart(er) City	A city in which information infrastructure for tele-communication is connected to every nook and corner like human neural-network	Regional linkage of information
U-City	Urban space where ICTs are embedded in physical spaces to collect various information and process them to provide U-Service which will be helpful to citizen’s quality of everyday life	Intelligent space and linkage of information

Data: Choi (2009)

U-City is neither any virtual space nor an electrical space. U-city is actually a space where the ICTs infrastructure is provided to support urban activities and lives of the citizens. In recent days, a smart(er) city is considered to be of similar space as that of a U-City. However, this is more focused on the information infrastructure and environmental issues than the ordinary life in urban space supported by ICTs in a U-City. To realize a U-City, the space in an urban area needs to become more intelligent and sophisticated through the linkage of information between space and human, space and space, and human and human as well to become a physical container of citizen's life.

2.2. Ubiquitous City and Similar Concepts

During the course of evolution of U-City from information city and space oriented future city, Lee and Leem (2008) defined the concept of U-City as an urban system which can provide advanced services to its citizens based on ICTs infrastructure, called as Multi-layered U-City. The components of this multi-layered U-city are U-Service for the citizens, U-Technology that enables the U-service, U-infrastructure in the city that can generate, process and deliver the information and U-Management in administrative, financial and public participation domain.

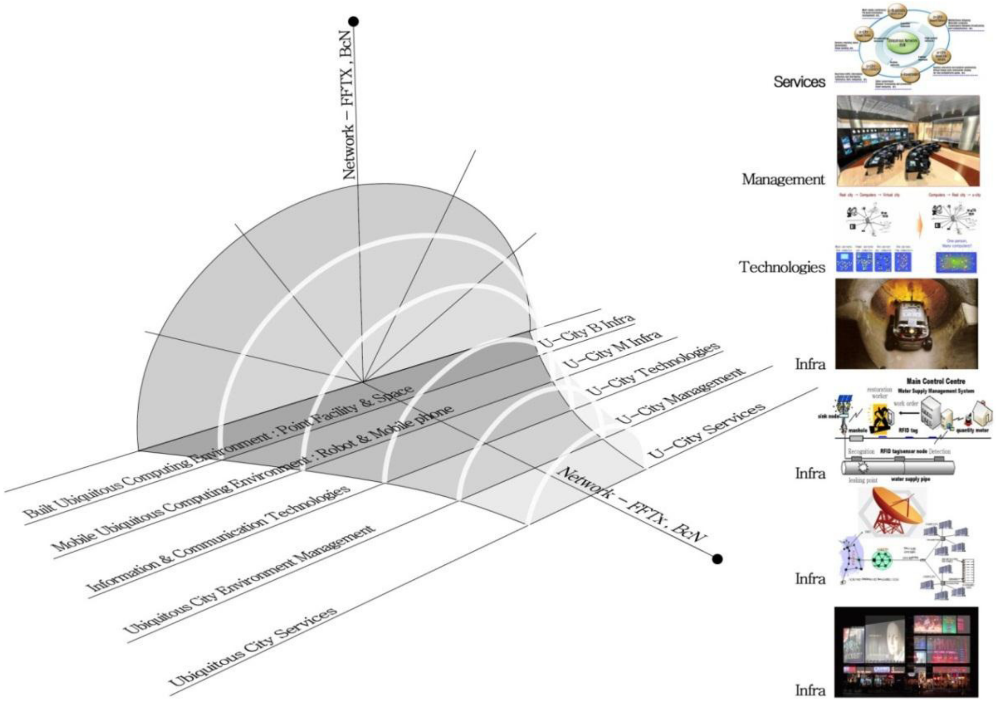


Fig. 1. Multi-layered U-city.

U-Service is one of the key factors in a U-City since it delivers direct utilities to the citizens. Until now, it has been very difficult to distinguish between the general information service and the U-Service. U-Service is a kind of urban service mainly provided by public parties based on ICTs. For example, information on the arrival and departure time of public transportation by sensed data from the bus and bus stops would be very convenient for the citizens and promote energy saving by increment of public transport usage in the urban area. The definition of U-Service was under a long debate, after which it was considered that U-Service should use real-time data itself or linked with urban information and should be helpful to enhance the utilities of any urban space.

As to the services related to urban space, U-Service has evolved from unit service to linked and upgraded service based on the development of ICTs in many fields. Seoul Metropolitan City[4] introduced linked U-Service and upgraded U-Service in addition to the existing unit service. Linked U-Service is an urban ICTs-based service which is linked with other data or information system to enhance the quality of the service. Upgraded U-Service is an advanced U-City service, onto which additional functions are added for functional expansion and enhancement of the quality of the service. Table 2 shows some examples of evolved U-City services.

