Crisisonomy Vol.12 No.10, 133-148
ISSN 2466-1198 (Print) ISSN 2466-1201 (Online) http://dx.doi.org/10.14251/crisisonomy.2016.12.10.133

Crisisonomy

Future Directions of Research on Crisis Management Using Big Data

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Abstract

Big data can be considered a new paradigm not only in developing disaster prevention technology but also in the area of comprehensive crisis management. To keep in step with this trend, this research attempted to explore ways that can be used to establish a crisis management system by crisis type. Findings of this research suggest as follows: First, big data in the field of crisis management has been used on analyzing disaster area, that should be expanded to the non-utilization field. Second, the construction of sustainable infrastructure utilizing big data is of vital importance now. Third, social media such as Twitter, Facebook should be used to their maximum potential as utilizing big data. Therefore, it will be analyzed synthetically and scientifically if big data-utilized data processes such as simulation, and visualization by making use of large-scale and complex information can be implemented.

Key words: crisis management, comprehensive crisis type, big data, social media

Ⅰ. Introduction

People in the modern society are enjoying comfortable lives with products and materials because of science and technology, going through the period of industrialization and modernization. On the other hand, damage of natural disasters has been increasing due to environmental changes because of exhaustion of resources. Also, new dangers such as variable diseases, nuclear power safety, attack of terrorists, and cyber terror are spreading across national boundaries (Choi, *et. al.*, 2014; Digital Times, 2016; JoongAng Ilbo, 2016). As this modern society is exposed to high-risk state, shift to a new paradigm from existing disaster management method is necessary for managing crises effectively. Here, big data, together with diffusion of digital economy, development of IT, and high technology is now considered a major source for innovation, reinforcement of competitiveness, and enhancement of productivity in an era of IT. Utilizing big data in the disaster field is also regarded as a part of this worldwide trend (Jung, 2013).

Utilizing big data for managing disasters can make

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it possible for a country to ensure its citizens, economy, and environment from all military and non-military crises that can threaten sustainable development. Along with this basic principle, research dealing with all crisis types should be conducted systematically (Lee, *et. al.,* 2012; etnews, 2016; Korea IT Times, 2016). Also Big data marks the beginning of a crisis management transformation(Viktor, 2013). For example, in Japan where a natural disaster such as earthquake is likely to occur, NTT Tokomo, a mobile telecommunication company, has been utilizing big data that is related to mobile space control technology in such diverse fields as disaster prevention, urban planning, and analysis of commercial spheres. In 2011, the company announced a simulation result which stated that, if an earthquake occurs in the Tokyo metropolitan area, 'those who would have difficulty going home' could reach 4,250,000 persons. This kind of research result can provide base for establishing disaster measures as temporary shelter and support for materials supply (Dong A Ilbo, 2016. 01. 05). And in Japan government will begin developing a system to help disaster victims by utilizing big data gathered from sources such as internet postings, and global positioning system (GPS) data from smartphones and car navigation devices(The Japan News, 2016. 10. 23).

The Park Keun-hye Administration has promoted Government projects by making public information available to the public in the 'Basic Plan for Promotion of Government 3.0' on May 28, 2013, and by demolishing barriers between Government departments for the sake of communication and cooperation in an effort to provide customized services to citizens. It also announced a new paradigm for operation of the Government that supported such worthwhile projects as job creation and creative economy using big data. This paradigm of Government operation included six major fields such as safety and welfare, and presented three primary pilot projects such as public order, disaster, and traffic safety. Currently, social conflicts keep on increasing due to an increase in natural, human, and social disasters caused by rapidly proliferating danger of terrorism and abnormal climate throughout the world, the new paradigm seems to be quite timely (The Relevant Authorities, 2013; Busan, 2016; Yonhap News, 2016; EBN, 2015; Seoul Public News, 2016).

