Disaster Prevention and Management

DRR technology sharing and transfer through web-based platforms: Lessons learned from Korean studies

Yongkyun Kim Hong-Gyoo Sohn Youngjai Lee Jong-Moon Chung

Received 4 May 2015
Revised 21 March 2016
29 March 2016
6 April 2016
Accepted 6 April 2016

DRR technology sharing and transfer through web-based platforms

Lessons learned from Korean studies

Yongkyun Kim
Ministry of Public Safety and Security, Seoul, Republic of Korea
Hong-Gyoo Sohn
Yonsei University, Seoul, Republic of Korea
Youngjai Lee
Dongguk University, Seoul, Republic of Korea, and
Jong-Moon Chung
Yonsei University, Seoul, Republic of Korea

Abstract

Purpose – Disaster risk reduction (DRR) technology sharing has emerged as an important global issue across national boundaries. As a result, the DRR technology-sharing environment needs strengthening based on the findings of difficulties in sharing, investment, and commitment. The purpose of this paper is to three fold: first, it will clarify that a web-based platform is the best conduit for linking DRR technology from the supplier to the beneficiary developing countries. Second, it will find the most evolutionary path based on Korean case studies. Finally, it will make recommendations for the efficient implementation of a web-based platform for DRR technology sharing.

Design/methodology/approach – This paper posits that DRR technology sharing is a necessary part of enhancing resilience to disasters in the Asia-Pacific region. The evolution of web-based approaches (a merchandise display-type platform, a journal-type platform, an electronic market-type platform, and an architecture and governance-type platform) and an actual case of space technology sharing providing support for an evolution toward community-based technology sharing in DRR. The research will find the most efficient way going forward based on the case study of a four-year R&D project sponsored by the South Korean Government. It will also find the success factors for the way to establish and operate the platform efficiently and effectively through case studies of the four types of web-based platforms.

Findings – Sharing of DRR technology through a web-based platform among Asia-Pacific countries is necessary in order to equip all parties with essential technology to mitigate intensifying disasters, to overcome the barriers of technology sharing, to breakdown transfer issues due to language barriers, and to strengthen insufficient DRR budgets. Among the four types of web-based platforms, the architecture and governance-type platform proved to be the most effective and efficient. In addition, four principles for an efficient implementation are identified through case studies, analysis, and research.

Originality/value – This paper reports on the reasons why it is difficult for DRR technology sharing in the Asia and Pacific regions and suggests a web-based DRR technology-sharing platform as a solution for the region. Moreover, it substantiates that the architecture and governance platform type as the most efficient and effective evolution with four principles: develop based on end-user's needs; take a problem-solving approach; contain interactive communication tools; and provide business opportunity.

Keywords Disaster risk reduction, Architecture and governance type, Community-based and problem-solving approach, DRR technology sharing and transfer, Web-based platform

Paper type Research paper

Disaster Prevention and Management
Vol. 25 No. 4, 2016
pp. 430-448

0965-3562
DOI 10.1108/DPM-05-2015-0097

1. Introduction

Advanced economies currently engage in a variety of activities to assist developing countries in improving their socio-economic development. For example, South Korea offers credit assistances to Lease Developed Countries (LDCs) via the Economic Development Cooperation Fund; sponsored by the Korean Export-Import Bank and Overseas Development Aid given by the Korea International Cooperation Agency. Although these overseas aid programs contributed to poverty reduction and economic development in LDCs, the lack of interconnection between donor countries and beneficiary developing countries remains, creating barriers to deliver aid programs effectively. Therefore, a new approach has been brought forward to pursue a strategy based on the clear understanding of recipients' needs over direct economic assistance programs.

This comprehensive strategy includes sharing experiences, policies, and technologies between developed countries and LDCs. One example is a knowledge-intensive economic cooperation project that contributes to the socio-economic development of target countries (Korea Development Institute, 2013). The project stressed the importance of developing a Knowledge Sharing Program (KSP). KSP, launched in 2004, is a knowledge-intensive development cooperation program through which the South Korean Government shares its economic development experience in order to support institutional reforms and capacity building of partner countries. KSP does this through a series of joint research projects and consultations on policy issues within the contexts of sustainable development. KSP also includes political research, consultation, training programs, and assistance for institutional reforms and capacity building.

Over recent decades, the concept of Disaster Risk Reduction (DRR) has emerged as an important global topic in the promotion of Climate Change Adaptation (CCA) and sustainable development. Consequently, there have been global dialogues around the sharing of DRR and CCA information and knowledge at global, regional, and national levels. The sharing and transferring of advanced policies and technology of DRR and CCA is becoming more necessary as the frequency, scale, and intensity of disasters increase. The outcome of the workshop entitled "Enhancing linkages between DRR project portal and DRR-related knowledge management/information management systems in Asia and the Pacific Region," clearly stressed that it was essential to support future disaster information system developments and share linkages among nations (UNISDR, 2013a).

In line with DRR information sharing, the online platform Prevention Web, launched by the UNISDR in 2007, is recognized as the key source of information on DRR. However, the Prevention Web does not deal with sharing DRR technology and associated information. Therefore, the Fourth Asian Ministerial Conference on Disaster Risk Reduction (AMCDRR), which was held in Incheon, South Korea in 2010, provided an opportunity to propose DRR technology sharing for the Asian-Pacific region. One of the action plans proposed in the Incheon Regional Roadmap on DRR through CCA in Asia and the Pacific (REMAP) was that DRR technology sharing should be promoted in order to enhance the transfer of technology. Furthermore, the Sendai Framework for DRR; recently adopted at the 2015 World Conference on Disaster Risk Reduction (WCDRR) in Sendai, Japan, also emphasized the importance of enhancing technology transfer involving a process of enabling and facilitating flows of skill, knowledge, ideas, expertise, and technology from developed to developing countries (UNISDR, 2015).

As one of the follow-up projects from Inchon REMAP, the former National Emergency Management Agency for the Republic of Korea (NEMA Korea) launched the initiative "A Platform for DRR Technology Sharing." To this end, NEMA Korea has sponsored the pilot R&D project for a web-based technology-sharing platform; initiated in 2011. Despite the investment of financial and technical support by NEMA Korea, a practical outcome has not yet been achieved. Even though the DRR technology sharing project is still under way, it is worthwhile analyzing the lessons learned since it began operation and research. Therefore, this paper identifies necessities, analyzes problems, and proposes indicators for desirable solutions for DRR technology sharing by examining its concepts, presenting the cases, and disclosing the barriers why the DRR community has not yet embraced technology sharing and transferring.