Another criterion of U-Service is space-based services. Each space has its own uses and sometimes has its own problems. As an urban space, U-City also has its own uses and problems as well. However, U-City always tries to enrich the utility and diminish the vulnerable points of space through ICTs. Below is an example of a traditional village at the center of Seoul, Korea named Bukchon (means northern village).As per regulations, to retain the beauty and historical value of Bukchon ordinary activities, such as repairing or redeveloping any house or the whole village is strictly prohibited in this area. However, ICTs helped in various ways to settle the spatial problems of the dwellers and also to provide adequate information to the visitors. Planners suggested ICTs-based garbage collection system and car parking system to let the residents live a comfortable life. On the other hand, virtual reality system is proposed as an explanatory tool and an element of landscape of the space.

Table 2. Examples of linked and upgraded U-services.

Field	Unit Service	Linked Service	Upgraded Service
Smart Living	U-Social Net	U-Barrier Free	Smart Work
	Crash Prevention at Crossroads	Safety Map by Citizen	U-Seoul Children Safety Zone
Eco-friendly	Waterfront Facility Management	Carbon Point	Eco Information System
	Waste Management	U-Park Network	Safety Surveillance for River Facilities

Data: Seoul Metropolitan City[4].

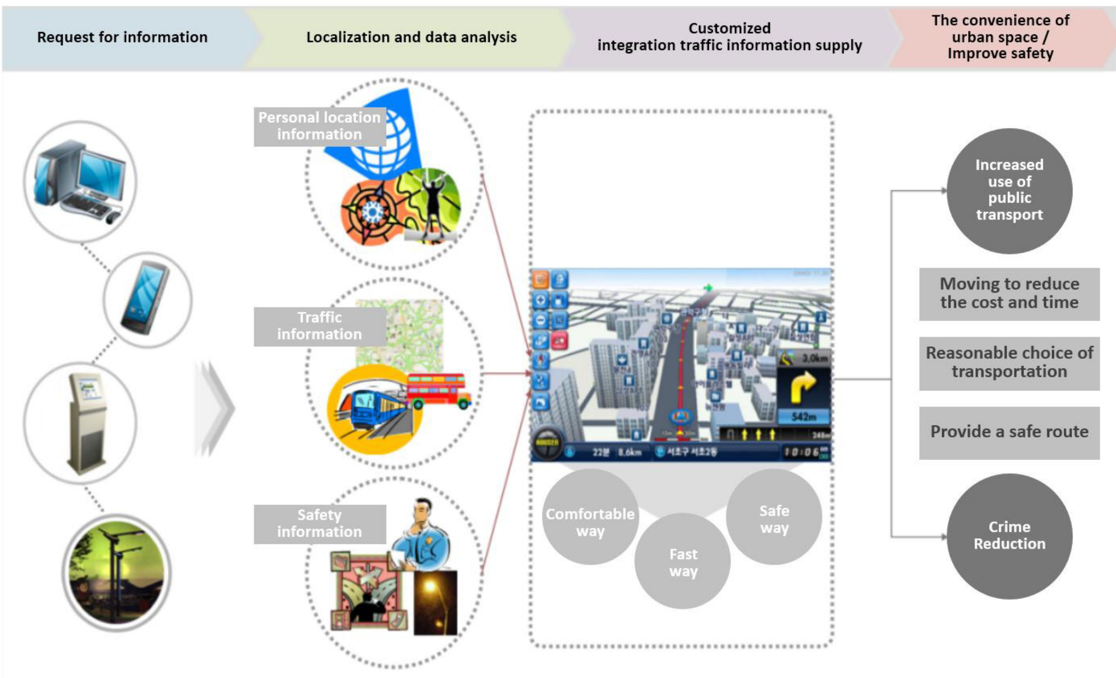


Fig. 2.U-service based on data linkage.

In Bukchon area, U-Service planning empowered the potential of the place as a tourists' destination, as well as a place to dwell. This is an example of space-based ICTs planning, which recovered the publicity of a space.

