Cases of a Living Lab as Open Innovation in Korea

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***Abstract*:** *This study looks out for cases of current Living Labs in Korea. Living Labs promote examples of open innovation and are an open innovation model where end-users actively participate and solve problems in a particular place or region that has been actively used in Europe. Korea's government and Research Foundation have been beginning to apply Living Lab concepts in research development projects for solving social issues. This study analyzed the similarities of the two Living Labs with respect to their process and the implementation system of the two Living Labs in progress, based on their current results. Eventually the Living Lab concept of open innovation was determined to be excellent in resolving social issues, so South Korea Living Labs in their initial stages will be grown and developed more, in this case of considering to continually contribute to the modern world of living lab from an STS perspective.*

Keywords: *Living Lab, Korea, Open Innovation*

1. Introduction

Europe 2020 has set *digital society, digital economy, access and connectivity, and research and innovation* as the 4 domains of its agenda and has been promoting goals and establishment-related policies for each domain [1]. *Open Innovation*, promoted by *Research and Innovation* is the only domain among the 4 that meets the paradigm of the new technological society [2]. Specifically, the organization came to promote an *open innovation* which actively receives the external capacities, while breaking away from the original inward looking *Closed Innovation*. Furthermore, it is transforming into an open innovation 2.0 which takes a wider consideration of all participants. One major promotion of open innovation is a Living Lab. A Living Lab is an open innovative model which encourages end-users to actively participate in problem solving in certain regions. This is also viewed as a test bed where users participate in technological development and test out the improvements in their daily lives [3].

ICT infrastructure is an absolute requirement for a Living Lab and this is because Living Lab has its foundation in ICT, IoT. In other words, Living Lab is closely related to information communication components in its practical implementation. At this juncture, it would not be an exaggeration to say that Korea would have a suitable communication infrastructure for Living Lab. This is because Korea has a top level ICT infrastructure to the point that 94% of the Korean population uses wifi and 88% of the adult population uses smartphones [4]. In addition to this, analyzing the ICT capacity based on the report of the International Telecommunication Union (ITU shows that the capacity of Korea reaches the level of the best in the world [5]. Based on these data, Korea has an excellent ICT infrastructure.

Unfortunately, the introduction of Living Lab as well as its development is relatively slow in Korea. The Korean government only started discussing the adoption of Living Lab in the year 2014. The process of adopting Living Lab is also only at the primary level. However, Korea is a country that needs a developed Living Lab more than any other country. About 1.44 million cases of death occurred in the last 5 years caused by accidents and fire [6]. The scale of damage of large accidents is also gradually increasing. The Daegu subway fire in 2003, Gumi's hydrofluoric gas leak in 2012 and the Sewol ferry accident in 2014 not only took away countless lives,

but also caused property damage of 1.7 trillion won and an annual average of 2.6 trillion won of restoration expenditure. Since safety is directly linked to life, the equipment that the fire fighters use must reflect their opinions.

Based on this, the research aims to study some of the cases of Living Labs in Korea that are implemented by the Korean Institute of Researches - *Establishment and technological development project on portable disaster communication network* and technological development project on *Firefighting, protective equipment and emergency rescue equipment*. The study also aims to review the progress, results, and future plans of Living Lab. The two projects have introduced Living Lab in their product development and made an effort to develop an efficient and effective equipment through interactions between the developer and the fire fighters. This aims to provide a thrust for the development of Living Lab in Korea and find ways to actively utilize the ICT infrastructure that Korea has in its advantage

2. Theoretical Background

2.1. Definition of Living Lab

Living Lab is an ecosystem of open innovation where research and progressive processes are incorporated in the real world. The users can actively participate and their opinions are reflected in the development. Technological innovation is in the core of society, and it develops with the participation of the citizens

Among several international institutions that represent the ICT Living Lab industry is ENoLL, the largest among all the institutions in size. ENoLL stated that Living Lab is a joint collaboration of users and producers improving towards technological innovation and consists of various participants in order to achieve a user-oriented open innovation, *PPPP: Public-Private-People-Partnership*. This is a user-oriented open innovation process where innovation happens through the cooperation of all interested parties. Moreover, the final users are given the role of an innovation agent. Ideas about new products, services, and systems are actively attained from the end users; and the place in society where users live functions as a laboratory and the end user performs innovative activities using *Society as a Laboratory* [7]

2.2. Introduction Background of Living Lab

Living Lab began with the proposal of Professor W. Mitchell of MIT and its initial aim was to analyze and observe home life. MIT introduced a Big Data-based research on Living Lab and researched on the *big data* by gathering all the individual's IoT *small data*. The users were provided with feedback based on the experiment. Then, its suitability and applicability in the home environment regarding IoT service were studied. In addition to that, MIT assigned about 300m^2 of MIT PlaceLab and named it *An Alive Laboratory* and started observation [8].

