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Deriving Topics for Safety of Folk Villages Following Scope and Content of ICT-Based DPD

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ABSTRACT

This paper presents a novel concept of Disaster Prevention Design (DPD) and its derived subjects and topics for the safety of folk villages in both Korea and Japan. Nowadays, design concepts are focused on 'human-oriented nature' as a whole and this tendency fits to be appropriate for disaster prevention against real dangers of a future society, which is expected to have far more complicated features. On the other hand, convergences have performed with other areas in the field of Information Communication Technology (ICT) so that we can easily find examples like 'the strategy of ICT-based convergence' of the Korean Government in 2014. Modern content designs including UI (user interface) and USN (ubiquitous sensor network) have been developed as one of the representative areas of ICT & UD (universal design) convergences. These days this novel concept of convergence is overcoming the existing limitations of the conventional design concept focused on product and/or service. First of all, from that point our deduced topic or subject would naturally be a monitoring system design of constructional structures in folk villages for safety. We offer an integrated model of maintenance and a management-monitoring scheme. Another important point of view in the research is a safety sign or sign system installed in folk villages or traditional towns and their standardization. We would draw up and submit a plan that aims to upgrade signs and sign systems applied to folk villages in Korea and Japan. According to our investigations, floods in Korea and earthquakes in Japan are the most harmful disasters of folk villages. Therefore, focusing on floods in the area of traditional towns in Korea would be natural. We present a water-level expectation model using deep learning simulation. We also apply this method to the area of 'Andong Hahoe' village which has been registered with the World Cultural Heritage of UNESCO. Folk village sites include 'Asan Oeam', 'Andong Hahoe' and 'Chonju Hanok' villages in Korea and 'Beppu Onsen' village in Japan. Traditional Streets and Markets and Safe Schools and Parks are also chosen as nearby test-beds for DPD based on ICT. Our final goal of the research is to propose and realize an integrated disaster prevention and/or safety system based on big data for both Korea and Japan.

Key words: *DPD(disaster prevention design), UI(user interface), USN(ubiquitous sensor network), UD(universal design), Folk Village, Monitoring System, Flood, Sign System.*

1. INTRODUCTION

1.1 Modern Environment Changes

According to variance of modern environments including increment of natural disasters, exhaustion of resources, and acceleration of technology development, there have been a lot of changes in consumers' requests. It can be recognized as a sort of social syndrome that there happen to be appearance of consumers preparing their survivals among these dangerous society throughout their brain rests, meditations, and/or healings etc. In recent, we experience a new style of 'urban survivalist' in our modern society who pursues their safety, emotional stability, and psychological healing [1]. Area of personal disaster management as they expect to possess would be far wider and wider because of these environmental problems. Although the reports consider 'urban survivalist' as a special group of people in modern society, it should be so common that they are willing to prepare against expected crises in this dangerous environment. As we are all feeling of this world, there have been a lot of environmental changes, and we can expect much more serious changes in the near future.

On the other hand, entering 21st century, convergences between various industrial areas starts generating new demands in new industrial areas so that a kind of total change can be possible in our modern design. We need a totally novel concept of design which can reduce the usage of natural resources and energy in order to fitting our modern environment.

From these considerations, we figure out the main factor of danger for the future society are as follows; rapid aging society, severe income differences, increment of safety problem for social weak-party, big urbanization and its resulting into huge disasters, increment of natural disasters caused by extreme climate changes, terrorism, and variations of international situation. Disaster Prevention Design(DPD) based on ICT can be submitted as a possible solution to reduce the danger of future society. It is a kind of modern concept of

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design getting along with the trend from visual- or product-oriented feature to human-oriented nature. It can also be called 'Design for All' to be 'Barrier-Free Design' or UD(universal design). Converging with summit ICT technologies, we can add the characteristics of 'Convenience/Easiness' and 'Safety/Security' for the people in week-party like aged, handicapped, child, and/or pregnant woman. In view of human-friendly design concepts, ICT-based universal design makes sure of functional, convenient, and safe features of design results at the same time.

1.2 National Strategy of Korea Government: ICT-Based Convergence and Design Thinking

Korea Government has been promoting 'Creative Economy' focused on 'the strategy of ICT-based Convergence' since 2013 the beginning of this new Cabinet. President Park said as follows in her national strategic speech; "Converging industry with other industries, or industry with other cultures based on ICT, we can generate a novel industry and job-positions that can be so called 'Creative Economy'". Also Ministry of Science ICT and Future Planning announced 'the Act of ICT Promotion' which comes into effect on and after Feb. 2014. The total plan of it is called "ICT WAVE Strategy" including 5 Areas, 10 Core Technologies, and 15 Future Services as shown in Fig.1. [2].

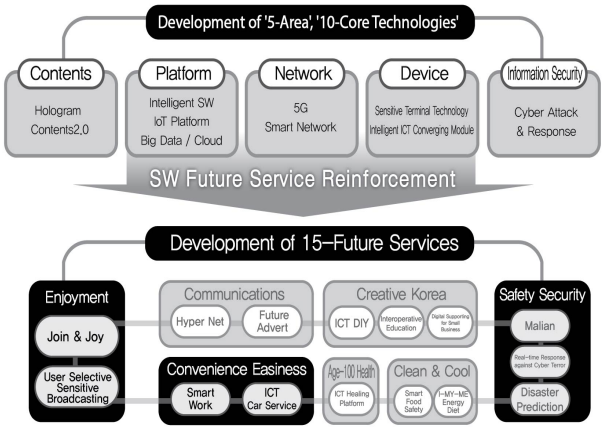

Fig.1. Korea Government ICT WAVE Strategy : 5 Areas, 10 Core Technologies, and 15 Future Services

The main topic of this paper 'ICT-based DPD' which is also the same as our bilateral cooperative project between Korea and Japan [3], [4], is directly related to the 'Safety/Security' services theme of ICT WAVE Strategy. In addition, services of 'Enjoyment' and 'Convenience/Easiness' in the 15-Future Services are also closely connected with our topics.