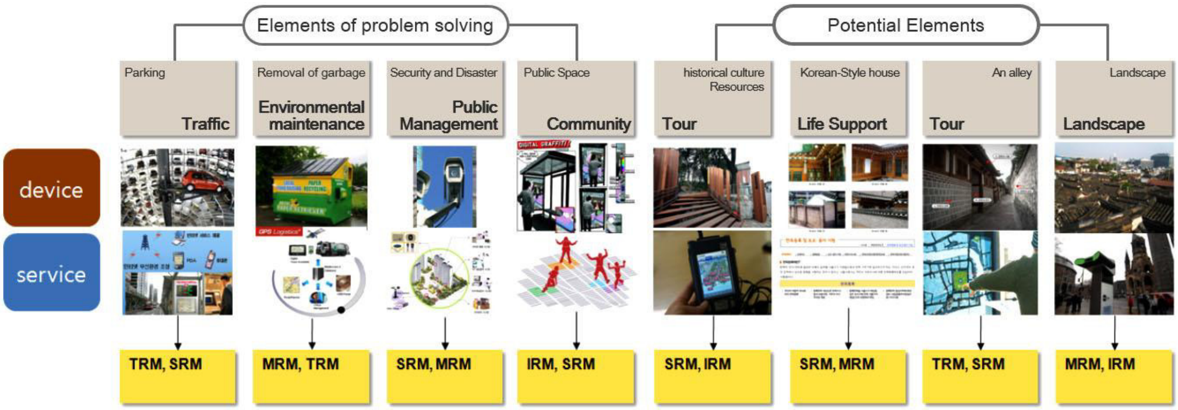


Fig. 3.U-service for Bukchon, Seoul.

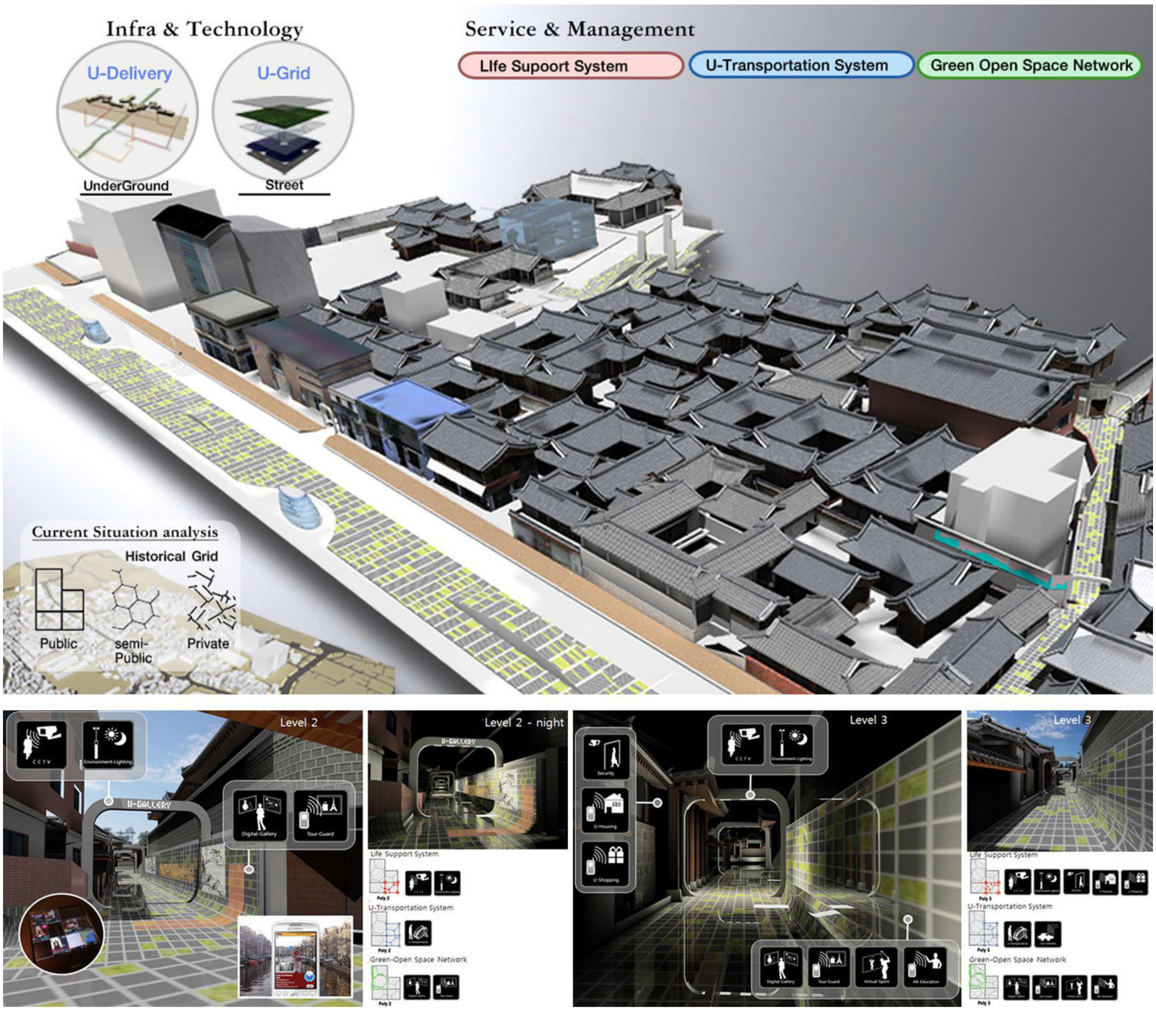


Fig. 4. U-Service planning for Bukchon
Data: Seoul Metropolitan City[4].