The initial model was a service that finds people based on IT tools, sensor, and others. The users understood the responses and points to ameliorate through the appropriate specifications of the service, and they were production or producer-oriented [9] ENoLL was established in November 2006 under the support of the European President of Finland and grew to be an international league. There are about 390 different Living Labs in the European government and all researches are done in all kinds of industries such as energy, media, mobile, medicine, and agriculture. The Living Lab research are backed with systemized support of institutions like EU and governments, and about 390 of them are registered on ENoLL [7].

2.3.Classifications of Living Lab

Living Lab can be largely classified based on *management structure* and *management agent*. The classification based on *management structure* can further be divided into supply-oriented type, production process-oriented type, and promotion of user network [10]. Supply-oriented type is in the Living Lab structure to test the applicability and suitability of technology and resembles the primary Living Lab model while it also provides customized services. The production process-oriented type goes beyond the process-oriented Living Lab and provides a better service through understanding how they are used after production and putting values

in the products. In terms of user network promotion, it is a dynamic living Lab where it is not just about producing the products but also about communication and exchange of opinion in a network of users.

The classifications of Living Lab based on the agents is largely divided into 4. First is the corporate-led management form which focuses on developing a product or a service through Living Lab. It offers relatively speedy progress and values feedback which is important in product development. Management by local government agencies generally promotes constant development rather than a speedy one. There are also several instances where it develops into a user-led form. Those led by research institutes usually focus on research about innovative activities of Living Lab rather than performing projects and developing products for the innovative activity itself. Lastly, user-led form is a method of having the users solve the problem themselves. Therefore, the focus is on providing solutions to actual problems (common at home and housing crisis).

3. Example of Two Ongoing Cases

Living Lab case of Korea analyzed in this study is a national research development project by the support of the Future Creation Science and Research Foundation. In disaster safety, there are network project and fire, protective development equipment deployment project for field agents. Both studies have the purpose of securing the safety of firefighters and rescue subjects. These are significant for an open innovation using Living Lab that users, producers and sellers are involved actively in technology development and improve and verify product development reflecting the result during conducting the project

3.1. Management of User Centered Living Lab and Development of Cervical Collar[1]

The goal is to develop firefighting, protective gear which can reduce the casualties of rescue agents and subjects of rescue at the occurrence of a fire, building destruction, and other disasters. To ensure the safety of firefighters and the subjects of rescue and to improve operational efficiency, Living Lab began to develop popular tools that can enhance user friendliness.

The main products that the project aims to develop include individual firefighting, protective gear like gloves, fire escape hood, air respirator, and rescue equipment like portable video laryngoscope and a cervical collar. Moreover, it manages a Living Lab which enables the new products to be experienced, applied, improved, and verified by companies and field agents.

Duration of Research is July 14th, 2015~ July 13th, 2017. Continue the research for 2 years and create products with the expertise of Busan University, Hankuk Carbon, Hanyang University, and Ewha Women's University, and exchange different ideas through regular meetings. Moreover, produce and supply improved firefighting equipment through continuous reflection of the ideas of the firefighters - the end-users. The Table I is a participating agency of Living Lab project.

The first 4 stages of a Living Lab were conducted in the first year, and in the second year, there will be an exchange of ideas through agents, an advisory committee and field test completing the 4 stages of Living Lab from steps 5 to 8. It aims to gather users' feedback and capture their changing needs through repeating the product tests and user tests.