On the other hand, Ministry of Trade Industry and Energy also announce 'the Strategy of Design Industry Convergence' which promotes design convergence with other industrial areas to create new industrial environments. Design Thinking in all kinds of ICT industries and convergence of software technologies can generate a new market, as a final result we can promote 'Creative Economy' as shown in Fig. 2. [5].

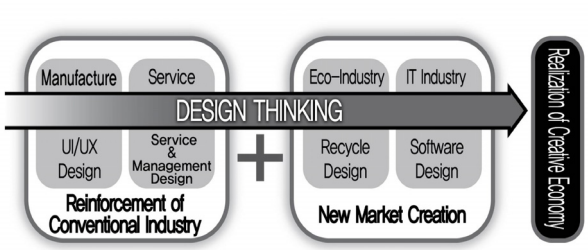

Fig. 2. Concept of Design Thinking : Design Convergence with Other Industrial Areas Realizing 'Creative Economy'

Basic concepts of 'Design Industry Convergence Strategy' will be recognized as action plans in order to achieve the goal 'Creative Economy'. In other words, modern concept of design is a new conductor who promotes this innovation. Real actions to realize this creative economy are just convergences between industries with various design areas. This strategy definitely has something to do with the topic of 'ICT-based DPD' of this paper. They explain mega trend of design has been changed from 'industrial design', 'functional design', 'commercial design', 'specialized design', 'competition power of company', to 'new innovation leader'. So nowadays, 'Design Thinking' is recognized as an active party leading a lot of convergences with any other parts of industries. This tendency is another background of our bilateral project and closely related to the basic concept of this paper. Design thinking with ICT and SW technology promotes new markets and generates a lot of new job-positions. ICT-based DPD is a kind of convergence of design activity with ICT technology so that we can realize 'Creative Economy' the goal of the strategy.

1.3 Deriving DPD Subjects and Topics

Depending on the basic concept of ICT-based DPD mentioned above, we derive several specific subjects or topics to generate safety and security of residents in traditional towns with local heritage. A bilateral cooperative research project between Korea and Japan has been figuring out ICT-based modern design of disaster prevention for persons in need of aids in some traditional towns since our pioneering paper [1] was published. We have been investigating actual spots and deriving applications for the following test-bed sites;

- Andong 'Haheo' village in Korea (AHK)
- Asan 'Oeam' village in Korea (AOK)
- Chonju 'Hanok' village in Korea (CHK)
- Beppu 'Onsen' village in Japan (BOJ)

In addition, we focus on the following sites as appropriate near-by test-bed for the themes of safety/security using ICT-based DPD in our local area;

- Traditional Streets and Markets
- Safe Schools and Parks

Convergence of ICT with universal design concept must be more effective in disaster prevention methodologies because we can obtain 'Convenience / Easiness' gains, 'Safety / Security' capabilities, and 'Feedback in the Closed Loop Control' from verified technologies shown in ICT WAVE Strategy of Fig.1. We have been deriving the following subjects or topics which can be naturally applied on the test-bed sites mentioned above;

- Design of maintenance and management monitoring system for safety of structures in traditional towns
- Safety signs and sign system standard in traditional towns in Korea and Japan
- Development of scientific model for expectation of water level in the area of traditional towns
- Integrated disaster prevention and safety system for traditional towns in Korea and Japan.

The rest of this paper is organized as follows; In Section 2, we present safety/security themes of ICT-based DPD concepts and their related works applied to traditional towns in Korea and Japan. We utilize some of the basic concepts of DPD from [1] to build up a connection with safety themes for traditional towns. In Section 3, we figure out design procedures and their results from each subjects of applications of DPD described above. Monitoring system for safety of structures, signs or sign systems, and water level expectation method can be explained like separated independent topics. But we can combine this branch of researches into an integrated disaster prevention and safety system as a final goal of this study. Finally in Section 4, we summarize the results of this study and submit some topics of future works.

2. SAFETY THEMES ON RELATED WORKS

In this section, we briefly explain the concept of DPD based on ICT presented in [1] to build up a connection with safety themes of our test-bed sites such as traditional towns, streets or markets, and schools or parks etc.

2.1 ICT-Based DPD and Its Applications

DPD(Disaster Prevention Design) is a newly defined concept to make a switch over to safety/security themes of applications of the ICT-WAVE strategy shown in Fig. 1 [2]. Therefore, DPD is defined as design activities that protect life and property of human beings, minimize damages, and make the recovering process rapid and easy against any kind of disaster. Fig.3 shows the basic concept of DPD which refers to recalled figure of our original paper [1].

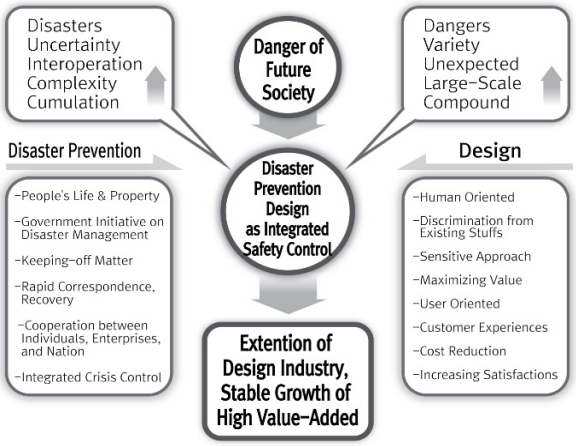

Fig. 3. DPD Activities as an Integrated Safety Management (a revised figure from [1])

We can easily expect that danger of future society will be dramatically increased because natural or artificial disasters are far more uncertain, complex, and interoperated cumulative in the future urban society. Dangers of variety are also unexpected, large-scale, and compound. We combine disaster prevention with design concept to build up a new field of DPD as an integrated safety control. And we also expect this convergence makes the conventional design industry far more extended to achieve stable growth of high value-added industry in the near future. So any kind of effort to minimize the damage of human or their properties from any sort of disaster can be called DPD activity as well as prevention their expansion to other areas.