3. Case 1; Carbon Emission Monitoring in Sejong City, Korea

3.1. Objectives and Concept of the Service

To address the global warming issue, many significant progresses have appeared in urban planning, for e.g. energy efficient buildings, and communities and zero-carbon cities. To encourage the participation of the citizens into the movement of carbon emission reduction, the Korean government already introduced carbon point system, which gives virtual points to the citizen for their effort to reduce energy consumption. The points earned, can be used in the same way as money to purchase environment-related goods. However, it is also necessary to provide the citizens with the information on energy consumption of their house and the government agencies seek data on this to make further policies.

In Sejong City, which is newly developing as a multi-functional administrative city, carbon emission monitoring system (CEMS) is designed and developed together with the urban information system (UIS) for municipal administration. On the basis of well-equipped urban ICTs, automatic remote meter-reading and data treatment system for carbon emission have been implemented in the U-Service concept. This system not only measures the quantity of emitted carbon but also identifies the characteristics of each household and house type by static and time-series statistics. To construct and use such kind of statistics on energy consumption is also very important to the decision-makers for making future policies.

3.2. System Structure and Data Sharing

After each household agrees to share, the UMS collects the household and housing data, which is subsequently processed. Analyzed results are then sent to both the residents and the decision makers to use while making urban policies.

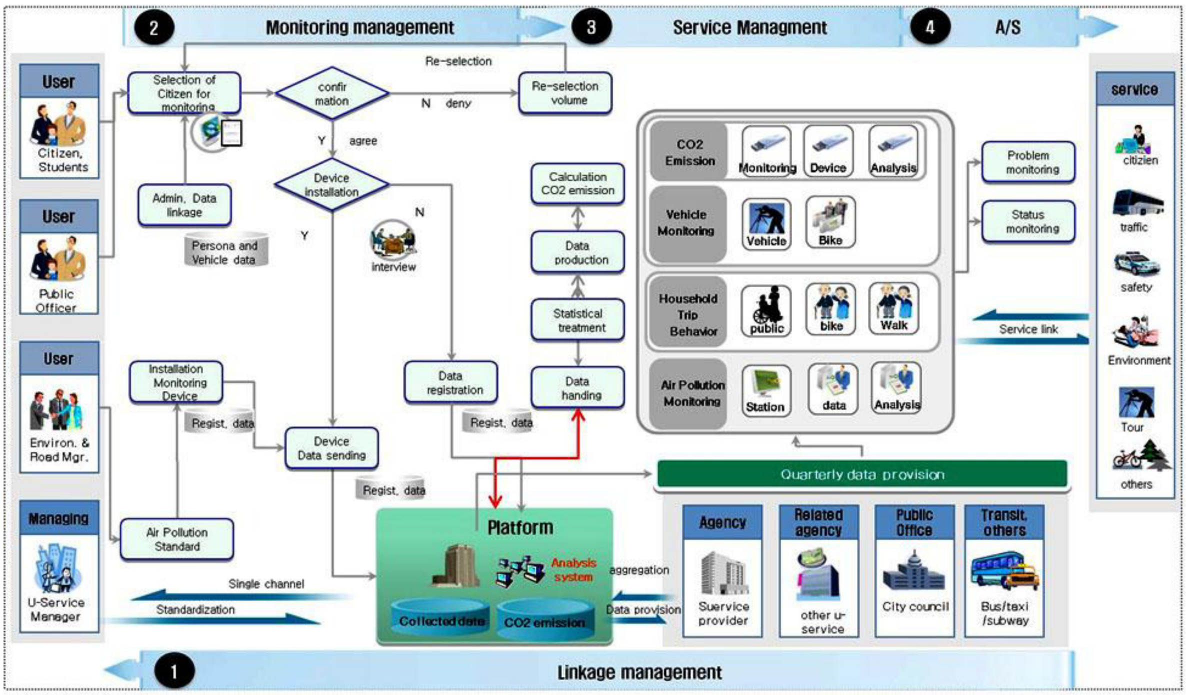


Fig. 5. System structure of CEMS, Sejong City.