Successful transferring of knowledge and technology cases within the field of DRR is rare. Therefore, we examined cases of knowledge and technology transfer in other fields, which we believe parallels the DRR situation. Furthermore, we considered whether there is a relationship between national DRR budgets and international aid, and the rate of acceptance and investment in DRR technology by analyzing national DRR budgets and international aid. While doing this, we weighed the relation between insufficient DRR budgets and the level of DRR technology sharing and transfers. Next, we examined other logical barriers to transference by studying the difficulties of space technology sharing and transfer in Cambodia.

With all the possible solutions in mind, four types of web-based platforms have been established and are evolving: merchandise display-type platform, journal-type platform, electronic market-type platform, and architecture and governance-type platform. And, after analyzing all four types, we identified four principles for the operation of a web-based platform and made four recommendations for the successful implementation of the platform for DRR technology sharing and transfer.

2. Current issues on technology sharing on DRR

2.1 Technological approach for DRR

The UN office for DRR, UNISDR, has recently stressed the importance of science and technology within DRR. As the paragraph 25 g of the Sendai Framework suggests, "Enhance the scientific and technical work on disaster risk reduction and its mobilization through the coordination of existing networks and scientific research institutions at all levels and all regions with the support of the UNISDR Scientific and Technical Advisory Group […]." UNISDR started to organize the conference to support a collaborative science and technology roadmap to 2030 for the implementation of the Sendai Framework (UNISDR, 2016b). Mainstream of the roadmap is to stress out the importance of science and technology in providing the evidence and knowledge on disaster risk.

UNISDR held a conference in 2016 on the topic of the role of science and technology for the implementation of the Sendai Framework with financial and technical support from Mexico, Indonesia, the Republic of Korea, Turkey, and Australia and other countries. The conference invited organizations, institutions, networks, and platforms working on DRR and emphasized that national governments should promote and support the availability and application of science and technology to decision-making with DRR leaders and institutes. Under these circumstances, a web-based platform for DRR technology sharing will create a cohesive and influential sphere, whereby DRR technology can be found and accessed easily to better mitigate the impact of disaster for the stakeholders of developing countries.

2.2 Technology sharing and transfer

Tangible and intangible expertise and technical development are critical for any company to grow successfully. However, it is difficult for companies that do not have enough human expertise and material resources to develop technology independently and enhance expertise. This problem may be solved with technology transfer, which is the process of technical trading between the licensor; who has the know-how and the technology, and the licensee; who does not have these assets for the company (Allen, 1984). Depending on the subject, technology transfer can be performed in functional areas of corporate and intra-organizational transfer, intra-and inter-organizational transfer, and cross-country transfer (inter-economy).

As industries rapidly increase global interdependency, the transferring of international technology is activated between headquarters and subsidiaries, companies and joint venture partners, and companies and technology achieving foreign companies (Walker and Ellis, 2000). International technology transfer not only gives a competitive edge to subsidiary and joint venture companies that use their technology, but also allows them to maintain a technological advantage over foreign competitors (Buckley and Casson, 1976; Anderson and Gatignon, 1986; Isobe *et al.*, 2000).

Technology transfer can be performed with personnel migration, publication of technical books and documents, seminars, conferences, symposiums, technology trade such as technical symposiums, training, plant tours, and hardware transfers such as among manufacturing facilities. Despite these various methods, technology transfer still remains limited – especially through overseas aid programs. There are several reasons why technology transfer is difficult. The first reason is that developed countries are reluctant to share advanced technologies with developing countries in order to protect their business, i.e. developing countries are worried that their key techniques may be exposed to competitors or other countries (e.g. technology leakage between the Shanghai Automotive Industry Corporation and SsangYong Motors) during technology transfer (Kim, 2012). Second, technology transfer generally requires the transfer of funds, business expertise, human power, facilities, and core mechanical components, which are normally lacking within developing countries. Finally, different economy-of-scales, industry maturity, political stability, and cultural acceptance rates between developed countries and developing countries may work as barriers for technology sharing and transfer.

2.3 Recent research applicable to technology sharing for DRR

Important issues in providing the technology-sharing platform have arisen like: how can we believe or buy the technology listed in the platform. Concerning this issue especially in the field of emergency operation center information systems (EOCIS), Prasanna and Huggins (2016) analyzed current technology models; concluding that technology acceptance factors; including performance expectancy, effort expectancy, social influence, and information quality, explained 65 percent of variance in symbolic adoption. They also argue that technology acceptance model (TAM) and Unified theory of acceptance and use of technology (UTAUT) models of technology acceptance remained fundamentally incomplete. Therefore, they suggested a research model for factors affecting end-user's acceptance of EOCIS by combining the strengths of the TAM and the UTAUT (Venkatesh *et al.*, 2012). This research gives an insight into the acceptance and uptake of technology in emergency management and provides key concepts that DRR technology developers should follow. It can also serve as a guide to develop a platform for DRR technology sharing among developers and users.

Concerning the importance of technology sharing for DRR, there has been too little research on the key factors, the efficient ways, and the effective types for the enhancement of DRR technology sharing. In this regard, two predominant works were done by UNISDR. It developed a framework for information and knowledge management for DRR (IKM4DRR) in 2013 (UNISDR, 2013a). The principles and key concepts of the framework are a demand-driven approach, embraced information standards, collaborative partnerships, sustainable mechanisms, transparent practices, and regular monitoring and evaluation. It also includes the requirements for the success of IKM4DRR; listing 16 essential elements and providing corresponding scorecards. Additionally, UNISDR insisted in the UNISDR Scientific and Technical Advisory Group using science for DRR report that the more widespread integration of science into DRR policy-making will depend on science being useful, usable, and used (UNISDR, 2013b). These two achievements by UNISDR can be used as the foundation for the successful development of the web-based platform for DRR technology sharing in this research.

3. Methodology

The methodology in this research follows three leading steps: identify barriers to DRR technology sharing through literature review and a case study; find the potential of a web-based platform to solve identified barriers; and evaluate the four types of evolving web-based platforms initiated by NEMA Korea. These three steps in conjunction with lessons learned and experts' opinions are the basis for our recommended suggestion for a successful DRR technology sharing web-based platform.