In 'ICT-based DPD', design concept and its specialists deeply take part in the process of fabricating products or services from the beginning of the project because of their characteristics such as human-orientation, discrimination, cost reduction, and satisfaction etc. as shown in Fig. 3. But we can suffer from the lack of automation concept when we try to build some kind of DPD products without helps of ICT. Any of automation or feed-back control applied to DPD products and services can be included using ICT technologies such as USN, neural network, and/or big-data control etc. Moreover, ICT-based convergence is the core feature of ICT-WAVE strategy depicted in Fig. 1. We also achieve convenience/easiness themes as well as safety/security themes by converging ICT with DPD.

As shown in Fig. 4, recent mega-trend of design area is moving largely from appearance or product oriented characteristics to human oriented feature. On the other hand, mega-trend of ICT area can be called 'Convergence' with other area to generate novel industries.

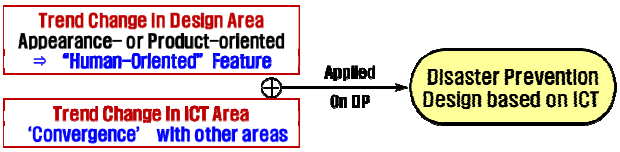

Fig. 4. Convergence Concept of ICT-based DPD

We combine design part with ICT part to be applied on disaster prevention to generate our ICT-based DPD concept and its related industries. It should be expected that this converging advantages realize convenience/easiness features included in ICT WAVE strategy with the original safety/security themes at the same time. In addition we can overcome the limitations of design contributions in products or services of applications using automation or feedback technologies like USN, UI, and big-data control etc.

Applications of ICT-based DPD are naturally opened according to its principal subjects, classifications, and scopes. Referring to the levels of DPD applications and their activities, we can classify it into private, enterprise, and national DPD [1]. However ICT-based DPD concept and its applications can be apparently revealed by its scope and content when we approach to realistic activities in detail of application areas. We depict Fig. 5 as a revised edition of scope and content of ICT-based DPD and their activities.

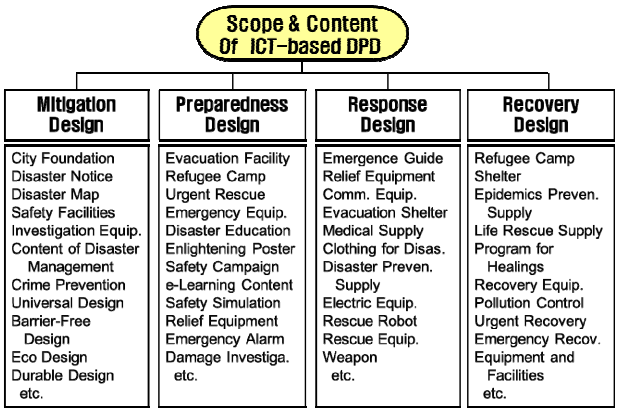

Fig. 5. Scope and Content of ICT-based DPD

We can realize a very wide area of activities for disaster prevention with the convergence of ICT and design. With the bilateral project team as the central figure, we have found some application sites like traditional towns including cultural heritages in Korea and Japan, and then derived four different topics from each category of DPD scope shown in Fig. 5. Therefore each research topic corresponds to each category in a one-to-one matching manner classified like Fig. 5. We have investigated 3 traditional towns in Korea and one in Japan, and expanded the concept to traditional streets in city area, traditional markets in Korea, schools, and parks as mentioned in section 1.3. Using these sites for our test-beds, we actually deduce and research 4 different topics obtained from the convergence of ICT with design concepts.

2.2 Investigations of Traditional Towns with Cultural Heritages as Test-bed Sites

As mentioned in previous sections, we have established a bilateral project on DPD based on ICT applied on Korea-Japan provincial traditional towns with cultural heritages. In this section, we present the results of our field investigations of their characteristics and differences between both countries. In addition, we submit a model of DPD based on ICT for supporting social weak party who is living in these towns. Arranging the concept of DPD based on ICT, we present modeling of information path for social weak party or public personnel helping the residents.

We choose Andong 'Hahoe' (AHK), Asan 'Oeam' (AOK), and Chonju 'Hanok' (CHK) villages as our test-bed sites in Korea. For Japan side, we select Beppu 'Onsen' (BOJ) village which includes a lot of similarities with Korean traditional towns. They all contain valuable cultural heritages, residents who are living in the towns and very narrow asset streets and alleys.


Fig. 6. A Bird's Eye View of a Traditional Town and Pictures Showing Identifying Features of AHK, AOK, and CHK

2.2.1 Kyungbuk Andong 'Hahoe' Village (AHK)

AHK is one of representative folk villages maintaining a lot of Confucianism Cultures in Korea. It is a very ancient-like traditional town where only people with the same last name "Ryu" are actually living in. We call it "SSiJok-Maeul" of 'PoongSan Ryu the last name'. The word 'Haheo(河回)' means 'River Turns' ie, because the 'NakDong River' flows around the 'Hahoe-Maul' like the shape of English letter 'S'.

AHK was established about 600 years ago. The Eastern part of AHK consists of the tails of 'TaeBaek' mountain range. One of them is 'WhaSan' mountain which runs along the central trail of the village, and there are a lot of old trees like 600 years old. In July 2010, AHK was finally registered as 'World Cultural Heritage' of UNESCO (34th Committee in Brazila, Brazil). AHK is well harmonized with traditional houses and traditional schools named 'SeoWon(書院)', additionally distribution of the town space is appealing the culture and social structure of "JoSun(朝鮮)" Dynasty [6]. According to the historic registrations of AHK, Andong provincial area has been very safe from natural disasters such as earthquake, flood, and/or typhoon etc. They say AHK has been relatively safe from fire disaster because there were scarcely big fires in this area for a long time and the positive effect of 'river turns'.