3.3. Interface and Data Analysis

CEMS provides 3 kinds of user-interfaces– basic data, cross-sectional data and time series data. The basic data interface presents and gets data by table format with which users can check their energy usage or input their own data by themselves. The cross-sectional data expresses by table and graphics. GIS techniques are adapted to generate the information map as a result of data processing. The time-series data is normally expressed in graph format. Daily, monthly data and trends over year can be presented via graph. The basic data and climate data are linked with UMS and other governmental agencies.

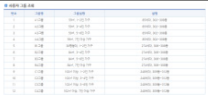
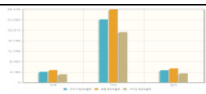
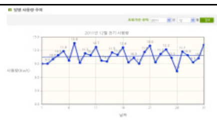
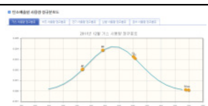
		Type	Screen Examples	Screen Description
Basic data	Socio-economic characteristics	Table		Building area, households from A1 to C4 according to the groups classified by a total of 12 screens
Cross-sectional Data	Carbon emissions by building	GIS-based		The color indicates the home's carbon emissions.
	Carbon emissions by household	GIS and Table		The GIS and Table indicates the home's carbon emissions.
	Average Carbon Emissions (Daily)	GIS and graph		
Time Series Data	Changes in temperature	Graph		In conjunction with the National Weather Service showing monthly temperature.
	Status of monthly usage	GIS and graph		household's electricity, water and gas usage showing.
	Daily usage trends	Graph		A household's daily electricity, gas and water usage trends and averages for the graph
	Regular distribution of consumption by source	Graph		Carbon emissions compared with a group of homes

Fig. 6. System interfaces of CEMS, Sejong City.

From more than 600 household, the carbon emission data was collected from 124 household over a period of 9 months and processed. The results showed that carbon emission in a house is largely dominated by their electricity usage. More than 86% of total carbon emission is caused by electricity. Seasonal change of energy consumption is directly related to the usage of electricity.

It has been proved that the amount of energy consumption depends upon the family size and the floor area of the house. Larger the family size and the area of the house, greater is the energy consumed. People of higher income are assumed to use more energy. Water consumption by families with infants and children ranked the highest position. Households, with 5 persons or more members consume much more electricity in spring and autumn season, compared to other groups in summer. For electricity, houses with medium ($84m^2$) and large ($102m^2$) areas showed a large difference from small-area houses ($59m^2$). In gas consumption, it was very difficult to find out any difference among houses with different floor areas. As a result, the increase in the number of nuclear families are becoming a threat to energy consumption and campaign for CO_2 emission reduction should be targeted toward medium and large-sized houses, especially during the summer season.

With this system where the residents participated in the survey, were very satisfied to have the energy consumption information of their own family and the comparative data with others under similar conditions. This policy, thus proved itself unequivocal to the local government officials.

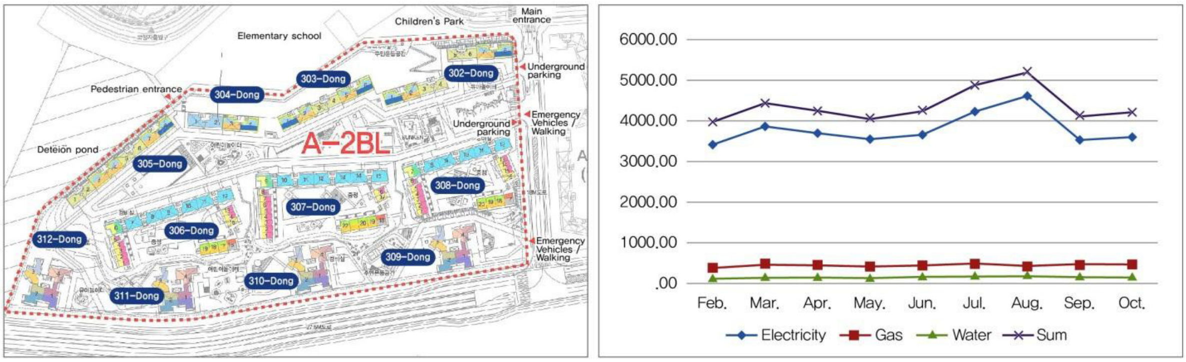


Fig. 7.(a) Survey site; (b) monthly carbon emission by energy consumption.