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TABLE I: MANAGEMENT METHODOLOGY OF LIVING LAB

.	Management of Living Lab : Main Function
1st stage	Accepting User Opinions, Advisory panels Gathering material from surveys to identify problem and to seek solution
2nd stage	Accepting user opinions and Survey Constructing the substance to accept various and comprehensive opinions
3rd stage	Accepting user opinions, Advisory panels Constructing 3 different sessions to define product development concept
4th stage	1st stage product test Advisory panels, Research Lab Evaluation on Prototype of all details
5th stage	2nd stage product test Verify agents, testing the scene
6th stage	3rd stage user test Advisory panels, research lab
7th stage	4th user test Verifying agents, testing in the scene
8th stage	Release it in EXPO
Final	Launching the Final Product

Developing tools of emergency rescue equipment with ergonomic design and special materials and managing Living Lab research was conducted from November 4, 2015 to July 4, 2016 and the contents were as follows:

TABLE II: THE LIVING LAB RESULTS AFTER THE 1ST YEAR

Duration	Item	Contents
1st Living Lab	Gather user opinion (advisory committee)	November 4, 2015
		Formation of an advisory committee composed of 44 members
		Design the survey questions in such a way to derive solutions for problems in the product.
2nd Living Lab	Gather user opinions (survey)	Content of the survey: general, overall contents for satisfaction, wear comfortability, design, functionality, etc.
		The survey consists of 193 questions (10 types of survey per product)
		Use online survey services
		Answer rate per product: Total of 5846 cases (December 7)
3rd Living Lab	Gather user opinions (Advisory committee and invitation to related organizations)	December 17, 2015
		Consists of 3 sessions for concept establishment of product development
		Participating organizations: Korea Fire Safety Association, Korea Fire Industry Technology Institute, FDA, Korea Testing Laboratory, Cham Joeun consulting and other related organizations.
		Disclose the statistical data from the survey
		Gather the opinions of each advisory and field expert.
4th Living Lab	1st stage new product test (Advisory committee per section)	Evaluation of the details of the new product by the advisory committee

The most notable characteristic of this Living Lab is the lively participation of the firefighters. The second Living Lab survey was able to get a total of 5846 respondents. Also, it achieved an outstanding performance of various converging opinions of users and converging public presentations by equally gathering the opinions of experts and advisors. The stage 1 achievements include 8 items and 25 products including gloves, hoods, boots, and cervical collars. It has also made 7 materials from 5 enterprises which include Kolon Fm. The future plan is to manage Living Lab through stages 5 to 8 and provide products with improved wear comfortability and functionality through gathering ideas on their improvement for a second evaluation and accomplish the final product management of Living Lab, functional evaluation of the new product, production of product brochure, investigation of the sales network, and registration at the public procurement service

3.2.Deployable Emergency Communications Network Development for Rescue Worker's Safety in Disaster Situation

The project aims to produce, develop, and manage a disaster communication network in order to secure the safety of field agents in disaster situations when there is a barrier in communication. The project is concerned with the safety of field agents when communication network failure occurs and when there is the danger of disconnection in the communication network at the collapse of a building or at an underground situation during a disaster. It also began from the need to lessen the burden of the field agents by securing a stable communication network

This research project attempts to use the method of Living Lab, it has the intention of developing the desired products in the field, reflecting faithfully voices and opinions of the disaster site workers from the first step, because that it is the project for the safety secure.

Duration of the research is November 30th, 2015 ~ November 29th, 2017. and Continue the research for 2 years and create products with the expertise of Kookmin University, Seohwa Inc, Nomad Connection, Adone Tech, Hanyang University, and Ewha Women's University, and exchange different ideas through regular meetings. Moreover, produce and supply improved firefighting equipment through continuous reflection of the ideas of the firefighters - the end-users.

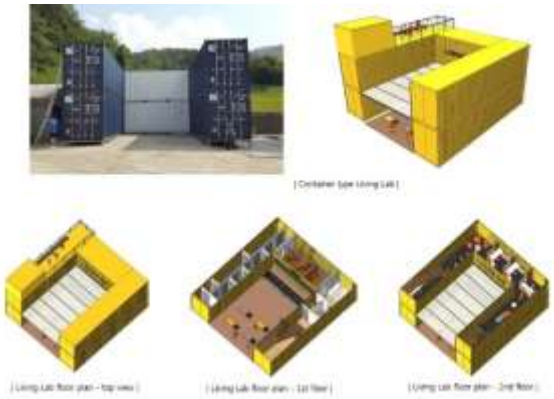

Fig. 1: Container-type living lab

Fig. 2: Training tower living lab

Fig. 1. is on propelling performance Verification of developed equipment in the underground disaster through the establishment of container-type Living Lab of a fully shielded structure. Fig. 2 is a living lab that experiences the ground and underground disaster situations using the comprehensive training tower 7-10 floors. It operated a secondary Living Lab Utilizing the container box and the comprehensive training tower and gave an opinion on the portions to be improved in future studies after firefighters experience the developed prototypes. Also, the technological development of a portable disaster communication network, and the management and main functions of Living Lab, are as follows:

TABLE III: THE DEVELOPING TECHNOLOGIES REGARDING MOVABLE EMERGENCY INFORMATION NETWORK

Management of Living Lab	Main Function
Creating a similar environment and test the developed product in order to verify the function	Monitoring the environmental conditions such as flame, watering, and smog
Creating extreme environments with flame, watering, and smog	Monitoring the network status of movable relay equipment and Life-line connected relay equipment
Testing the status of network and location tracing in each extreme environment	Monitoring location tracing of field agents
Testing the movable emergency information network and control technology of emergency information	

The first stage of Living Lab has been completed through the advisory conference held on March 31 and the survey test in April. The opinions of the firefighters were taken into consideration in improving the product and the developer tested out a Living Lab from October 6 to 10 with the improved product. The developer also

conducted a survey after the second Living Lab test in order to get a comprehensive understanding of various responses regarding product satisfaction, functionality, etc.

TABLE IV : MANAGEMENT METHODOLOGY OF LIVING LAB

	Management of Living Lab : Main Function
1st stage Living Lab	Evaluation of existing product Confirming the advisory panel and operating 1st advisory meeting Survey*100 firefighters are estimated to participate)
1st stage Prototype development	Reflecting advisory opinions and results of survey Seminar with experts
2rd stage Living Lab	Opening second advisory meeting Evaluation of 1st stage prototype (20 people of advisory panel and fire fighters are estimated to participate) Opinions for improvements
2nd stage prototype development	Reflecting the result of Living Lab and improvement Seminar with experts
3rd stage Living Lab	Opening third advisory meeting Evaluation of 2nd stage prototype (50 firefighters are estimated to participate) Opinions for improvement
3rd stage Prototype development	Reflecting the result of living lab and improvement Seminar with experts
4th stage Living Lab	Opening fourth advisory meeting Evaluation of 3rd stage prototype (50 fire fighters are estimated to participate) Opinions for improvement
Producing Final Prototype	Promotion about things such as participating in fair and opening exhibition Setting Sales Strategy

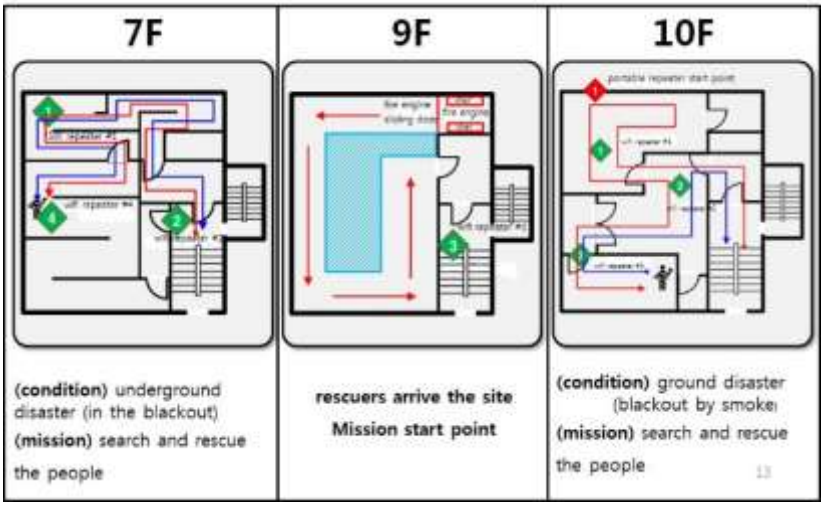

Fig. 3: Scenario experienced in training tower

Fig. 4: Multi-standard portable gateway and the on-site crews prototype

Fig. 3 is the scenario experienced in comprehensive training tower during secondary Living Lab. Firefighters(users) used and experienced the prototype as real-situation a mission that structures the people in a disaster situation on the ground and in underground. Fig. 4 is a multi-standard portable gateway and the on-site crews prototype developed in this study.

