A Study on the Planning of U-Riverfront Town with M2M Technology

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Abstract

This study aims to create the U-City generation based on the future M2M technology, which has recently been evolved. To this end, we introduce the concept of 'u-Riverfront' along Sincheon River flowing through the center of Daegu to create the future urban waterfront space and propose a urban regeneration method through natural connection to the adjacent old towns. To achieve this 'u-Riverfront' considering city generation, first, we need to improve the facility management along the current riverside, since pedestrians are less accessible to this area in terms of connection with adjacent areas. Second, we need to induce the IT infrastructures to the public city planning facilities in order to build infrastructures for urban restoration and development projects. Third, we need to provide citizens who use this Sincheon River with various portal service, culture, amenity, and security to lead to a substantial activation of waterfront.

Keywords: M2M Technology, u-City, u-Riverfront, Urban Regeneration, unmanned robot sensor

1. Introduction

Quite recently, the paradigm of waterfront space for urban restoration has been changed into various directions. the development of IT technology, which is based on the ubiquitous technology, is an opportunity to create new urban cultural space by connecting deteriorated old towns with the waterfront space and a bridgehead to establish the integrated and conjunctive infrastructure of U-City for urban regeneration and revitalization in the existing towns through 'u-Riverfront' which usually uses M2M information and communications technology[1].

This study aims to induce the creation of urban restoration-based project for the riverside flowing through the center of Daegu and the surrounding old towns for u-City-based urban restoration with M2M technology introduced. To this end, this study introduced the concept

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of 'u-Riverfront' along the new riverside to revitalize the identity as a water-familiar big city of Daegu, create future urban riverside space, and finally propose urban restoration method through natural connection with adjacent old towns

2. Study Scope

As for the approaches to studying the u-City-based urban restoration based on M2M technology[1], as shown in Table 1, first, we aim to summarize the meanings of waterfront town in conjunction with U-City through literature reviews. Second, we extract major benchmarking elements by analyzing the water-familiar space development cases with 'u-Riverfront' concept centering on domestic and international large cities. Third, we investigate into the unique characteristics, problems, and improvement directions by analyzing the status on the relationship with the existing old towns centering on'u-Riverfront' to be established around the Sincheon River. Fourth, based on the findings from the status analysis, we present the basic directions of urban and architectural plans and designs in waterfront space by region by classifying each region into stage 1 to stage 3. Finally, we suggest an unmanned sensor robot system to be operated in water space with M2M technology applied.

Table 1. Study Scope

Scope	Description
Analysis of preceding research data and related data	- Investigation into and analysis of preceding research data - Synthesis of related research findings and hierarchicalization - Finalization of status investigation scope and object - Investigation into and analysis of foreign examples
Actual condition investigation of a targeted area	- Analysis of the current status of major facilities management in a targeted area - Derived problems
Setting of the boundary of a targeted area	- Setting the stage 1 area - Setting the stage 2 area - Setting the stage 3 area
Unmanned Sensor Robot System Service	- Water quality data measurement system in water-familiar intelligent robot - Smart water quality information service in real time for users - Regular monitoring through central control system

3. Theoretical Considerations

3.1. Development of Waterfront Space in Conjunction with Urban Restoration

Considering the urban restoration connected with the waterfront space, Young-Sang Gwon and Sang-Gyu Cho(2011) presented the waterfront city in conjunction with urban restoration centering on urban scape and green growth directions[12]. Ji-Young Mun and Deok-Seong Oh(2007) classified the riverside development elements into 7 sub-categories[13], and again classified these into five strategic elements for urban restoration to find out the association. In addition, they are suggestive of human-centered, culture-centered, and eco-friendly development based on cases. Beom-Hun Lee and Gyeong-Bae Kim(2009) analyzed the relationship between water law for urban design and urban restoration centering on the

riverside space at Hamburg Hafencity, an advanced case in Germany and tried to seek out ways to apply the water law[14]. Hyun-Su Kim and two others(2008) present the water law for urban design at the riverside space in terms of urban restoration in old towns by comparing and analyzing the domestic and international cases[15]. Do-Sik Yang(2008) presents approaches to urban restoration centering on urban design elements in more considerations of cultural and public redevelopment process[16].