4. Case 2; Imagery Data Integration in Anyang City, Korea

4.1. Objectives and Concept of the Service

Imagery data collected from CCTV is expanding its territory to a variety fields, such as transportation, public security, healthcare, and facility management. In Korea CCTV terminal installation is rapidly increasing for surveillance on crime, illegal parking, traffic accident and even enforcement of rubbish dumping in spite of the privacy issues. For example, at the end of 2012, the number of installed CCTV cameras by public institutions exceeded 460,000.More than 54 % of the CCTV terminal devices were installed for urban facility surveillance and other 40 % were for public security. Despite the privacy issues, the number of CCTV is growing in Korea like many other countries. This is to mention that, the average annual growth rate in the number of CCTV installation was over 30%in the past three yearsin Korea.

Table 3.No. of CCTV cameras by purpose in Korea (at 31 Dec. 2012).

	Total	Purpose			
		Security	Facility Management	Traffic Enforcement	Transportation] Information
Central government	277,064	112,016	153,916	6,038	5,094
Local government	184,682	76,152	96,031	9,008	3,491
Total	461,746	188,168 (40.8%)	249,947 (54.1%)	15,046 (3.3%)	8,585 (1.9%)

Data: National Information Society Agency (www.nia.or.kr), 2014

However, CCTV has certain kinds of physical and institutional limitations caused by fixed location, different operation agencies and prohibition of the usage for the purposes other than approved. The central government of Korea has recognized these problems and already initiated research to find out the common usage of imagery data from various sources.

Anyang City, with a population of 620 thousand and covering an area of 58.5 square kilometers, is one of the nearest satellite cities of Seoul Metropolitan City, sharing the same border. Like other cities, the CCTVs linked with ITS (intelligent transportation system) and for security surveillances, especially around the children's safety zone are installed and under operation. In addition, more CCTVs to watch illegal parking, bus-only lane violation and other objects are also in operation.

Some officials expected a more effective use of the existing CCTVs for undesignated purpose. By increasing the surveillance range, the CCTVs for traffic management, were mobilized to lookout any mountain fire, stream overflow or road deterioration. CCTVs that watch road congestion also monitor the adjacent mountains periodically during dry season and lookout for streams and riverside public parking lots in the city during typhoon or heavy rain.

Imagery data by CCTV can provide more valuable information due to recent developments in ICTs. CCTV control system of Anyang City can even recognize license plate numbers in the CCTV image in real-time and compare them with the numbers of cars that are wanted by police or listed in the tax-dodgers management system database. This newly developing service, based on the data linkage contributes in the prevention of additional crime or in reducing the expenses for tax collection. These developments in imagery data utilization through connection with the existing urban database system (UMS) are being absorbed into the higher urban services. CCTV can trace the suspects through relay of the image data between the unit CCTVs.

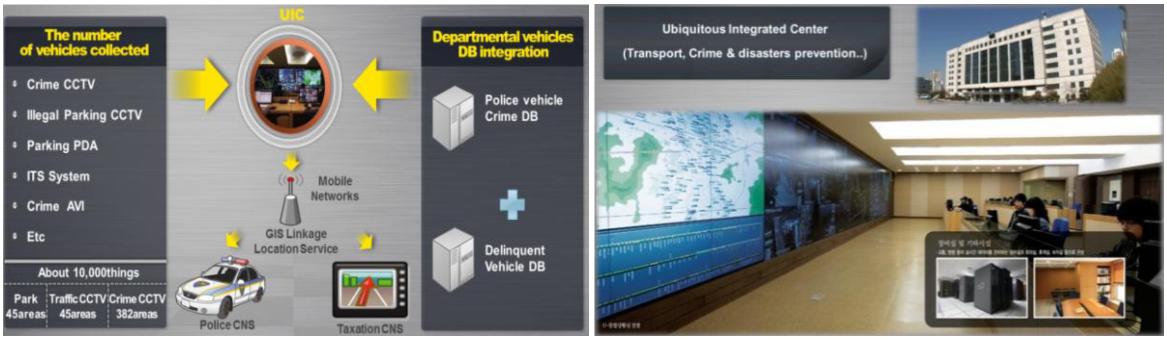


Fig. 8.(a) Service linkage concept; (b) ubiquitous integrated center of Anyang City.

4.2. System Structure and Data Sharing

To utilize the individual CCTV systems for additional purposes in Anyang City, the control centers of each system were integrated together to form a 'Ubiquitous Integrated Control Center'. The integration was not totally completed internally, however, the operators of transportation, urban facilities and crime prevention system can assist each other with their data and experience too. This physical integration has showed a large improvement in their daily- work efficiency.