However, there are a lot of structures like 'Kiwa'(black tile roof) and 'Choga'(rice straw roof) houses, wooden sticks inside the roof, and other fragile facilities in AHK and its surroundings. Like other folk villages in Korea, AHK is also weak for fire and other disasters. If fire occurs in these structures, we can easily expect lots of difficulties in fire-fighting processes. Furthermore, narrow alleys between houses in the town can make another hindrance in the case of fire trucks working, and also make difficulties for the evacuation of residents [7]. We expect our concept of ICT-based DPD can be applied on these situations as an integrated monitoring scheme with USN sensing networks. Although more than 50 fire detectors are scattered over the village and a fire station is located in 1km distance from the center of the town, danger of fire disaster and its damage still commonly exist because there is no fire-fighting facilities for an initial stage of fire and to top it off major part of residents consists of elderly who cannot easily evacuate from that case of disaster [8].

2.2.2 Chungnam Asan 'Oeam' Village (AOK)

AOK is one of Korean famous folk village formed about 500 years ago. The first picture of Fig. 6 shows a bird's eye view of AOK from a civil aviation. Various types of traditional houses are preserved in good state. There are totally 78 old style houses with roofing 30 'Choga', 20 'Kiwa', and 28 others.

In general, 'Choga' is rather weaker for fire because of its roof made by rice straw than 'Kiwa' of which roof is made by black roofing tile. But most of the houses in AOK are timber structure so that they can be seriously vulnerable when there happen a big fire or fire caused by earthquake or other natural disasters. One of the characteristics of AOK is that most houses have their own names that imply the position or hometown of their owners. For example, "Champan-Daek" follows owner's position, and "YoungAm-Daek" implies that the owner is from YoungAm. Most of the houses are 100~200 years old [9].

They use the water of stream from valley of Mountain 'Sulhwa' as gardening or fire-fighting water. There are a lot of folk materials like 'JangSeung', 'BangA', and 'Rice Straw Roof' etc. in the village. These are actually fragile and weak for fire because most of them are made by woods. Moreover, evacuation routes or fire-fighting paths are not arranged properly so that our concept of DPD based on ICT might be helpful application. The surroundings of AOK are also famous that many dramas were located and then a lot of tourists are coming to see them these days.

There are 274 sorts of digestion facilities including hydrants and extinguishers installed over all area of AOK. Although lots of fire detectors are scattered over the village, danger of fire disaster and its damage still commonly exist because there is no fire-fighting facilities for an initial stage of fire and major part of residents consists of elderly who cannot easily evacuate from that case of disaster just like AHK of the previous subsection. Very narrow alleys between old houses add dangers and possible damages on fire disaster.

2.2.3 ChonBuk Chonju 'Hanok' Village (CHK)

'Hanok' means Korean traditional style of house which has its roof with black roofing tile 'Kiwa' and most of its structure with timber and muddy walls. There are 800 or more 'Hanok' houses in CHK. In other words, 'Hanok' houses in CHK are collected around the center of a big city 'Chonju'. CHK has been established since 100 years ago, so these are relatively recent style of 'Kiwa' ie, an urban style of 'Hanok'. Going to CHK, we can experience not only the beautiful shape of 'Hanok' traditional houses but also traditional foods and activities. The provincial area of 'Chonju' is very famous because of amazing foods and elegances.

Generally speaking, 'Hanok' is cool in summer season and warm in winter season. In addition, they generally establish 'Ondol' as the floor of the house. Although CHK is rather arranged well as a new urban town because of its new generation, we can say that it is also very weak for fire and other disaster because 'Hanok' mainly consists of timber structures. Pavement streets and back alleys are relatively clean and well maintained compared to other traditional folk villages mentioned in previous subsections. We can especially indicate that CHK is formed at the center of a big city Chonju. But residents did not have any disaster prevention education or learning from cyber facilities, so our DPD based on ICT concept will be applicable to improve public notifications [10].

CHK is geographically located in Kyo-dong and Pungnam-dong, Wansan-gu, Chonju City. Although its history started from the beginning of Chosun Dynasty King 'Taejo', present shapes are originated from 1930s. Despite of its total area of 0.25km^2, 700 or more houses have been constructed in various styles along the very narrow alleys. And to top it off, about 5 million tourists are visiting CHK per year so that there can be serious congestions of people and traffic jams every weekend these days. According to our detailed investigation, most of Hanoks just a little old do not have inside sprinklers and major part of fire-fighting instruments are just powder extinguishers. Although there are a few fire stations near the village in Chonju City, it will be impossible for the fire-trucks to approach to the actual spot of fire disaster because of its narrow alleys and congestion of other cars parked along the street.

2.2.4 Beppu 'Onsen' Village in Japan (BOJ)

Beppu(別府) is very famous tourism city having a lot of hot springs located in Oita Prefecture, Japan. We can find lots of close similarities of BOJ comparing with folk villages of Korea mentioned in the previous subsections. On the other hand, BOJ has totally different environmental conditions from any other tourism cities in Korea.

Beppu possesses a lot of tourism resources including hot springs and other natural environments. There are mainly old houses constructed with timber structure along the narrow alleys. Residents of major part consist of weak party of society such as old-aged, handicapped, and children etc. BOJ still has a lot of active volcanos nearby and that's why it can be a great 'onsen' village and one of the most famous tourism cities at the same time. It especially suffers from possible natural disasters such as earthquake, tsunami, volcano and flood and so on [11]. Therefore, our safety/security themes of ICT-based DPD concept will be naturally applicable for BOJ.

Fig. 7. Signs for Precaution showing Altitude above the Sea Level in Beppu City

One of the most singular sign boards we can easily find over all in Beppu City is the sign showing the lowest altitude above the sea level of corresponding spot as show in Fig.7. Totally like all around the city, it has very low altitudes from the sea level so that we can easily expect serious damages from possible earthquake and/or tsunami. Documents of registration, prevention plans, and social regulations for these natural disasters are well arranged and furnished. So we can approach in a view of 'sign system standardization' for folk villages or tourism villages both in Korea and Japan.