Considering there has been little research on technology sharing and transfer in the DRR field, this research used two methods to identify potential barriers to DRR technology sharing and transfer. First, studies on barriers to technology sharing in other fields and the ratio of DRR budgets and DRR-related issues in developing countries are used for analysis. Second, a case study on space technology in Cambodia was conducted to find obstacles for adopting advanced technologies by a developing country.

Based on the study on the advantages of computing platforms and the analysis of 195 DRR information and knowledge-related web sites, the potential of a web-based platform as a solution to identified barriers was tested, and various types of web-based platforms were reviewed for implementation.

There are many key performance indicator (KPI) parameters that can be used in evaluating web sites. Some of the important success indicator parameters of web-based platform are described as follows.

In ISO/IEC 25010 (2011), resource utilization is used as a metric to evaluate the performance efficiency, where performance efficiency represents the performance relative to the amount of resources used under stated conditions of the web platform. In addition, accessibility is used as a metric to evaluate the usability, where usability represents the degree to which a web platform can be used by specific users to effectively and efficiently achieve a desired goal.

Target action, prospect rate, and committed visitor index are some of the KPIs used to evaluate the key numbers for progressive management of an effective web site (Dainow, 2016). The philosophy behind progressive management is that no web site is efficient, effective, and powerful from the beginning. Rather, progressive improvements can be made by using the right target KPIs in analyzing the current situation, and then one can improve one's web site in the most effective direction.

The average session duration is used along with the bounce rate to evaluate the page tracking characteristics of the web platform users. These Google analytics KPIs indicate whether the visitors of the web platform find what they were looking for, or decide to quickly give up and leave (Moore, 2014).

Based on literature reviews on recent research applicable to technology sharing for DRR, we developed an evaluation framework to evaluate the four types of evolving web-based platforms (Peterson, 2005; Tonkin *et al.*, 2011; Moore, 2014; Dainow, 2016). The evaluation framework incorporates three evaluation criteria and seven indicators listed in Table I. As an evaluation criteria of the four types of evolving web-based platforms, three criteria "useable," "used," and "useful" were derived and utilized based on seven evaluation indicators. The detailed description of seven evaluation indicators were also listed.

The criteria "useable" is focussed on the level of user effectiveness in accessing the platform. Therefore, "useable" is evaluated based on the level of how the web site is used by people with the widest range of characteristics and capabilities to achieve a goal using the platform, which is accessibility, how easy it is for visitors to engage in the platform; defined as the target action, as well as how many visitors are getting to point in the platform, which is defined as the prospect rate.

The criteria "used" is focussed on the level of the platform being used. Therefore, "used" is evaluated based on the level of which types and amount of functions and resources have been used that meets requirements, which is resource utilization, percentage of visitors who stick around and read content in the platform; defined as the committed visitor index, as well as the level of involvement visitors have with contents; defined as the average session duration.

The criteria "useful" is focussed on level of depth that the platform had been used by its visitors. Therefore, "useful" is evaluated based on the percentage of visitors who use items in the platform; defined as the conversion rate; the percentage of people who just looked at a page; defined as the abandonment rate; and the percentage of visitors who return back to the platform to reuse it again; defined as the return rate.

4. Barriers to technology transfer and web-based platform as a solution

4.1 What are the barriers to technology transfer?

4.1.1 Barriers identified from other studies. A number of factors influence successful technology transfer. Larsson *et al.* (2006) analyzed these factors from cases of success

Evaluation criteria	Evaluation indicator	Indicator description
Useable	Accessibility	Level of how the web site is used by people with the widest range of characteristics and capabilities to achieve a goal using the platform
	Target action	Makes it easy for visitors to engage in the platform
	Prospect rate	How many visitors are getting to their end-point within the platform
Used	Resource utilization	Level of which types and amounts of functions and resources have been used that meet requirements
	Committed visitor index	Percentage of visitors who stick around and read content in the platform
	Average session duration	Level of involvement visitors have with content
Useful	Conversion rate	Percentage of visitors who use items in the platform
	Abandonment rate	Percentage of people who just looked at a page
	Return rate	Percentage of visitors who return back to use the platform again

Table I. Evaluation framework for the web-based platform and failure in technology transfer. First, educational preparation and training between technology providers and adopters when transferring technology makes for a successful transfer and is a key requirement. Cases of failures are attributed to the beneficiary country not having enough education or discussions during the transfer period. Second, providers should make every effort to minimize the cost burdens until the transfer is finished. Third, the conflict of interest between providers and adopters critically affects the result, and personnel exchange before and after technology transfer is a key factor for success.

There are some cases of failure in technology transfer where the levels of technique of the recipient countries were not considered. Agricultural and manufacturing industries were the main income sources of developed countries, and the total factor productivity of those industries was increased by a factor of nearly 4 from 1972 to 1992 (World Bank, 2008). In the past, technology transfers in the agricultural industries from mainly developed countries were unsuccessful despite the help of the international community. There are two types of causes for failure. First, beneficiaries of developing countries (country by technical importation) which had a limited ability to read and write found the comprehension of basic "advanced" technology difficult. Second, even if the technology could be understood intuitively, the beneficiaries did not have enough technical skills for it to be of practical use. Imbalances between recipient countries were caused by differences in technical abilities.

The main factor for failure in the transfer of technology is within a case study of Argentina concerning the 1940s (Hagood, 2006). President Perón; who was coming to power, and Argentina had a close relationship with European fascist and Nazis during Second World War. Subsequently, the Argentinean Council allowed German scientists safe haven under the condition of contributing toward military R&D. With these given conditions, Kurt Tank, the prominent German aircraft engineer, immigrated to Argentina with other engineers in 1947. After that, he immediately established the Instituto Aerotechico (I.Ae.) with the support of President from president Perón. In 1951, the early combat aircraft, Pulqui II, was developed using innovative techniques. However, the aircraft (which was in its fifth and final evolution) crashed in 1952. After disgracing President Perón in 1955, Kurt Tank immigrated to India in 1959.

In 1948, Richter, a German physicist of Austrian origin, was brought over by President Perón in order to develop a nuclear powered aircraft with Tank. He headed up the project on Huemul Island until 1949, but was unable to produce results despite running the program over budget. Therefore, the Perón Council denounced and canceled the project in 1952. At that time, Argentina faced an economic crisis and the Argentinean Council strongly focussed on the import-substitution industrialization (ISI) initiative, which had been in effect since the 1930s. However, the transfer failed because of limitations in ISI policy and an impractical plan established by a national reform system. Moreover, failures occurred during technology transfer to the local engineers and scientists who lacked the competencies to understand and grasp the new technology.