The present research attempts to explore ways that can help construct a crisis management system by crisis type utilizing big data. For accomplishing the research purpose, an attempt was made to figure out basic concepts of big data, crisis by type, verify management examples by disaster type utilizing big data, and lastly present developmental plans through utilizing big data in the future.

II. Theoretical Background

1. Definition of Disaster and Type of Crisis Management

According to Article 3 (Definition) of Framework Act on the Management of Disasters and Safety, a 'disaster' refers to what causes damage to life and physical body of citizens, property, and the state. First of all, there is a type of natural disaster such as typhoon, flood, heavy rain, gale, storm, tsunami, heavy snow, lightening, drought, earthquake, yellow dust, algal epidemic, ebb and flow, volcano activity, and damage caused by

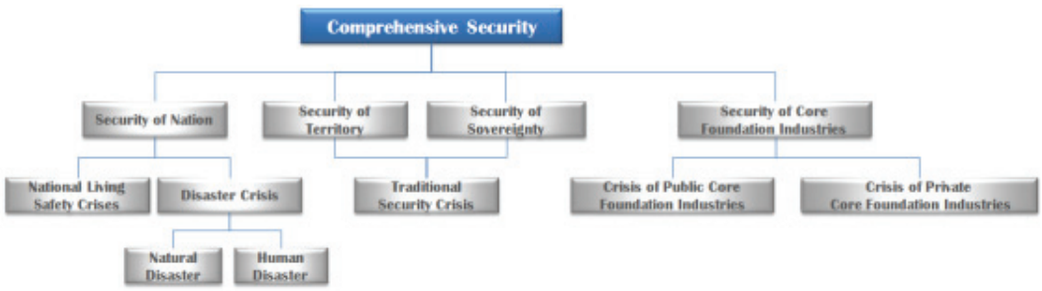

Figure 1. Concept of comprehensive security and crisis type (Modified from Lee, *et. al.*, 2012: 76)

similar natural disasters. Second, there is a type of social disaster such as damage caused by fire, collapse, explosion, traffic accident (including air and marine accident), CBR (chemical, biological, and radiological) accident, and environmental accident that are bigger than what are specified by Presidential Decree. Third, there are damages caused by paralysis of foundational systems of a nation such as energy, telecommunication, transportation, finance, medicine, water supply, infectious diseases as specified in Infectious Disease Control and Prevention Act or proliferation of livestock epidemic as specified in Act on the Prevention of Livestock Epidemic.

It was not easy for Korea to expand the area of crisis management since such traditional crises as war, local conflict, infiltration of territory, and impingement on sovereignty were more serious than any other types of crisis. But recently, there is increasing demand to construct management systems for types of crisis other than that of traditional security crisis with enhanced awareness. The so-called concept of 'comprehensive security' that encompasses not only military invasion from outside but also such diverse elements as various crises, diseases, hunger, unemployment, crime, terror, social conflict, political oppression, and hazardous natural environment as the target of security have emerged significantly in security discussions (Lee, *et. al.*, 2012: 70-72). The concept of security can be schematized as shown in 〈Figure 1〉.

As presented in 〈Figure 1〉, comprehensive security can be divided into security of nation crisis, security of territory crisis, security of sovereignty crisis, security of Critical Infrastructure industries crisis. Security of nation crisis can compose of national living safety crises and disaster crisis. Security of territory crisis and security of sovereignty crisis can be integrated into traditional security crisis, and security of Critical Infrastructure industries crisis can be divided into crisis of public Critical Infrastructure industries and crisis of private Critical Infrastructure industries. Included in national living safety crises are vulnerable social group crisis, living economy crisis, living public order crisis, traffic life crisis, vocational life crisis, school life crisis, living foodstuffs crisis, household items crisis, living health crisis, living facilities crisis, and living environment crisis. Disaster crises can be divided into natural disaster and human disaster, and included in the former are typhoon, heavy rain, localized heavy rain, storm, earthquake, tsunami, heavy snow, and heat wave, whereas included in the latter are fire, collapse, explosion, sinking, fall, traffic accident, and CBR (chemical, biological, and radiological) accident. Included in