2.2.5 Street, Old Market, Safe School and Park

As another extended applications of our ICT-based DPD concept, we have been focused on streets of provincial cities, traditional old markets, and elementary schools and parks as shown in Fig. 8. According to our investigations, there are a lot of safety/security problems in these sites so that we can easily

extend and apply the concept of DPD and need some sensing and feedback control using ICT-based UD(universal design) approach. We expect that convergence of information and communication technology with universal design can generates some smart results like USN+UD smart traditional market, ICT+UD safe school and park.

Fig. 8. Applications of Street, Old Market, School and Park

For traditional markets and schools, we need prevention plans against artificial disasters like fire, violence and/or explosion rather than natural disasters. Safe streets and parks are also possible when an integrated platform built with ICT-based UD or DPD concept. We consider an integrated monitoring system for safety of these test-bed sites. The main features of the platform are 1)Fire Watching, 2)Urgent Rescue, 3)Maintenance and Management of Structures, 4)Urgent Communication, 5)Safety Control Based on Position, and 6)Safety Monitoring in Construction Sites.

3. DERIVING TOPICS REFERRING THE SCOPE OF ICT-BASED DPD

We can extract various research topics or subjects from the scope of ICT-based DPD shown in Fig. 5 because there is abundant area of items in each category of its content. Some topics are already developed and applied for some real sites, and the other subjects are not considered to be realized. In this section, we derive 4 different topics from the concept of ICT-based DPD which corresponds to each category of the scope with one-to-one manner. Although each topic has its independent goal and independent research team, they will be combined to be contributed for safety/security themes of test-bed sites mentioned above which can be considered as a purpose of ICT-based DPD. In addition, some of these results are just temporary because they have been studying since our bilateral project was started both in Korea and Japan.

3.1 Design of Monitoring System for Safety of Structures in Traditional Towns

The category that this monitoring system occupies in ICT-based DPD scope is ‘Response Design’ which includes communicate equipment, rescue equipment, and relief equipment as shown in Fig. 9. It is relatively apparent to indicate this category for this topic even though other opinion of ‘preparedness design’ including urgent rescue is also possible. We recognize that our monitoring system mainly consists of ICT-based sensor networks responding to any extraordinary symptoms in a common situation rather than emergency so that we can classify it into ‘Response Design’.

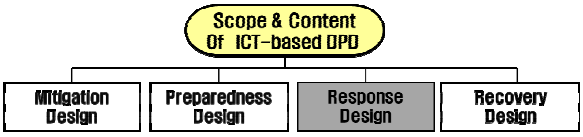

Fig. 9. Category Indication of the Monitoring System of this Topic in ICT-based DPD Scope

3.1.1 Design of the Monitoring System

One of the most intuitive applications for safety control of constructional structures in traditional towns with cultural heritages is monitoring system using USN, SaaS, and mobile cloud. This monitoring system is originally designed for structural measuring and management of bridges, tunnels, and/or buildings in cities. Fig. 10 shows the design of an integrated monitoring system including 3 parts of manager [12].

Sensors like elasticity, fluctuation, luminance, and accelerometer are installed on critical points of objective structures and connected through USN. They are detecting mal-function data and transferring them to the managers of the monitoring system. We operate virtualization schemes of the Field Manager and Data Collecting and Analyzing Manager to watch any problems from mal-functions even if the monitoring system is physically far apart from the sensors. Sensors like heat, smoke, gas, and temperature can be possibly applied to our traditional town structures for fire alarm and fire-fighting feedback control schemes. We can easily collect these monitoring data from sites at the Central Manager, which makes it possible to respond to these real-time occurring and to improve our effectiveness of operations.

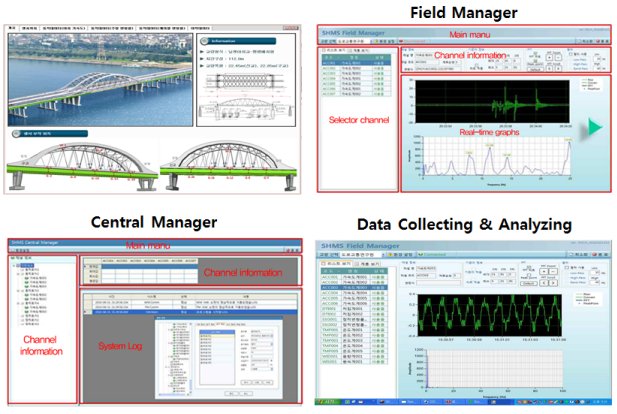

Fig. 10 Program Elements of the Monitoring System (Managers)

We can overcome maintenance problems occurred in C/S or ASP type structure importing mobile cloud or level-3 SaaS mechanism on our software developing procedure. This strategy also provides users and field engineers better services that emphasize Web service search, accessibility, usability,

content creation, interoperability and a personalized service. We additionally offer various mash-up services using open API, user authentication, and access privilege management, which must be provided using the homepage login linking.

3.1.2 Applications for Safety of Traditional Towns

We focus on Andong 'Hahoe' Village (AHK) and Asan 'Oeam' Village (AOK) for finding possible applications of our monitoring system described above. AHK and AOK are not only two representative folk villages in Korea but they have a lot of old structures to be monitored using the system, of which consist bridges, houses, and other structural facilities.

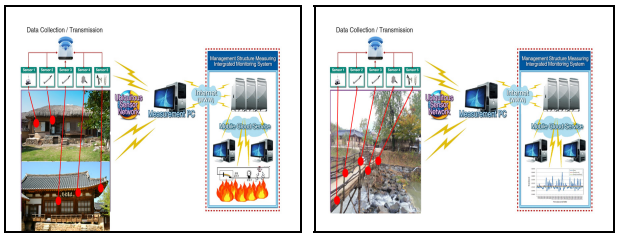

Fig. 11 Applications of the Monitoring System for AHK and AOK

According to our investigations briefly described in subsection 2.2, there are about 125 old traditional houses in which residents are actually living in AHK. Most of these houses are mainly constructed using timber structure and very narrow alleys between houses hinder them from fire-fighting activities. Maybe it seems to be almost the same situation for all folk villages in Korea. As a result, we can easily recognize they have some serious weak points against fire disasters. Once a big fire occurs, it must be difficult to extinguish because of their structural properties as well as their close positions with each other. Although there has been very small possibility of natural disasters in the area of AHK, we expect serious damages from fire and/or artificial disasters to threat its safe conservation.