As shown in Table 2, Hoyle et al.(1998) make a systematic description of the changes in spatial structure of waterfront towns in the historical context from the earlier ancient cities to the late 20th century[17]. Breen *et al.*, (1996) classified the types of urban waterfront space development into six subcategories - commercial, cultural, educational, and environmental, historical, recreation, dwelling, and industrialization - depending on the purpose that the project has been developed[18].

Table 2. Hoyle(1998)'s Urban Context and Waterfront Space[2]

Stage	Period	Description
Initial stage	Ancient times and middle age~19th century	Had a deep relationship created along the spatial and functional waterfronts and cities
Urban expansion	Early 19th~20th century	Ship-related industry developed while the rapid growth of businesses and industries exceeded the capacity of the functional cities located around the riverfront area.
Modern industrial city	Mid-20th century	A large-scale waterfront space was demanded due to the industrial growth(oil), appearance of large container cargo, and growth of related cargo ship and facilities
Isolation from the waterfront space	In the 1960~1980s	Cities are functionally isolated from the waterfront space with the increased necessity of the industrial development areas along the watersides due to the changes in the ocean-related technologies.
Redevelopment of waterfront space	In the 1980~1990s	The large-scale space deserted when cities are spatially and functionally isolated from the watersides was redeveloped.
U-Waterfront	In the 1990~2010s	With the urban restoration activation in conjunction with U-City, the ubiquitous integrated management of spatial and physical environment of waterside space was performed.

3.2. Ecological River Development Project Directions in Sincheon River

Recently, various policies and development plans have been proposed for the management and restoration of waterside space ranging from Sincheon through Gumho River to Nakdong River. The Ecological River Development Project for local rivers mostly includes [3].

-dredging of the deposit soil for water quality improvement and flood prevention and replacement of concrete facilities into the ecofriendly ones
-creation of riverside park into green spaces including wetland, strolling alley and cycle path, and installation of water-friendly facilities including waterside square
-supply of water to maintain water and secure rich water quantity, restoration of riverside waterway to restore it into the existing look of old river, and river maintenance in conjunction with the creation of ecological forest
-expectation of balanced regional development since the cultural, tourism, ecological, and historical network centering on the riverside ranges from the main stream of four rivers to the branches of the rivers
-expectation of the creation of new jobs in the region and the activation of the regional economy with the expanded opportunities for local companies to become involved.

In relation to the major contents of the Ecological River Development Project for Sincheon and Gumho Rivers, Daegu reported the same plans at a final briefing session regarding the Sincheon and Gumho Rivers Development Project [4]. To achieve this, the goal of the city is to make a safe ecological river, create Sincheon River with all season themes, and build Gumho River where various ecological parks meet.

4. Internal and International Case Analysis

4.1. 'U-Riverfront' Development Project in Conjunction with'U-City'

With the development of IT technology, the ubiquitous system built in Taehwa river, Ulsan and Hwaseong Newtown Model Complex provides simplified monitoring and alarming services of the water resources utilizing the water level, flow meter, water quality TMS(tele monitoring system), and video data established in the river basin within the water management system. It is also a primary management system to identify the current status of river discharge considering the water intake quantity and the displacement capacity and provide the information largely on the demand side management of residential water at water and sewage establishment and industrial water at factories[19].

A relatively well-established integrated case of the concept of U-Riverfront in Korea can be taken with the 'U-Water Street' in Gwanggyo New Town[20]. Gwanggyo U-City has been systematically managed with the classification of eight categories of u-service(facilities management, crime/disaster prevention, environment, urban management, portal, civil affairs administration, education, and traffic), and special services especially for u-Gwanggyo include family relief service, IT media street, and u-Bike service function.