traditional security crisis are war, local provocation, sudden change in North Korea, development and proliferation of WMD (weapons of mass destruction). military threat from neighboring countries, conflict and clash with neighboring countries, infiltration of territory, damage to sovereignty, local conflict, and terror. Included in crisis of public Critical Infrastructure industries are finance, traffic and transportation, electric power, telecommunication, energy, nuclear power, dam, government facilities, public safety, public health, industrial complex, and historical relic and remains, whereas included in crisis of private Critical Infrastructure industries are commercial facilities, daily necessity, social conflict, and hazardous material crisis (Lee, *et. al.,* 2012: 76).

2. Big Data and Disaster

Big data refers to massive data that is difficult to collect, store, retrieve, and analyze with existing methods as the volume of its generation, cycle, and form are too big in comparison to existing and traditional data. Big data appeared as volume of data was increasing due to development of the Internet. As computer and technology have been developed and data analysis has been carried out using big data in the digital environment, the advent of a new perspective or principle can be discovered regarding changes in social phenomena are likely to be realistic (Parkmoonkak, 2013).

One of the characteristics of big data is that, when a user wants to find something, it finds and analyzes data and provides results. Especially, big data is voluminous in size and includes unstructured data such as multimedia in addition to log record, social, location, consumption, and reality data. Also it encompasses varieties of data, generates fast, and circulates speedy in real time data such as object information (sensor, monitoring) and streaming information (Hwang, *et. al.,* 2013; Choi, 2012).

Big data is expected to possess excellent utility in the field of crisis management. It will enable real-time processing of large capacity information that is generated throughout such diverse fields as climate change, prevention of marine pollution, and detection of radiation leaks[1]. It can be utilized in such areas as financial fraud, money laundering, and analysis solution of customer behavior. It can be used in analyzing information on typhoon, precipitation, and earthquake in order to predict possibility of tsunami and flood (National Informatization Policies Committee, 2011). More recently, ISIS (Islamic State in Iraq and Syria), the terrorist group that attacked Paris and Beirut, is known to have used social media for the purpose of propagating their propaganda and messages throughout the world. Thus, the skillful utilization of big data can help detect and respond to elements of national security threat in advance (LG CNS, 2015). Of special concern in this regard is the use of social media, which refers to a platform that enables subscribers of Social Networking Service (SNS) such as Twitter and Facebook to share their information and opinions in order to broaden their human networks. Virtue of this kind of social media

1) Such advanced countries in disaster prevention as the United States, Great Britain, and Japan are cooperating each other to prevent disasters by linking and constructing diverse monitoring systems using advanced equipment and sensors (National Informatization Policies Committee, 2011).

lies in its capacity to exercise power when an accident or disaster occurs (Lee, 2013).

3. Previous Studies Related to Big Data in Crisis Management Field

Until recently, previous studies related to big data in the field of crisis management have been concentrated on system development, utilizing sensing of disaster signs, analysis of foreign examples, and the role of central and local governments.

Kim & Cho (2013) have carried out research for introducing big data to local governments. Results of the research have indicated that, in order for local governments to utilize big data, an analysis of public data in possession and the state of infrastructure should be analyzed first. Also private businesses' participation should be actively induced through an emphasis on proliferation of shared culture by allowing free access to public information through open platforms, and maximization of collective intelligence through activation of related industries and establishment of related policies in local governments. They also observed that local governments should utilize the central government's big data support projects in public field, and adopt an analysis service utilization-type approach, which is an object-oriented introduction method.

Min & Jeong (2013) have defined constituents of big data (volume, variety, velocity, complexity), and carried out an empirical analysis of the effects that they have on decision making regarding disaster response activities. Results of the research revealed that flexibility, real time, cumulativity, expandability, analyticity, and convergence of big data have significant effects on situational awareness of disaster managers, but variety and un-structuredness do not have such effects. Situational awareness of disaster managers, however, had significant effects on decision making regarding disaster response activities. In addition, visualization turned out to have moderating effects on in-between situational awareness and decision making regarding disaster response activities.