The first part of Fig. 11 shows an application of the monitoring system designed in the previous subsection to detect symptoms of fire disasters in the structures of 'Choga' and/or 'Kiwa' houses. Sensors of flame, heat, smoke, gas, and temperature connected with monitoring system through USN can be installed to make the structures safer by operating fire alarm and/or fire-fighting loop control scheme.

Another situation of AOK is that there are a lot of objective structures to be monitored by the system. Inheritances like old bridges, 'BangA', 'JangSeung', and other traditional folk antiquities are preserved with 74 old style houses. They are apparently disclosed to the possibilities of crack, collapse, or even vanishing occurrences. They do not have any modern countermeasure against natural or artificial disasters.

We propose the monitoring system designed in the previous subsection can be applied to preserve these folk facilities as a good counterplan against any kind of disaster. Measuring, maintenance, and management of constructional structures include cleaning, safety diagnosis, repairing, reinforcement, and restructuring etc. can be achieved. The second part of Fig. 11 shows an example of application that the monitoring system is established at the critical spots of a timber bridge located in AOK. Sensors like elasticity, fluctuation, luminance, and accelerometer are installed and connected throughout the USN so that we can collect various sensing data and transmit them to both static and dynamic measuring tools. We can automatically detect mal-functions of the bridge beforehand. Any possible variation of the bridge such as damage, crack, and/or moving can be detected by processing the accumulated data by the algorithm of component extraction.

3.1.3 Expectations of Future Work

Although we have already fulfilled TTA authentication test for the platform of our monitoring system, which includes SaaS maturity, performance, and its application program functions. But we are not sure this authentication should prove our applications for structures of traditional folk villages in Korea and Japan. Web accommodation test for the application and operational test using real measuring data obtained from the actual sensor installed on actual sites. Thus, we should prove our system can perform good monitoring functions of maintenance, management, and measuring for constructional structures of actual traditional folk villages.

In the near future, we expect a continuous research topic to prevent traditional structures from any kind of disaster using the monitoring system mentioned above. Some applications to traditional market, school, and park can be realized after some trivial modification of the monitoring system. And additionally we expect advanced applications associated with big data solution.

3.2 Sings and Sign System Standard in Traditional Towns in Korea and Japan

Safety signs and their system can be classified as 'Mitigation Design' category in the scope of ICT-based DPD including city foundation, disaster notice, and UD concept as shown in Fig. 12. Barrier-free designs included in UD concept are also frequently referred.

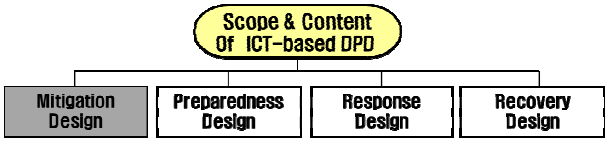

Fig. 12. Category Indication of Signs and Sign System Standard in ICT-based DPD Scope

3.2.1 Signs and Sign System of Folk Village

A sign is a kind of mark delivering specific meanings, which includes signatures, indications, symbols, and/or signals. It describes what the content wanted be delivered by symbols or indicates methods of activities. In other words, we can see it like a meaningful symbol as an element of communication or an instrument of information delivery helping users understand environments.

Sign system is a standard feature of making signs in a given area or situation. It gives regulations to signs and their environment so that users can easily understand them. Sign system should be designed referring functional side of

information delivery as well as esthetical side of harmonizing beauty with surroundings. After investigations of signs and sign system of folk villages in Korea and Japan, we decide that there is an essential need to build standards of signs installed in folk villages in Korea and Japan. Also sign system planning is to study, investigate, and install these signs as designed to reach the purpose of the system.

3.2.2 DPD Applications in Terms of Sign System in AOK and BOJ

We need to transfer our design concepts into DPD when we apply our theory of sign system to actual signs installed in traditional towns with local heritages, because common principles of DPD like installation, structure, and necessary conditions are properly coincided with sign system. Increment of natural and artificial disasters, increment of social weak party, transferring from facility-oriented to human-oriented, from recovery to precaution-oriented, and social variations of legislation strategy are deeply influencing on our DPD based sign system.

As shown in Fig. 5, 9, 12, DPD scope includes mitigation or prevention design, preparedness design, response design, and recovery design. We can confirm a lot of DPD strategies realized in the range of sign system. Precaution or mitigation design suppressing disaster occurrences by analyzing weak points of objectives and planning for education and/or public information of residents are all included in the range of DPD based sign system. When we are planning sign system strategies, we have to refer to purposes and characteristics of the specific area and need to make sophisticated priority measure on each performing so that we can achieve them more effectively.

For the purpose of an approach into sign system standard for folk villages in Korea and Japan, we investigated AOK(Asan Oeam Village) in Korea and BOJ(Beppu Onsen Village) in Japan. We submit some special characteristics of these 2 towns as shown in Table 1.

Table 1. Characteristics of AOK and BOJ

Towns	Geographical	Spatial
AOK in Korea	▪ Nominated as a folk village (in 2000) ▪ A kinship village ▪ Located under Tae-Hwa Mt. ▪ Waterway is going through the village ▪ Danger of fire disasters	▪ A tourist favorite spot of traditional folk ▪ A lot of visitors and tourists ▪ A lot of old structures ▪ An agricultural village ▪ Social weak party and elderly residents
BOJ in Japan	▪ Nominated as a tourism village ▪ Volcano near-by ▪ Located under Tsurumi Mt. ▪ Near by seashore ▪ Dangers from disasters like earthquake and/or Tsunami	▪ A tourist favorite spot of onsen ▪ A lot of visitors and tourists ▪ A lot of old structures ▪ A traditional town and city village ▪ Social weak party and elderly residents

As for Korean and Japanese cases in common, spatial structure of traditional town, in general, consists of public space and private space. Public space includes main entrance & exit, walkways, waterways, rest areas, empty lands, public toilets, and other facilities. On the other hand, private spaces are houses, gates, walls, and farm fields etc.