4.2. Internal Case Analysis of U-City Test Bed

As shown in Table 3, the Ministry of Information and Communication and the National Information Society Agency reflect the technical maturity and the demands of local government and promotes the u-City Test Bed tasks for the first time in the world centering on the relatively higher publicity, urgency, and technical feasibility according to the'Basic u-City Activation Plan(Dec. 2006)'established by the Ministry of Information and Communication. The major purposes for each city and major IT technologies used are described [5].

Table 3. Domestic Cases of U-City Test Bed

Major City of Test Bed	Purpose	Technology
u-Songdo International Business City	management of underground utilities and retarding reservoir, real-time parking management, air-environment management	RFID/USN, 3D GIS, N/W CCTV, Wi-Fi
u-Cheonggye Stream	Real-time ecological and cultural information provision Urban regeneration-based creation	USN, IPv6, GIS, N/W CCTV, media board
u-Taehwa River	Contamination control in industrial area, environmental inspection, bridge management and information provision, facilities management, and atmospheric monitoring	GIS, RFID/USN, N/W CCTV, Wi-Fi
u-Haeundae	tourist information provision, missing child-locating service, walking tour service, and waterfront wave height monitoring	RFID/USN, N/W CCTV, GPS, large PDP, terminal
u-Sejong city	crime prevention service, waste water process management, construction information and construction waste management	2D/3D GIS, M2M solution, DMB, MPEG, RFID/USN

4.3. International Cases of U-City Test Bed

Table 4. represents major IT technologies for each city and describes the major cities and purposes of Test Bed abroad. In Korea, we have more cases of u-City Test Bed at a national level[6].

Table 4. International Cases of U-City Test Bed

Major City of Test Bed	Purpose	Technology
HP(Hewlett Packard) Cool Town Project	Interaction between persons, things, and places(connection) Implementation of Internet world as if it were a real space	RFID/USN, PDA, real World Wide Web System
Amble Time Project	Establishment of a safe and comfortable environment for pedestrians Implementation of digital map reflecting the concept of time frame	Location Based Service System, PDA
Urban Tapestries Project	Perception of threads and information with mobile device Public authoring, communication	Mobile Device, PDA, Urban Tapestries System
INTELCITY Project	Realization of roadmap for development of 2030 Future City Development e-Democracy, Virtual City, Cultural City, Environment City, Post-catastrophe City	RFID/USN, Mobile Device IOSCP(Integrated Open System City Platform)

5. Current Status of a Targeted Area

5.1. Current Status of a Targeted Area

Like other cities, Sincheon River in Daegu lacked an ability to use water as a water-friendly function for dwellers because it mainly focused on the supply of physical facilities emphasizing on the economic aspects including urban efficiency and functionality due to the desire for poverty eradication and economic development in the 1960-80s and was isolated from the urban space due to less accessibility. In the late 20th century, the city had expanded the waterfront facilities gradually going beyond the growth and development period as shown in Figure 1. In the future, the 21st century riverside space is expected to change to an eco-friendly waterfront space enough to achieve a sustainable competitive advantage if we make the city into our living foundation for us to be beautiful and clean and gather together with good management of the city centering on its surrounding environment in terms of its paradigm. Particularly through the continuous development of IT technology, the waterfront space in the city will gradually take its place as the foundation for public facilities for'U-City' by connecting the 'U-riverfront' with the information and communication technology while requiring new identities and various facilities in the region physically and spatially.

Figure 1. Shincheon Water System & Shincheon River Image

5.2. Major Management of 'u-Riverfront' and User Facilities

Major management facilities at Sincheon and Gumho Rivers for u-Riverfront are as shown in Table 5. And major facilities status for users are shown in Figure 2. Centering on these facilities located around the Sincheon River, the purpose of the u-Riverfront plan is to utilize various IT information and communication technologies for bidirectional communication and build the infrastructure to expand the urban generative u-City in conjunction with the adjacent urban development projects around the city[7, 8].