Low investment in DRR can also play as barriers to DRR technology sharing. Most governments in developing countries do not allocate enough budget to disaster prevention, as their priority is to foster their national economic development. For example, the ratio of total DRR budget to national budget in Indonesia is insignificant, accounting for only 0.7 percent (Darwanto, 2012). India also shows the low investment in DRR, accounting for only 1 percent of the national budget (Gordon, 2013).

The awareness related to DRR appears in the flow of international aid. Funds for DRR occupy a very small portion of the total amount of international aid. According to the report published by the Global Facility Disaster Reduction and Recovery, "Financing Disaster Risk Reduction – a 20 year story of international aid," international investment in DRR is still a low or even non-existent priority (Kellett and Caravani, 2013). Three trillion dollars have been invested in international aid during the last 20 years. Nonetheless, only 106.7 billion dollars was used for disaster-related activities and only 13.5 billion dollars was allocated for DRR. Conversely, spending money after a disaster for reconstruction was 23.5 billion dollars. This is more than twice the amount of DRR allocations. During the past 20 years, DRR has received the support of only 0.4 percent of total international aid and this shows that the priority of DRR is very low. As explained above, the low investment in DRR makes it difficult to transfer technology within the DRR community.

4.1.2 Barriers to adopting advanced DRR technology: Cambodian case. Cambodia is a country located in the southern part of the Indochina peninsula and one of the most naturally stable countries in terms of disaster occurrence; the number of disasters from 1900 to 2013 is only 35. However, 16 out of 35 cases occurred during the last decade and flooding is the most frequent disaster (accounting for ten cases during the decade). For example, flooding in 2011 claimed about 250 lives and left 1.6 million people homeless, which are record-breaking figures in Cambodia. Another flood in 2013 claimed the lives of 170 people and more than 1.7 million people suffered damages (EM-DAT, 2016).

During this research, a disaster monitoring system was established using remote sensing technology and transferred to Cambodia for building a disaster management system for the country's DRR. Since storms and floods were determined to be particular threats, this research aims to develop a system that can monitor deforestation and rainfall level in order to identify the strength of floods.

The system is based on free data that can be shared over the internet, which allows the transfer of the methodology mentioned above. First, data obtained from the Radar Altimetry (Jason-2/Envisat) satellite is used for water-level monitoring. The Radar Altimetry satellite can directly measure changes in water levels by measuring the distance from itself to the water's surface. This distance is calculated by using the turnaround time of the radio waves emitted from the satellite, which are reflected by the water's surface back to the satellite (Lee *et al.*, 2013). The Jason-2 satellite flies at an altitude of 1,336 km, has 9.9-day repeat orbits, and the accuracy of its sea-level measurements are within 3 cm (Nerem *et al.*, 2010). The Envisat satellite flies at an altitude of 800 km; 800 km lower than the Jason-2 satellite, and its revisit period is about 35 days. Envisat's orbit is composed of 1,002 tracks. For observing sea level, the accuracy of RA-2 mounted on the Envisat is about 4-5 cm (Frappart *et al.*, 2006).

The Tropical Rainfall Measuring Mission (TRMM) data are used to determine the rainfall characteristics. TRMM was launched by NASA and carries a TRMM Microwave Imager sensor and a Precipitation Radar (PR) sensor for rainfall measurements. NASA integrates satellite data with the PR sensor and is providing daily rainfall data from the north latitude 50° to the south latitude 50°, through the cooperation of JAXA and CNES. Finally, Landsat TM and ETM + satellite image data are used for deforestation monitoring, which is expected to increase flood risk in Cambodia.

The monthly rainfall accumulation was analyzed to determine the relationship between the water level and rainfall. Inclination change, which represents the cumulative rainfall trend, can affect the trend of water levels. The time delay between precipitation and the rise of the water level was identified by correlation analysis. As a result, the maximum correlation of the time delay was 0.849, which represents a strong relationship. In particular, a massive flood in 2010 had a significantly high correlation. When analyzed annually, 3-16 day delays are shown. In addition, the rainfall intensity and the time delay have positive correlations.

Trend analysis using Normalized Difference Vegetation Index (NDVI) values was performed for deforestation monitoring. The NDVI of the study site was reduced from 0.566 in 2003 to 0.440 in 2013, which is a 23 percent drop. According to the NDVI difference image, forest destruction occurred mainly in the outskirts of the Phnom Kulen National Park in the northern part of Siem Reap.

The research for the Cambodia case was intended to identify the availability of remote sensing data for flood risk reduction in Cambodia. Radar Altimetry (ENVISAT/JASON-2) and TRMM measured water levels and precipitation data, while deforestation levels were monitored using LANDSAT imagery. However, the research has several limitations. The main limitation is the lack of in-situ data for data correction and accuracy verification. Two obstacles exist for obtaining the in-situ data in Cambodia.

The first obstacle is a lack of basic data due to insufficient disaster response systems in Cambodia. The Cambodian Government only recently began disaster preparation efforts since the country had a stable history in terms of natural hazards. Therefore, there is a lack of measurement data for disaster management. The World Meteorological Organization (WMO) is operating the World Weather Information Service to provide weather information. The WMO Typhoon Committee consists of 14 countries in the Asia-Pacific region such as the Republic of Korea, Japan, China, Thailand, and the Philippines (including Cambodia) in order to mitigate hurricane damage. However, weather forecast information is not available in Cambodia due to a lack of correct weather gathering nods.

The second obstacle is the language barrier. Cambodia is a non-English-speaking country and their average TOEFL grade is 68 points (132nd rank out of 157 countries) (ETS TOEFL, 2010). The problem is that access to data is difficult when foreign researchers try to cooperate with government officials and encounter linguistic barriers.

As analyzed, the barriers to DRR technology can be summarized: insufficient capabilities in beneficiary countries, cost burdens of providers, the conflict of interest between providers and adopters during technology transfer and sharing, lack of additional budget for DRR technology sharing, recipient countries' insufficient enabling environment to adopt advanced technology, and language barrier.

4.2 Web-based platform as a solution

A web-based platform emerges as a solution to foster technology sharing since it provides an extremely valuable and powerful ecosystem that quickly and easily scales, morphs, and incorporates new features, users, and partners (Simon, 2013). Additionally, a web-based platform can successfully solidify into a powerful tool that incorporates DRR technology developers, practitioners, and stakeholders into one community, which will entice powerful outsiders to join in the exchange of knowledge, accessibility of information, and forum to suggest possible solutions.