We need to analyze what the purpose of signs in traditional towns is. Residents are living in the town and their movements or activities are like plain lives or conversations with each other. And also activities of tourists are like from sightseeing to moving, eating, and shopping etc. Although the most part of sign systems in these towns has been developed for convenience of tourists, residents can always be main victims of disaster occurrences so that we should focus on sign system development to delete danger factors for the residents themselves.

However we try to analyze characteristics of sign systems in an integrated view to extract properties as a basis of disaster prevention design for traditional town in Korea and Japan. We have visited AOK and BOJ to get the real aspects of sign systems from Aug. 2014 to Jan. 2015. Fig. 13 shows several signs in AOK and Table 2 explains their graphical, structural elements and execution methods of the sign system in AOK.

Fig. 13. Signs in AOK in Korea

Table 2. Graphical, Structural Elements and Execution Methods of Sign System in AOK

Items		Analytical Properties
Graphical Elements	Layout	▪ Text, Figure, Pictogram, Arrow ▪ Simple and surplus space ▪ Line-up to center, or left-right
	Color	▪ Gray, White, or Yellow background ▪ Black or Red Characters and graphics
	Font Style	▪ Gothic, MyeongJo
	Pictogram	▪ Arrow, Forbidden signs
Structural Elements	Material	▪ Metal, Wood, Plastic, PVC etc.
	Shape	▪ Rounded square, Oblong etc.
	Texture	▪ Glassy, Hard, and Shiny
Execution Methods	Model	▪ Fixed or Mobile Stand-type, Attached
	Illumination	▪ Reflection from outer lights ▪ No lights
	Termination	▪ Silk printing, PVC sheet

Sign system of AOK is recently established to be well-shaped in order, but some of them are mixed with old ones.

Moreover a part of the signs might be made by residents so that it can be difficult to manage them in an integrated manner. Another problem is that most signs are installed for tourists or visitors so that residents can suffer from these improper signs.

Fig. 14 and Table 3 show several examples of sign in BOJ and their graphical, structural elements and execution methods.

Fig. 14. Signs in BOJ in Japan

Table 3. Graphical, Structural Elements and Execution Methods of Sign System in BOJ

Items		Analytical Properties
Graphical Elements	Layout	▪ Map, Text, Pictogram, Arrow ▪ Full space and Readability ▪ Line-up to center, or left-right
	Color	▪ White background ▪ Black, Red, Blue, Yellow text/graphic
	Font Style	▪ Gothic, Caligraphy
	Pictogram	▪ Arrow, Forbidden signs
Structural Elements	Material	▪ Metal, Wood, Plastic, PVC etc.
	Shape	▪ Square, Oblong etc.
	Texture	▪ Coarse, Unshaped, and Hard
Execution Methods	Model	▪ Fixed or Mobile Stand-type, Attached
	Illumination	▪ Reflection from outer lights ▪ No lights
	Termination	▪ Paint, PVC sheet

There are a lot of guidance signs like ‘altitude (height above the sea level)’, ‘evacuation shelters’, and ‘arrows’ etc. prepared for earthquakes or tsunamis in BOJ. The sign system applied to BOJ should be resident-oriented concept so that most of the signs can be used to communicate with residents themselves. Several bulletin boards installed all around the town have to be examples from the concept.

3.2.3 A Guideline of Sign System for Folk Villages

We present a design guideline of sign system for traditional towns in both countries on the basis of analyses described in previous sections. Not only does it focus on resident oriented concept, it also pursues satisfaction of visitors or tourists. We bring the concepts of ‘Mitigation Design’ and ‘Preparedness Design’ in our guideline of sign system in order to fill up with DPD advantages. Table 4 shows this design guideline of sign system following specific places in traditional towns.

Table 4. Design Guideline of Sign System for Traditional Towns

Places	Design Guideline
Main Entrance	▪ Fixed Guidance Signs - Map of the town, Explanation, Visitors’ Guidance - Signs of Toilets, Evacuation Routes etc. - Hydrants’ locations ▪ Fixed Induction Signs - Buildings, Directions, and Distances etc.
Walkways	▪ Fixed Induction Signs - Pictures and Names, Directions, and Distances - Cross Sectional guidance signs - Walking guidance lights (on the floor)
House Gates	▪ Fixed Explanation Signs - Photos, Ichnography, and their explanations ▪ Movable Regulation Signs - Keep out, Quiet, and No Smoking etc.
House Indoors	▪ Movable Explanation Signs - Types, Precaution, and Evacuation for Accidents - Coping with Disasters, Fire-fighting methods etc. ▪ Fixed Directional Signs - Fire Exits, Extinguishers, and Emergency Bells
Wall or Fence	▪ Fixed Regulation Signs - No Climbing, CCTV recording etc.
Unoccupied Ground	▪ Fixed Guidance Signs - Map of the town, Explanation, Visitors’ Guidance - Time tables, Evacuation Routes etc. - Hydrants’ locations ▪ Fixed Explanation Signs - Types, Precaution, and Evacuation for Accidents
Parking Lots	▪ Fixed Integrated Guidance Sign - Map of the town, Explanation, Visitors’ Guidance - Time table, Events’ information etc.
Fire-Safety Facilities	▪ Fixed Directional Signs - Hydrant, Emergency Bell, and Fire-fighting Equip ▪ Movable Explanation Signs - How to handle etc.

3.3 Development of Scientific Model for Expectation of Water-Level in the area of Traditional Towns

This is a simulation of water level in the area of Andong for possible prevention plan of flood disaster of the area. Therefore this modeling can be classified as ‘Preparedness Design’ category in the scope of ICT-based DPD as shown in Fig. 15. Emergency alarm, damage investigation, and preemptive protection are more emphasized rather than recovery strategy in modern DPD principles.