Table 5. Current Status of Major Management Facilities for 'u-Riverfront' at Gumho and Sincheon Rivers

Facilities	Location	Size
Sincheon and Gumho Rivers	Sangdong Bridge ~ Chimsan Bridge	9.1Km
	Hwarang Bridge ~ Gumho Bridge	20Km
Gumho River, Sincheon Fountain, and Lavabo	Gumho River, Sincheon	Fountain : 8 plcs at SincheonLavabo : 14 plcs at Sincheon, 3 plcs at Gumho River

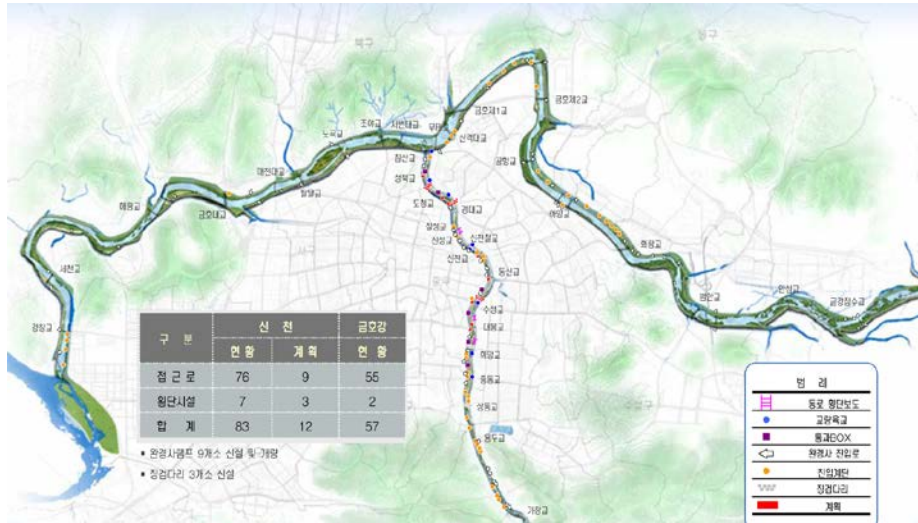| Total	Road Facilities					City-owned Architecture	Underground shopping center
	Subtotal	Bridge	Tunnel	Underpass	Cover Roads		
313 plcs	154	114	4	35	1	157	2

Figure 2. Current Status of Major Users' Facilities for 'u-Riverfront' at Gumho and Sincheon Rivers

6. Service Model with Unmanned Sensor Robot Technology

6.1. Unmanned Sensor Robot System

As seen from Figure 3, the unmanned sensor robot system operating powered by the battery and solar energy is equipped with water quality measuring sensor, GPS, and Wireless Communication Module and measures water quality information while moving freely within water space. The measured water quality information is sent to Smart Remote Management System in real time and can be transmitted to the user's M2M terminal [9].
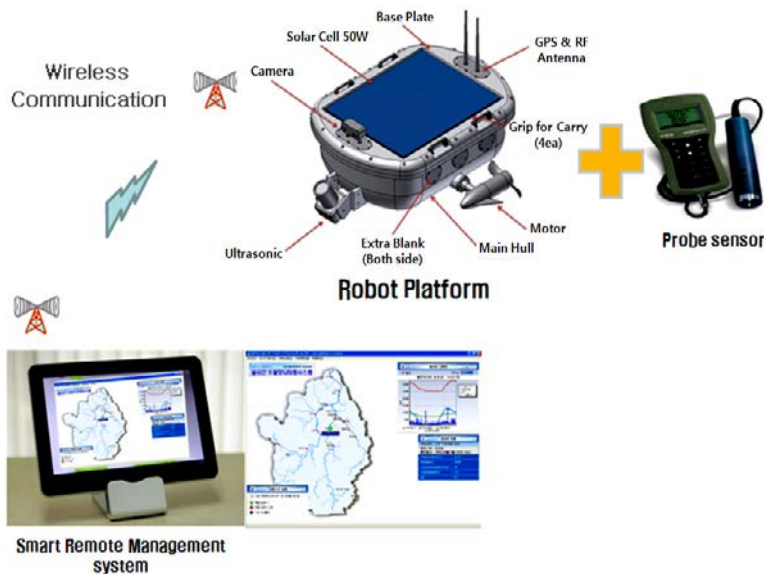