Even with the advantages of a web-based platform, there has been little progress in the development of web-based platforms in the area of DRR technology sharing and transfer. We searched and analyzed 195 web sites operated by international, Asian, America, and EU organizations containing information related to overseas disaster technology and information platforms. We identified that these web sites contain information on meteorology, hydrology, geology, geospatial information, disaster information, climate change, etc. More notably, the contents of these web sites are limited in scope to presenting tools, solutions, and software products related to: research and expert evaluation, project information, disaster data and statistics information, and real-life case studies. However, there are only a few web sites dealing with disaster technology products in the DRR field.

Considering the urgent need of a web-based platform for DRR technology sharing, NEMA Korea pledged to contribute to the development of a web-based platform for DRR technology sharing in 2010 at the fourth AMCDRR. The AMCDRRs have been held every two years since 2004 for the engagement of high-level government officials on disaster management and other stakeholders including parliamentarians and science and technology groups. At the fourth AMCDRR, held in Incheon, Korea, in October 2010, the Incheon REMAP was adopted by ministers and high-level officials from 53 countries in Asia and the Pacific region.

The key issues of the fourth AMCDRR were as follows: "strengthening capacities for DRR and CCA," "sharing technology and information," and "integration for DRR and CCA into development." Of particular importance, agreements were reached on plans to organize education and training programs on CCA and DRR for government officials and other stakeholder groups. In addition, design plans for establishing a web-based platform for collecting and dispersing data and technology on climate changes and DRR were developed (NEMA Korea and UNISDR, 2010).

NEMA Korea has continued to develop the web-based platform as a follow-up of the Incheon REMAP since 2011 by recognizing the importance of technology sharing among Asian and Pacific region countries. In the following section, four types of technology sharing platforms that NEMA Korea have attempted will be explained. Users and subject matter experts have developed the platforms according to inputs.

5. Evolution of web-based platform developed by NEMA Korea

5.1 Evolution of web-based platform

5.1.1 Merchandise display-type platform. As shown in Figure 1, the platform was constructed in a way that existing technologies (product) were listed and show cased since the fourth AMCDRR in 2011. DRR technology is displayed according to the item category. Over a year, the research staff operated web-based platform had approximately 100 visitors who were mainly professionals. However, the number of visitors had not significantly increased and an evaluation of the platform was made by two professors, one national disaster mitigation institute staff, one UNISDR professional officer, and one disaster management consultant. Out of the rating standards of poor, good, and excellent, the usability of the platform was rated as good while its usefulness was rated as poor.

Many visitors had a difficult time in identifying the key content of the technologies because there were too many products listed. It was criticized for not having enough technical content. In addition, there was difficulty in communication between technology providers and consumers. This platform is too similar to the existing DRR web site (e.g. Prevention Web), so people tended not to visit it more than once. The platform attracts consumers by site design rather than actual disaster technology content. This type of platform is too cumbersome to obtain enough vital users because necessary information is scattered across the platform.

5.1.2 Journal-type platform. A journal-type platform was chosen to overcome the disadvantage of the merchandise display type. This type of platform involves professionals from across various countries and regions building an online community in the form of disaster news articles, exhibitions, fairs, and various fields. In this way, experts can share their opinions and ideas on a variety of international disaster technologies and information sharing platforms through blogs or other media (Figure 2).

Figure 1.
Merchandise display-type platform

Source: Created by authors

Figure 2.
Journal-type platform

Source: Created by authors

Professionals from the UK, Canada, Japan, and the USA who participated in ISO/TC223 also rated the web-based platform. The raters included the Societal Security Technical Committee, five professionals who participated in TIEMS (The International Emergency Management Society), one DRR technology consultant, two government officers, and three professors. The platform received a poor rating in both usability and usefulness.

Despite this aim, the number of searches decreased due to the lack of publicity. To make up for previous failures, this platform was introduced with content similar to foreign web sites that incorporate international conferences and seminars. However, it also failed due to low participation. The weakness of this method was the requirement for significant labor to provide and update various information, practices, research information, news, trade shows, and conferences. In other words, someone who is quantitatively and qualitatively equivalent to a journalist should continuously generate content. In addition, copyright restrictions remained a serious problem.

5.1.3 Electronic market-type platform. To overcome the deficiencies of the journal-type platform, an electronic market-type platform was developed as shown in Figure 3. The platform allows the exchange of information about disaster technologies through the web site to support offline trades among market users such as companies providing technical content, potential consumers, such as national and local governments in Asia and the Pacific, and UN organizations.

With applications in e-commerce, the web-based platform allows transactions in DRR technology to be made between suppliers and consumers with technology providers such as businesses, research institutes, and public institutions. Consumers such as governments, UN institutions, and corporations can access the technology online and foster commerce within the platform through offline communication.

Before making the platform public, we collected professional opinions on its feasibility. Approximately 20 professionals from Indonesia, Laos, Germany, Japan, India, USA, Korea, UN institutions, and others who participated in the International

Source: Created by authors

Figure 3. Electronic market-type platform

Conference (2013) and the DRR Professionals Conference (2014), and ten experts from DRR technology corporations evaluated the platform. It received a rating of good for its usability and usefulness.

According to the overall opinions from experts, the main challenge in operating an electronic market-type platform was the proactive engagement of suppliers and consumers. Suppliers are intended to provide DRR technology only if consumers show interest in actively participating in the platform. Even if the suppliers make a wide array of technology content available, generating consumer interest remained a challenge. Experts summated that this problem would be difficult to overcome if the main draw to the platform is limited to just technology content.

In this approach, providers spontaneously introduce their technical content, and then DRR experts evaluate the provided technical products. The key success factor for this approach is how many providers and consumers work together voluntarily to enhance the platform. However, this approach turned out to be non-functional due to insufficient consumers and providers. To attract consumers, the operator had to advertise their platform. This diminished the original purpose of the electronic market-type platform, which promoted direct connections between the providers and consumers.