Deployable emergency communications network development for rescue worker's safety in disasters research methods of an advisory conference and a survey were used for the study. An introduction as well as advisory was requested at the advisory committee regarding the newly developed portable disaster communication network equipment and Living Lab at the advisory meeting on March 31, 2016. The advisory of the committee were taken in and the first Living Lab survey content was edited, improved, and finally approved. The survey was conducted for 14 days (April 18, 2016 - May 1, 2016) and was done both online and offline. A total of 219 responses were recoded and out of them, 178 valid responses were analyzed through SPSS 23.0. The results are as follows:

TABLE V: THE RESULT OF OPINION'S POLL

Item	opinion
Hazards in disaster sites	The biggest physical hazard is unclear vision due to thick smoke
	*T*It is a restricting factor on the activities at the disaster scene and it manifests both information and physical restriction.
Existing wireless communication equipment	Mainly uses UHF and a part uses TRS on the side
	Frequent occurrence of interruption on wireless communication
Major factors in consideration for the new portable disaster communication network equipment	Portable gateway: convenient operation and weight
	Lifeline and connection form repeater: weight and length, durability
	Portable repeater: easy operation method and weight, durability
	Portable field control system: Internal information of the site (risk detection), easy operation method, the grasping location of the equipment and the agents
Management method of the new portable disaster communication network equipment	Preferred method of attaching it to the existing equipment and a disposable form with an average quality
	They tend to dislike putting additional effort to transport or retrieve it.