Figure 3. Overview of the Unmanned Sensor Robot System

6.2. U-Riverfront Service Model

Figure 4 represents a U-Riverfront service model available at waterfront space. As it has photovoltaic power-based Eco-Media Pole System, unmanned automatic bicycle system, ecofriendly music bench, and intelligent water level monitoring and alarming system as well as unmanned robot sensor system, the U-Riverfront service is available. This suggests that users are able to receive information as freely as possible while moving at the waterfront space and swiftly respond to the emergent situations with entertainment as well.

Figure 4. Examples of U-Riverfront Service

7. U-Riverfront Management Area at Each Stage

As part of efforts to carry out the recent urban restoration projects and transform the urban rivers flowing into the center of the city into water-friendly spaces for the revitalization of the old towns, Daegu has been devising its Basic Landscape Project, Sincheon and Gumho Rivers Special Landscape Plan, and Historical and Cultural Landscape Management Plan and seeking out how to manage them. In particular, the city is establishing the building height and elevation blockage ratio standards(September 28, 2007) around the Sincheon Riverside, a central river flowing through the city and seeking out ways to manage the height, blockage ratio, and open space ensuring outlook or space view at an height of 200m around the boundary of Sincheon Riverside.

We aim to reflect these basic plans and establishment stages, seek out systematic management plans for more spatial scopes, and suggest management plans for public and private cooperation and joint development. First of all, the 1st scoping stage includes seeking out ways to identify facilities status and manage them around the Sincheon Riverside Space and the 2nd scoring stage includes accommodating the boundary of 200m from the Sincheon Riverside area and the boundary of 500m from the Gumho Riverside area and establishing management plans. Finally, the 3rd scoping stage comprises urban restoration projects currently under way or under conception and redevelopment and reconstruction, urban improvement project, and residential improvement projects by the city and the other private enterprises. Besides, the main purpose of this study is to present measures to connect widespread and comprehensive but consistent waterfront spaces including all plans that can

be associated with the Sincheon waterfront spaces including landscape management plan promoted by the city and historical and cultural landscape management plan.

7.1. 1st Area-Major Management Facilities and User Facilities in Sincheon Riverside Area

As in Table 6., the 1st management areas around the Sincheon and Gumho Rivers cover major bridges and facilities installed within the riverside area. Figure 5 represents the future M2M technology that can be used to monitor bridges, water spaces, and riverside facilities which are various facilities for u-Riverfront and provide various information and amenities.

Table 6. 1st Management Area of Sincheon and Gumho Rivers

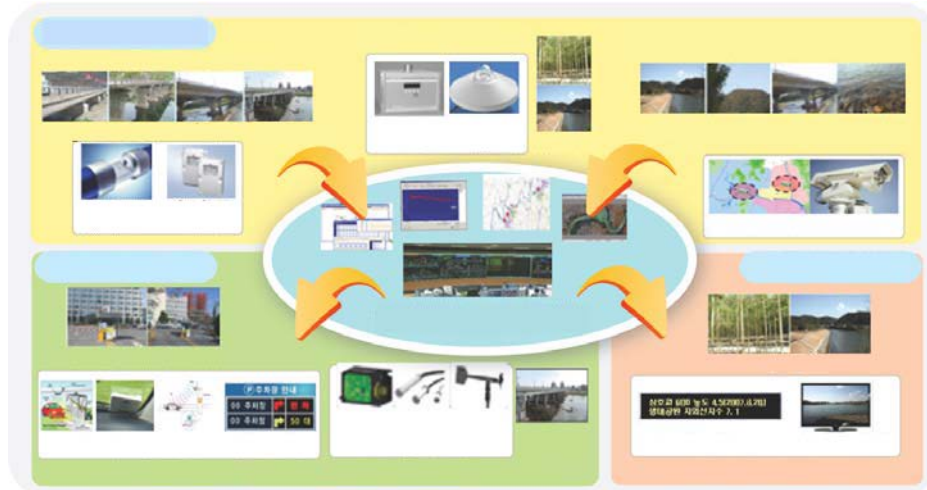| Facility	Location	Size
Sincheon and Gumho Rivers	Sangdong Bridge ~ Chimsan Bridge	9.1Km
	Hwanrang Bridge ~ Gumho Bridge	20Km
Gumho River, Sincheon Fountain, and Lavabo	Gumho River, Sincheon	Fountain : 8 places at SincheonLavabo : 14 places at Sincheon, 3 places at Gumho River