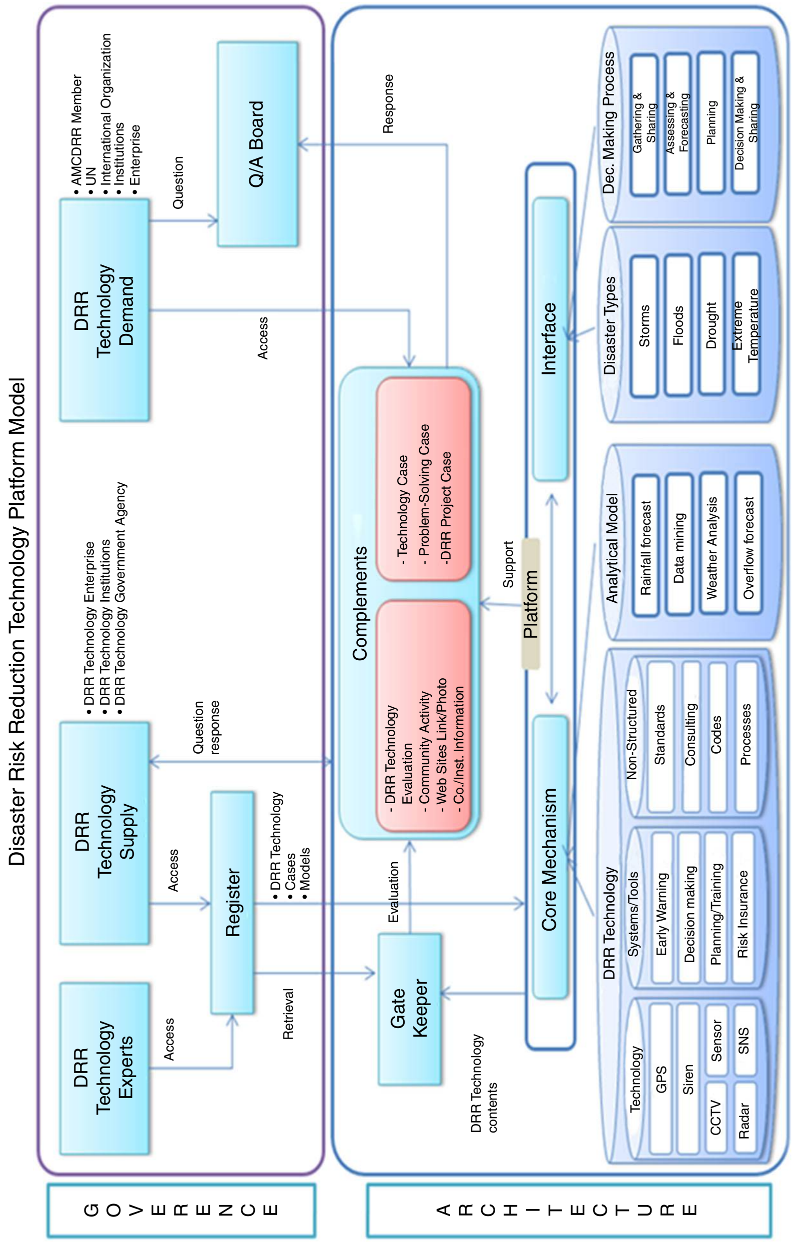
5.1.4 Architecture and governance-type platform. Based on the lessons learned from the previous three types of platforms and recent studies on technology information platforms (Eisenmann *et al.*, 2006; Eisenmann, 2007; Baldwin, 2008; Gawer, 2009; Tiwana *et al.*, 2010), a new type of web-based platform shown in Figure 4 was proposed; having two components: architecture and governance (Lee and Kim, 2014). Architecture defines the principles and guidelines of the design and alteration of the system while governance signifies the structure of opportunities and authorities among the participants of a business ecosystem and the system of incentive provision.

The architecture consists of several elements including key mechanism, supplement, gatekeeper, etc. The key mechanism, which is the DRR technology information that shows technologies, systems, tools, non-structured technologies, as well as an analytical model, is the central part that implements tasks through hardware according to the user's demands. An interface is the touch point between the user and the user application. The key mechanism with an interface is a module that is reused while the entire system remains unchanged.

The second element of the architecture is the basic and un-reusable module complements that include various advice, opinions, ideas, experiences, insights, and knowledge surrounding case studies where DRR technology is used. The third element is made up of the gatekeeper, who implements a decisive role in providing key values, is the constituent that qualitatively changes the information content by filtering, selecting, scaling, processing, and packaging it.

Governance will function as a tool that will provide opportunities for new groups participating in the platform and in creating new value. The main role of the platform's governance is to exchange the opinions, questions, evaluations, problems, and prepare incentives for sharing information among demanders and experts, as well as suppliers of private sectors and institutions.

To evaluate the effectiveness of the platform, three surveys were conducted over two years with 44 DRR experts: 15 in a side event during the sixth AMCDRR in Bangkok, Thailand in 2014, 19 in a side event during the third WCDRR in Sendai, Japan in 2015, and five from government/academia and five from disaster technology corporations in a DRR conference in Seoul, Korea in 2015. Totally, 35 experts in the



Source: Created by authors

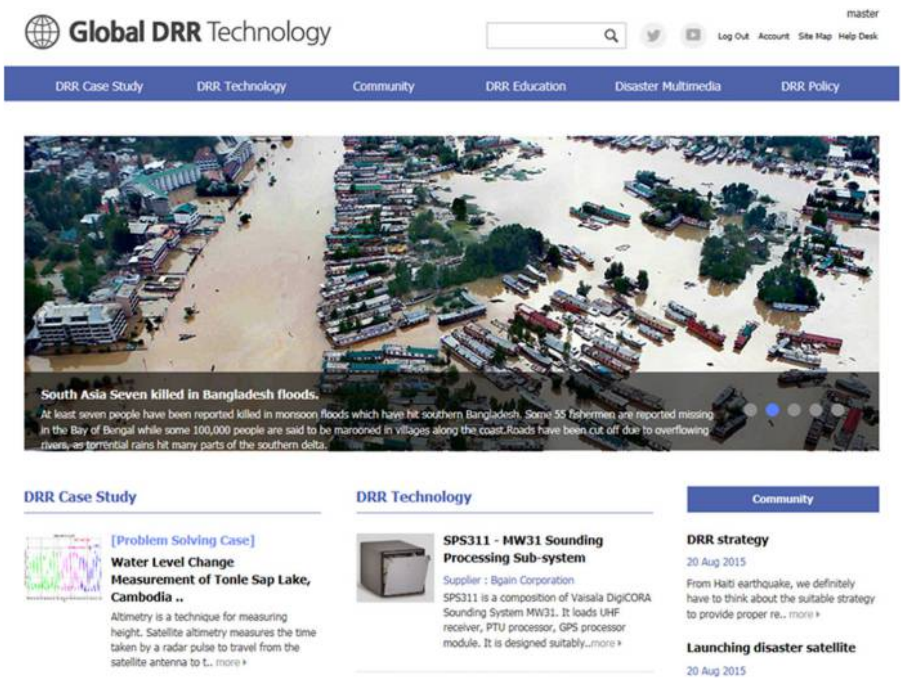
Figure 4.
Governance and architecture approach

survey gave an excellent rating to the platform's usability and showed a strong interest in being proactively engaged in DRR technology sharing through the platform. We also drew the following four key elements for the success of the platform from the survey results:

- the first element is the usage of the platform: the decision-maker should be able to glean critical information for the investment to DRR out of the national budget;
- the second element is its content: practitioners should be able to find applicable disaster cases that include the root-causes, problems, suggested solutions, and available technologies to sort out specific problems;
- the third element is its openness and engagement: stakeholders should be able to discuss problems, solutions, and technologies interactively and opine on the effectiveness of suggested technologies; and
- the last one is its commercialization: unlike general information and knowledge sharing platforms, the providers should be able to recognize new business opportunities for profit by opening their technology to potential clients (Figure 5).

5.2 Analysis of results

Great effort has been made to upgrade the technology sharing platforms. Lessons learned from operating the DRR technology platforms are summarized in Table II. This result is based on three evaluation criteria and seven indicators. The lessons and advertisement methods of each platform have been summarized. As shown in Table II,



Source: Created by authors

Figure 5.
Governance and architecture type platform

Framework	Success indicators
Merchandise display-type platform	Usable: good Used: good Useful: poor Good: accessibility, target action, prospect rate, resource utilization, committed visitor index Poor: conversion rate, abandonment rate, return rate Average session duration: 100 experts access 1 year operation by researcher
Journal-type platform	Usable: poor Used: marginal Useful: good Good: conversion rate, abandonment rate, return rate Poor: accessibility, target action, prospect rate, resource utilization, committed visitor index Average session duration: 20 expert registration 200 expert e-mail 1 year operation by reporter
Electronic market-type platform	Usable: good Used: good Useful: good Good: accessibility, target action, prospect rate, resource utilization, committed visitor index, conversion rate, abandonment rate, return rate Average session duration: 90 technical items
Architecture and governance-type platform	Usable: excellent Used: excellent Useful: excellent Excellent: accessibility, target action, prospect rate, resource utilization, committed visitor index, conversion rate, abandonment rate, return rate Average session duration: 93 technical items 3 types of case studies

Table II. Summary of web-based approaches on success indicators

four approaches have been evaluated based on the criteria where the technology was evaluated whether it is "useable," "used," and "useful" based on seven indicators. The analysis result indicates that architecture and governance-type platform is the most desirable type for DRR technology sharing, being rated excellent in all indicators. In addition, the following four principles were made through the lessons learned from the four years of experience in the development and operations of the three types of platforms and the surveys of experts' opinions. First, the DRR technology sharing platform should be developed based on end-users' needs, rather than that of the platform manager. Second, the platform must take a problem-solving approach, rather than a technology-display one. Third, the platform must contain interactive communication tools so that users can freely discuss problems, offer solutions, and provide technologies. Finally, the platform should provide business opportunities and profit for DRR technology providers who open their technologies. Overly, a continuous monitoring and evaluation should be followed to ensure the platform is successful.

6. Conclusion

The demand for DRR technology sharing and transfer has been increasing. In particular, in Asia-Pacific countries, which have experienced various catastrophic disasters recently and have expressed greater interest toward a DRR technology sharing platform. Even though many countries are willing to share lessons from failure, sound practices and technologies for DRR, it is hard to find web-based sites where developers, practitioners, government officials, and experts in developing countries can find appropriate DRR technologies and DRR technology developers to solve issues and risks.

This study identified the barriers why DRR technology sharing is limited in Asia-Pacific countries. The first reason is that disaster-related investment has been motivated by the government sector rather than the private sector. However, the investment priority of most governments for disaster preparedness is of least concern. Therefore, most disaster-related investment in developing countries have relied on the flow of international aid. Once international funds expire or run out, the beneficiary country is no longer capable of spending money on DRR within its own budget. Second, even though free or inexpensive technology, such as GIS and remote sensing technology, is available and ready for transfer, the enabling technical environment and human capital to apply those technologies are not ready in the beneficiary countries. Finally, the language barrier is an additional source of the difficulty of technology transfer.

In addition, four principles have been drawn and recommended: center on end-users' needs based on usage; focus on problem solving based on content; incorporate inter-activeness by targeting openness and engagement; and provide business opportunities through the commercialization of platform.

This paper focusses on DRR technology sharing and transfer in Asia and the Pacific region. However, the methodologies and recommendations of this paper can be applied and extended to the global level for future research.

References

Allen, T.J. (1984), *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R&D Organization*, MIT Press Books, Massachusetts Institute of Technology, Cambridge, MA.

Anderson, E. and Gatignon, H. (1986), "Modes of foreign entry: a transaction cost analysis and propositions", *Journal of International Business Studies*, Vol. 17 No. 3, pp. 1-6.

Baldwin, C.Y. (2008), "The architecture of platforms: a unified view", *Land Journal of Economics*, Vol. 37 No. 3, pp. 668-691.

Buckley, P.J. and Casson, M. (1976), *The Future of the Multinational Enterprise*, Macmillan, London.

Dainow, B. (2016), "Key performance indicators of web sites", available at: www.thinkmetrics.com/thebasics.php (accessed March 10, 2016).

Darwanto, H. (2012), *Preliminary Examination of Existing Methodologies for Allocating and Tracking National Government Budget for Disaster Risk Reduction (DRR) in Indonesia*, UNISDR.

Eisenmann, T. (2007), "Managing proprietary and shared platforms: a life-cycle view", Research Paper No. 07-105, Harvard Business School Technology & Operations Management Unit, Boston.

Eisenmann, T.R., Parker, G. and Van Alstyne, M.W. (2006), "Strategies for two-sided markets", *Harvard Business Review*, October, pp. 1-10.

EM-DAT (2016), "The international disaster database", available at: www.emdat.be/database (accessed June 21, 2016).

ETS TOEFL (2010), "Test and score data summary for TOEFL internet-based and paper-based tests", available at: www.ets.org/s/toefl (accessed March 15, 2015).