After the space integration, the data generated and processed in each system were utilized coherently. An image of crime caught by the transportation CCTV, which used to be pointed and informed verbally before, can now, be transmitted automatically to the crime-prevention officer. Moreover, real-time traffic situation images at the major intersections could also be sent to the fire engines anytime they are mobilized.

In addition to image sharing between systems, automatic car plate number recognition techniques played a great role to utilize the systems. Car plate numbers read by any CCTV can be sent to the police data center and tax office to verify whether they are crime suspects or tax delinquents. Fig. 8 shows the system structure of imagery data sharing in urban context.

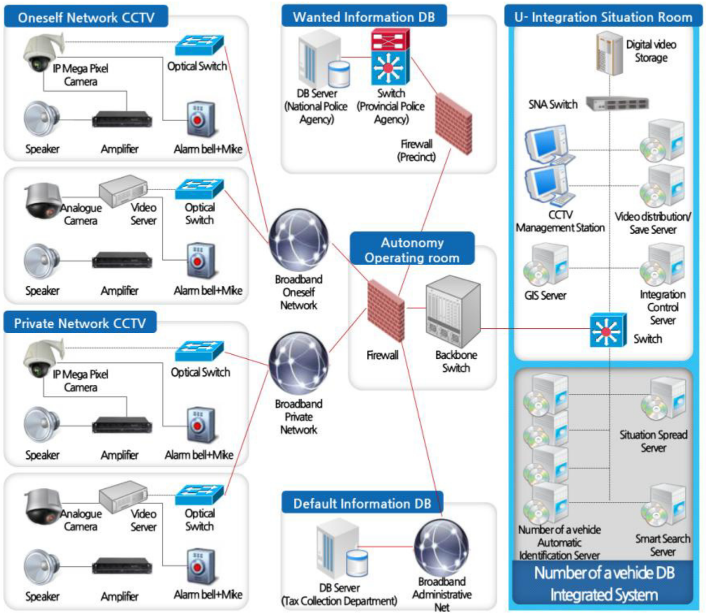


Fig. 9. Structure of integrated system for imagery data sharing.

Fig. 10 exhibits the system interfaces on the display panels. At first the plate number caught by CCTVs are read and surveyed to see whether they are listed with other agencies or not. If any car is verified as a wanted one by police or as tax delinquent it is informed immediately to the agency and field patrol as well by CNS (car navigation system).

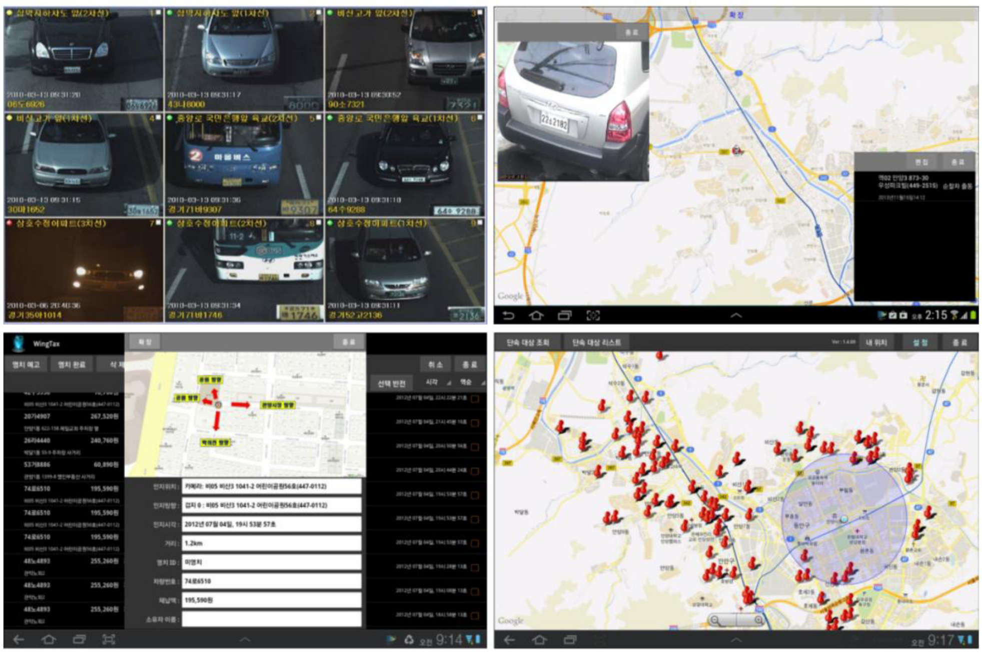


Fig. 10. Reading plate numbers and its presentation on interface.