Figure 5. 1st Management Area of Gumho and Sincheon Rivers(example)

7.2. 2nd Area – Management Area for Sincheon Landscape Management Plan[10] [11]

As shown in Figure 6 and Figure 7, the 2nd areas cover the areas that are included in the scope of the area with reference to the zone applicable to the Sincheon Landscape Management Project Zone. In particular, the 2nd area should take into account of adjacent areas and surrounding areas of Sincheon River and thus require the detailed management plans considering skyline, blockage ratio, open space ensuring outlook or view, association with major roadside, and landscape. Therefore, as the 2nd scope of area, we need to establish Sincheon Riverside District Planning and Redevelopment Promotion Area and set up the management guidelines based on the detailed items to be considered.
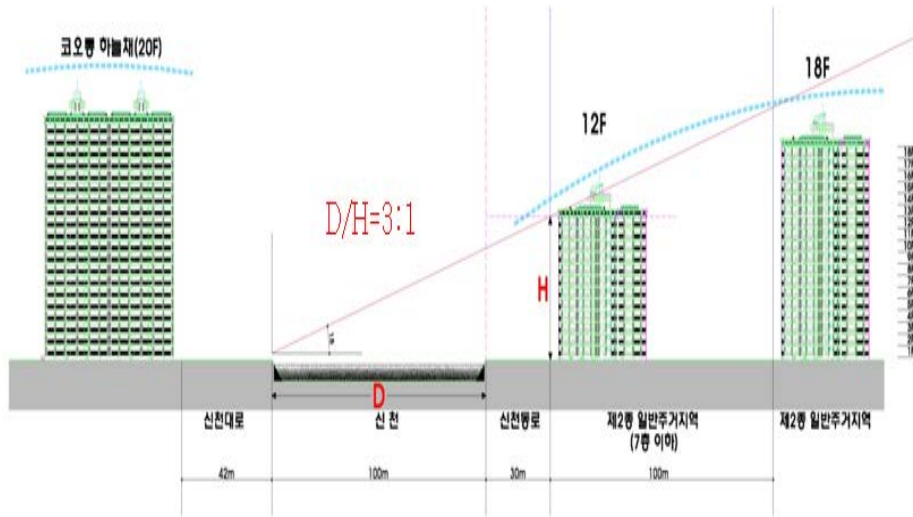
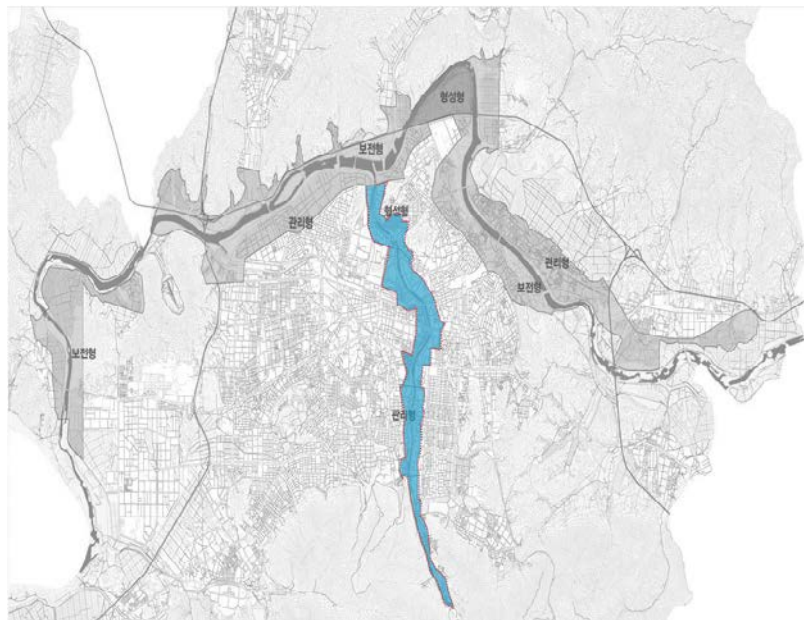**Figure 6. Formation of Buildings around the Sincheon River with Maertens's Law(example)**