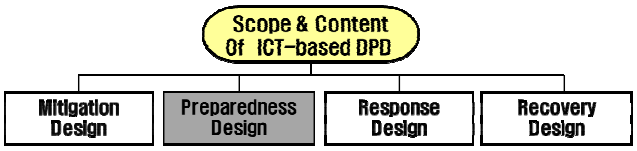

Fig. 15. Category Indication of Water Level Simulation in ICT-based DPD Scope

3.3.1 Development of Simulated Algorithm of Expectation of Water-Level in Andong Region

According to a statistical estimation, about 40% of total economic loss caused by disasters is due to flooding. Therefore this kind of work for expectation of water-level of the river in the area of traditional town would be meaningful.

We develop a hydrological model using MLP(multi-layer perceptron) to predict water-level of 'Nakdong River' near AHK with rainfalls at upper reaches of Andong [13].

'Gudam' is the location of water-level guage and 'Pungsan', 'Iljik', and 'Andong' are the 3 locations of rainfall gauges along the 'Nakdong River' near AHK. Data at each gauge are collected from March 1st to November 30th in 2012, 2013, and 2014 with the interval of one hour. We use the data in 2012 and 2013 to train MLPs for the hydrological modeling and the other to test the performance of water level prediction.

In order to verify the prediction performance of MLP after learning process, we plot the water level at 'Gudam' in 2014 for whole period and its predicted value in Fig.16. As shown in the figure, detail curves of the real and predicted ones are also meaningful. We can expect water-level of 'Nakdong River' throughout the MLP model discussed above and estimate the statistical relationship between real data and its prediction.

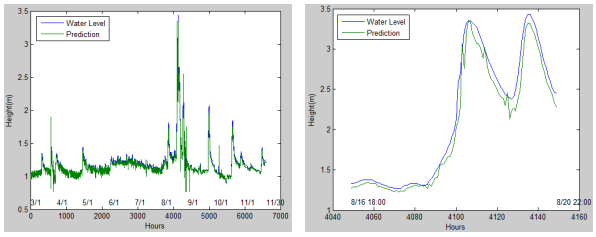

Fig. 16. An Example of Water-level Simulation Result at 'Gudam' in 2014 by MLP (from [13])

3.3.2 Expectation of Future Work

In this topic, we have developed an expectation model of water-level simulation using multi-level perceptron. And we have applied the model to AHK and 'Nakdong River' near Andong region. In recent years, MLP model reveals an excellent performance with an improvement of structure having deep architecture. Therefore we can easily expect that performance of water-level expectation will be far more advanced using this concept of deep learning.

Although we fulfill our research about AHK a world cultural heritage registered on UNESCO and its nearby region, this methodology can be easily extended to other similar regions with river and mountain neighbor.

In addition, development of model for water-level expectation is performed by machine learning and performance test simulation and the expected time-interval is basically 1 hour element. But in the near future, we advance to a multi-step prediction model for various possibilities of time-intervals.

3.4 Integrated Disaster Prevention and Safety System for Traditional Towns

This topic is one of the final goals of the bilateral research project mentioned above. Integrated system of disaster prevention and safety of traditional towns with cultural heritages based on big data concept which became one of the most active topics these days. Therefore this integrated system can be classified as 'Recovery Design' category in the scope of ICT-based DPD as shown in Fig.17. Urgent recovery, emergency recovery, and their equipment or facilities are also in this category of 'Recovery Design'.

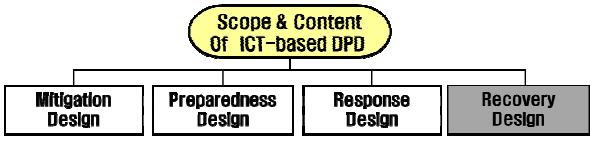

Fig. 17. Category Indication of Integrated Safety System in ICT-based DPD Scope

3.4.1 Core Entries of Integrated Disaster Prevention and Safety System for Folk Villages

The final goal of this integrated safety system for traditional towns is to analyze any dangerous element from collected information in real-time manner and then offer meaningful information for residents supporting recovery activities using big data concept and machine learning.

Various kinds of data such as formal, half-formal, and non-formal data are collected, classified and refined and then stored. These stored data can be offered as user friendly information after various processing and analyzing procedure using GPS positioning information and/or user input data throughout any smart device. Also system can offer alarm service when any dangerous entry occurs. When any disaster or safety accident occurs, system offers core status information for user and his environment and help user evacuate safely. Core entries of this big data processing and analysis are as follows;

- Data collection using multi source environment – Collecting of formal, half-formal, and non-formal data, Collecting of various type of data
- Real-time and Batch processing: Analyzing information in real-time manner from any kinds of smart device such as SNS, News, Blogs, GPS, and CCTV and so on.
- Big data analysis: Processing and analyzing various big data using multi-source environment
- Service Visualization and Alarm: Improvement of visualizing capability for direct understanding, Alarm service and evacuation guidance

3.4.2 Expectation of Future Works

In general, conventional disaster prevention or safety services cannot offer real-time data analysis service because of their public source data characteristics. Therefore they cannot realize adequate responses about user requirement or real-time requirement. In the near future, we can offer real-time services

by big data analysis and visualization such as user requirement, prediction information, and/or alarm real-time service. In addition, we can offer general statistics and accumulated data as well as tourism, danger alarm, and evacuation information as real-time manner.

4. CONCLUDING REMARKS

Throughout this paper, we have proposed some possible applications of DPD based on ICT including folk village sites and other useful test-bed sites. We investigated 'Asan Oeam' Village(AOK), 'Andong Hahoe' Village(AHK), and 'Chonju Hanok' Village(CHK) in Korean side, and 'Beppu Onsen' Village in Japan side for possible folk village sites. Additionally 'Traditional Streets and Markets' and 'Safe School & Park' in local area are presented as nearby test-beds for DPD based on ICT.

In addition, we have derived 4 different research topics which can be naturally applied on the test-bed sites investigated above and classified into 4 categories of ICT-based DPD scope just one-to-one correspondence.

In the near future, we expect a continuous research topic to prevent traditional structures from any kind of disaster using the monitoring system studied in this paper, additionally associated with big data solution.

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