4.3. Results in Efficiency and Livability of Urban Space

Nowadays the image data from CCTV is shared with other governmental or local agencies. Fire station, police, patrol cars, military bases and more than 12 local agencies are connected to share the CCTV image data for their own usage. This data linkage enhanced their work efficiency dramatically and it also contributed to the livability of the citizen. This is considered as a big step of synergy through a small technical progress. This technology was adapted to settle urban problems of any specific space through the analysis of present situation and goal of the service planning.

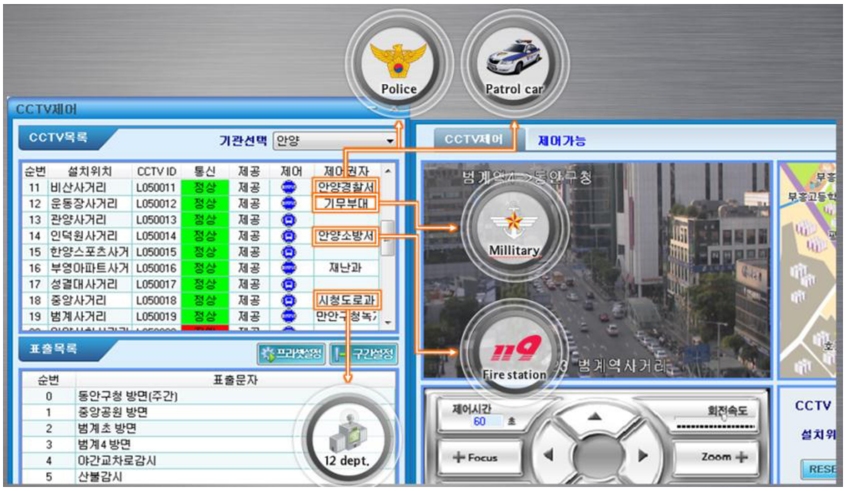


Fig. 11. Image data sharing between agencies.

Sharing the data from existing systems can help the other party to work. This innovative sharing system between the city council and the police agency in Anyang City contributed to both the urban securities and the public finance[5]. During the last 3 years (2011 to 2013), 9,636 image data, which contained the number plate photos, were handed over to the police agency and 177 suspects were arrested due to such cooperation between the agencies. Other image data handed to the local tax office also helped to solve the nonpayment of taxes problems. From June 2012 to November 2013, 453 times of alert were sent to the tax office from the U-City Control Centre.

Even persons who are in charge of natural disaster, facility management and public safety were assisted by the data from other parties' system until now. This kind of data sharing can be expanded to many areas of public services and in our society, as well. From early 2014 Sejong city is planning to develop systems to collect plate numbers of cars, which are entering and leaving the parking facilities within the jurisdiction. Furthermore, suspects tracing system between CCTV cameras were also developed and have been put in practices. Another kind of convergence focused on the imagery data with its infinite potential is expected to open new era in ICTs based society.

5. Conclusion

Until now many ICTs systems are built in an urban space and it costs a lot to operate similar systems for different purposes. The systems had worked individually and new systems were introduced for new purposes. They are operated with the same DB, such as urban GIS data or administrative data. This situation stimulated some planners or engineers to connect the systems and link the common data for additional U-Service at a substantially low cost.

In Sejong City, Korea carbon emission monitoring system was built along with the construction of UMS for newly developing city. The two systems shared GIS data and administrative database. In this linked system, only remote meter-reading data were added and it was possible to produce useful information for both the residents and the decision-makers. This inexpensive system promoted the residents' energy conservation practice and helped the local government to prepare policies to stop global warming.

Even CCTV based systems to collect imagery data needed a large amount of budget for their installation and management. On top of that, the collected data from the systems could not be used efficiently due to physical and institutional problem. Anayang city introduced an efficient use of CCTV images obtained from existing terminals through small idea and technology. A development of S/W with small budget made it possible to expand the usage of CCTV in transportation, urban facility management and disaster prevention. The linkage of the data collected and those recognized from the CCTV, with the police and the tax office database could reduce the social cost to roundup the crime suspects and tax delinquents.

These cases show that connection of H/W systems and addition of S/W systems can enhance the utility of existing urban facilities and it consequently raise the satisfaction of life in an urban area. Still lots of ICTs systems embedded in urban space have possibilities to be connected and linked to produce fusion services to the citizens. This is the direction to which U-City and Smart(er) City should lead.

Acknowledgements

This research was supported by a grant (13AUDP-B070066-03) from Architecture & Urban Development Research Program funded by Ministry of Land, Infrastructure and Transport of Korean government

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