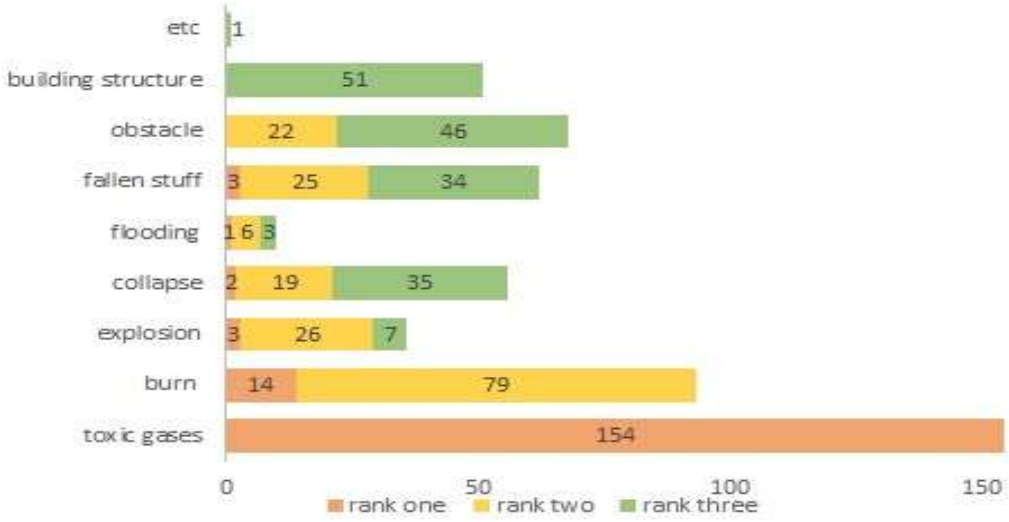

Fig. 5: Physical risks of disaster environment

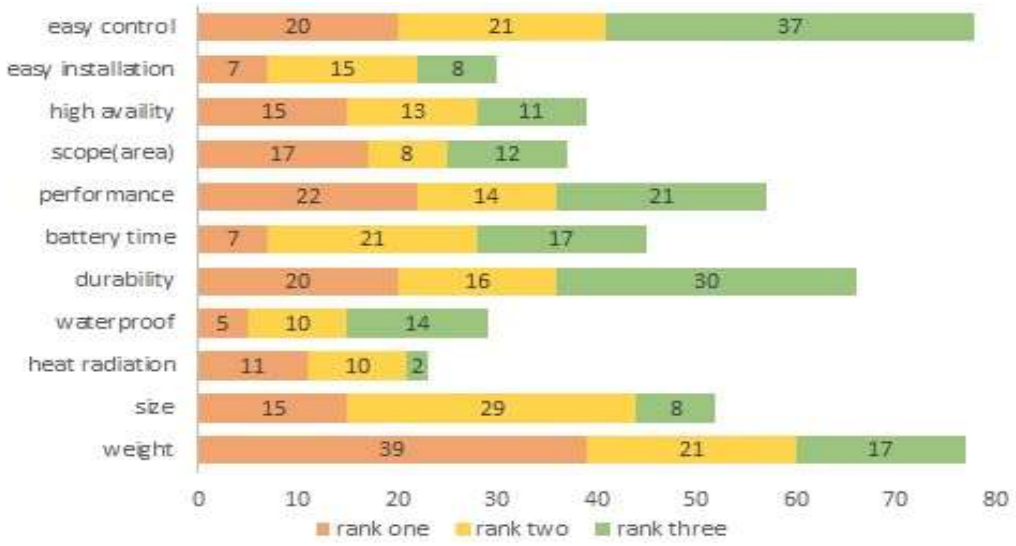

Fig. 6: Factors to be considered for portable repeaters

Fig 5, 6 are a part of the results of the first Living Lab and it is the answer from the survey regarding the factors to be considered for portable repeaters and the physical risks that firefighters feel in disaster situations.

The second stage of Living lab replicates the actual fire scene based on the content discussed in the first stage and is divided into underground and above ground. It was tested from October 6 to 10. Moreover, after the Living Lab test, the field agent should understand the inconveniences in the equipment, communication, site temperature and the accuracy of the agent's location, etc. and these should be reflected in the third and fourth stages of Living Lab. Future plans include verification of the product through user-oriented Living Lab management. Filling up the table of evaluation for the newly developed item and perform the 3rd and 4th stages of Living Lab. Moreover, the objectives of the research is to find methods for promoting the policy, law, system through improving the government departments, establishing a promotion and application system, and final product verification and evaluation.

4. Results and Findings from Two Korean Living Lab Cases

The research takes a look at two living Lab cases currently being done in Korea. The two projects are handled by the Korean Research Institute and they have the following common aspects:

First, in the living Lab management form, the common aspect is the *promotion of the user network*. This aspect falls under the form of Living Lab that is recently popular in Europe, and is an actual Living Lab where the user (firefighter) rather than the service provider is directly involved in the project.

Considering these points, an advisory conference was held for the firefighters and the user opinions were gathered through a survey. Moreover, tests were done while scrutinizing the product. Because this process was done, smooth communication and gathering of opinions through the user network could be achieved and could actively identify points for improvements.

Secondly, it showed that the subjects were all *government related agencies* or *government agencies* in terms of management subject. In other words, a research institute, a government agency, hosted and managed the project and this led to the development of the society through *firefighters and public safety,* It also developed a systematic form by having the firefighters at the center. In other words, the direction of product development was altered by reflecting the opinions of the firefighters and they improve the new product by testing it.

Thirdly, the two Living Labs were both connected to *disaster and fire safety*. However, this fact could also support an argument that the firefighting equipment in Korea are falling behind and public safety is in danger. Safety is directly related to life and that is why a Living Lab, which takes in a lot of user's input, finds solutions

to the social problems. In other words, the opinion of the firefighters who actually use the products, and not theoretical knowledge, needs to be heavily reflected. Likewise, firefighters will be guaranteed a higher safety, and this will relieve their mental anxiety and physical burden as users. Through this, they will be able to improve their capacity to perform a task and ultimately contribute to national safety.

Living Lab where all participants can contribute as a *co-producer* and *co-creator* is being established as an important paradigm in the world's technological society. Especially in the case of Europe, the Living lab started more than a decade ago and to date, ENoLL registered Living labs evolved to over 390 throughout the entire country. Contrary to the trend, Korea remains at the introductory stage. The discussion on Living Lab only surfaced in 2014 and established Living labs were not that much.

Of course these two projects cannot represent all of the Living Lab cases in Korea. Therefore, in further studies, researches should find other projects that contain the factors of Living Lab and study *what ways do the society gives meaningful values to the citizens*. Moreover, there is a need for a research that finds ways to make the findings of this study contribute to the development of Living Labs in Korea.

Specifically, it is necessary to develop and apply a Living Lab 'open innovation' concept where all participants interact with each other and solve social issues by spreading Living Lab in Korea in their preliminary phases. From the point of view of Science Technological Society (STS), there is a need to identify clearly on what living lab contributes substantially to the modern world. In this case of a fine grained in-depth study on these two dimensions, growth and spread of domestic Living Lab seems to be able to spur on new developments

5. Acknowledgements

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