Frappart, F., Calmanta, S., Cauhopéa, M., Seylerb, F. and Cazenavea, A. (2006), "Preliminary results of ENVISAT RA-2-derived water levels validation over the Amazon basin", *Remote Sensing of Environment*, Vol. 100 No. 2, pp. 252-264.

Gawer, A. (Ed.) (2009), *Platforms, Markets and Innovation*, Edward Elgar, London, pp. 19-44.

Gordon, M. (2013), *Exploring Existing Methodologies for Allocating and Tracking Disaster Risk Reduction in National Public Investment*, UNISDR & GAR, Geneva.

Hagood, J. (2006), "Why does technology transfer fail? Two technology transfer projects from Peronist Argentina", *Comparative Technology Transfer and Society*, Vol. 8 No. 1, pp. 73-98.

ISO/IEC 25010 (2011), "Systems and software engineering – systems and software quality requirements and evaluation (SQuaRE) – systems and software quality models", Monolingual, ICS: 35.080, 1st ed., 34pp, available at: www.iso.org/iso/catalogue_detail.htm?csnumber=35733.

Isobe, T., Makino, S. and Montgomery, D.B. (2000), "Resource commitment, entry timing, and market performance of foreign direct investment in emerging economies: the case of Japanese international joint ventures in China", *Academy of Management Journal*, Vol. 43 No. 3, pp. 468-484.

Kellett, J. and Caravani, A. (2013), *Financing Disaster Risk Reduction: A 20 Year Story of International Aid*, GFDRR.

Kim, J.H. (2012), "The influence of public dispute on trade/investment disputes: case of SsangYong Motors", *International Journal of Contents*, Vol. 8 No. 2, pp. 75-81.

Korea Development Institute (2013), "Impact evaluation at KDI school: lessons for the KSP", *International Conference on Developing Evaluation System for the Knowledge Sharing Program, Seoul, March 21-22*.

Larsson, M., Wall, A., Norstrom, C. and Crnkovic, I. (2006), "Technology transfer: why some succeed and some don't", *Proceedings of the 2006 International Workshop on Software Technology Transfer in Software Engineering, Association for Computing Machinery, Shanghai*, pp. 23-28.

Lee, H., Shum, C.K., Tsesng, K.-H., Huang, Z. and Sohn, H.-G. (2013), "Elevation changes of Bering Glacier System, Alaska, from 1992 to 2010, observed by satellite radar altimetry", *Remote Sensing of Environment*, Vol. 132, pp. 40-48.

Lee, Y.-J. and Kim, Y. (2014), *Establishing a Web-Based Platform to Share Technology and Information for Disaster Risk Reduction*, GAR, UNISDR.

Moore, K. (2014), "Top 5 Google analytics KPIs: a beginner's guide to web analytics,", available at: www.datapine.com/blog/top-5-google-analytics-kpis/ (accessed June 21, 2016).

NEMA Korea and UNISDR (2010), *The 4th Asian Ministerial Conference on Disaster Risk Reduction*, Registration No 11-1660000-000629-14, Incheon, October.

Nerem, R.S., Chamers, D.P., Choe, C. and Mitchum, G.T. (2010), "Estimating mean sea level change from the TOPEX and Jason Altimeter Missions", *Marine Geodesy*, Vol. 33 No. S1, pp. 435-446.

Peterson, E.T. (2005), "Chapter 4. Measuring web site usability", in Odewahn, A. and O'Brien, M.T. (Eds), *Web Site Measurement Hacks: Tips & Tools to Help Optimize Your Online Business*, O'Reilly Media, Inc., Sebastopol, CA, pp. 218-266.

Prasanna, R. and Huggins, T.J. (2016), "Factors affecting the acceptance of information systems supporting emergency operations centres", *Computers in Human Behavior*, Vol. 57, pp. 168-181.

Simon, P. (2013), *The Age of the Platform*, Motion Publishing, Henderson, NV.

Tiwana, A., Konsynski, B. and Bush, A.A. (2010), "Platform evolution: coevolution of platform architecture, governance, and environmental dynamics", *Information Systems Research*, Vol. 21 No. 4, pp. 675-687.

Tonkin, S., Whitmore, C. and Cutroni, J. (2011), "Chapter 8. Maximizing web site performance", in Booth, D.A. and Koberg, C. (Eds), *Performance Marketing with Google Analytics: Strategies and Techniques for Maximizing Online ROI*, John Wiley and Sons, Hoboken, NJ, pp. 119-223.

UNISDR (2013a), "1st information and knowledge management for disaster risk reduction (IKM4DRR)", final report, workshop, Geneva, May.

UNISDR (2013b), "Technology transformation", *Global Platform Conference*, *Geneva*, *May*.

UNISDR (2015), "Sendai Framework for disaster risk reduction 2015-2030", *Third World Conference on Disaster Risk Reduction*, *Sendai*, *March*.

UNISDR (2016), "The science and technology roadmap to support the implementation of the Sendai Framework for disaster risk reduction 2015-2030", Geneva, 29 February.

Venkatesh, V., Thong, J.Y.L. and Xu, X. (2012), "Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology", *MIS Quarterly*, Vol. 36 No. 1, pp. 157-178.

Walker, A. and Ellis, H. (2000), "Technology transfer: strategy, management, process and inhibiting factors, a study relating to the technology transfer of intelligent systems", *International Journal of Innovation Management*, Vol. 4 No. 1, pp. 97-122.

World Bank (2008), *Global Economic Prospects 2008: Technology Diffusion in the Developing World*, The International Bank for Reconstruction and Development/The World Bank, Washington, DC.

Further reading

Choi, B.S. (2012), "Value creation frame platform leads a plural revolution", *Donga Business Review*, Vol. 103 No. 2, pp. 68-75.

Jose, S.R.G. (2012), *Preliminary Examination of Existing Methodologies for Allocating and Tracking National Government Budget for Disaster Risk Reduction (DRR) in the Philippines*, UNISDR, December.

Phaup, M. and Kirschner, C. (2010), "Budgeting for disasters: focusing on the good times", *OECD Journal on Budgeting*, Vol. 2010 No. 1, pp. 1-24.

WMO (2016), "World weather information service", available at: http://worldweather.wmo.int/en/home.html (accessed March 5, 2016).

Corresponding author

Hong-Gyoo Sohn can be contacted at: sohn1@yonsei.ac.kr