Figure 7. Management Map for Special Sincheon Landscape Plan

7.3. 3rd Area-Adjacent City-related Development Project Area

As in Figure 8, the 3rd area needs to be planned in consideration of its association with its adjacent regions within the scope of the Management Map for Sincheon Landscape Management Project in carrying out urban development project or urban refurbishing project. This enables the city's association with its unique remodelling business and urban development project and urban refurbishing project and the expansion into the area of widespread management considering its association with other projects for natural urban restoration.
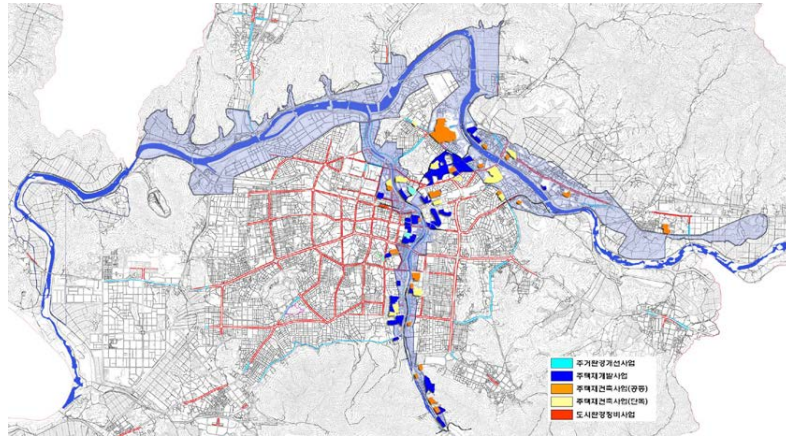
Figure 8. Urban Riverfront System in Shincheon Based on M2M(example)

8. Conclusions and Future Directions

8.1. Conclusion

The M2M-based Sincheon Waterfront Area aims to manage the spatial scope of 'u-Riverfront' and seek out ways to find out the current status of the facilities and manage them centering on the Sincheon River as the first scoping stage and establish the measures to manage the boundary of 200m from the Sincheon River and the boundary of 500m from the Gumho River as the 2nd scoping stage which are being established by Daegu. Finally, the 3rd scopring stage includes urban restoration projects or redevelopment and reconstruction currently under way or under conception, urban rehabilitation project, and residential improvement project by the city or the other private enterprises. Furthermore, we need to develop an integrative U-City associated with widespread and comprehensive but consistent waterfront space including all plans that can be associated with the Sincheon Riverside Area including landscape management plan currently being carried out by the city and specially-devised historical and cultural landscape management plan.

8.2. Limitations and Research Directions

As this study focuses on the methods of managing the spatial scope centering on Sincheon River by stage, it includes the limited information like presenting major directions or so. Later, based on this study, the cooperation methods with many urban restoration projects associated with the Sincheon River are expected to be studied in detail depending on section, or region, or block and include the verification process of objective data for the activation of riverside area by conducting a survey with the proposed unmanned sensor robot system and the other M2M technologies.

Besides, the future researches should include the consistency of city policies and plans, revenue generation model in the urban restoration process associated with the riverside areas by private developers, and improvement in the resettlement ratio by original settlers as well as the review of the relevant regulations or systems.

Acknowledgements

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