KIPA (2013) has presented its research results on big data and disaster management. Main agent of organization and personnel management should be set up for establishment and promotion of related policies together with sharing of big data for national disaster safety management and establishment of management laws and systems. In addition, plans should be prepared for establishment of principles on making public and private DB available to the public and for protection thereof in the field of disaster and safety management.

Choi (2014) developed a model for sensing of disaster signs based on big data. According to Choi, this model is capable of detecting signs of urban inundation by linking such structured data as precipitation information and expected inundation mapping, social network service (SNS) and news in order to analyze danger areas through early detection of urban inundation signs and to transmit prompt warning.

Kim, *et. al.* (2015) introduced an analytical technology of big data other than text data in the area of natural disaster. They asserted that it turned out that data-based machine learning is much faster in most cases in implementation speed in comparison to numerical prediction model. Therefore, it enjoys a big competitive edge in

Table 1. Relevant studies

Researcher(s)	Research topic
Kim & Cho (2013)	Introducing big data to local governments
Min & Jeong (2013)	Analyzing effects on decision making regarding disaster response activities
KIPA (2013)	Relation between big data and disaster management
Choi (2014)	Developing a big data-based model for detecting signs of disaster
Kim, *et. al.* (2015)	Finding out analytical technology that handles big data in the area of natural disaster
Shin & Kim (2015)	Utilizing a policy of big data in the field of disaster management in Korea

short-term prediction where data-based machine learning has good result in comparison to existing numerical model. In the field of pattern recognition that has no relation to numerical prediction, it seems to indicate high growth potential of its own in the analysis of natural disasters.

Shin & Kim (2015) conducted a study on big data utilization policy in the field of disaster management in Korea. As a result, they presented a policy task to be promoted jointly by public and private sectors for making disaster-related big data available to the public, expand infrastructure, construct a disaster information delivery system utilizing social network service, and nurture disaster related big data professionals.

Ⅲ. Big Data Utilization Possibility by Crisis Type

1. National Living Safety Crisis

National Living Safety crisis can be classified based on principal agent, occurrence of crisis, and range of damage effect. First, in terms of principal agent, national Living Safety crisis can be divided into individual and society. Here, society refers to such entities as government, public, and unit of civilian organization. Occurrence of crisis and range of damage effect can be divided into narrow range, intermediate range, and wide range. Narrow range refers to individual and family whereas intermediate and wide ranges refer to business site or company (Lee, *et. al.*, 2012: 83-84). Purpose of national Living Safety crisis ultimately lies in securing safety in everyday life. For the purpose, it is necessary to consider the area related to safe life of a nation comprehensively (Lee & Yoo, 2007).

As big data does not simply provide information but enables the central government, local governments, civil sector, and companies to communicate and cooperate with each other, utilization of big data seems essential in national Living Safety crisis that handles the comprehensive area.

2. Disaster Crisis

With regard to disaster crisis, when a large-scale disaster occurs, if the government does not respond effectively in protecting lives and property, legitimacy of the government can be suspected. Therefore, it is necessary to approach disaster management on the dimension of national crisis management. Crisis in the field of disaster can be divided into natural disaster and social disaster (Lee, *et. al.*, 2012). As specified in Framework Act on the Management of Disasters and Safety, natural disaster refers to typhoon, flood, heavy rain, gale, storm, tsunami, heavy snow, lightening, drought, earthquake, yellow dust, algal epidemic, ebb and tide, volcano activity, fall or collision of a natural space object such as asteroid and meteoroid, and a natural phenomenon or its equivalent. Social

disaster refers to damage that was caused by fire, collapse, explosion, traffic accident (including air accident and marine accident), CBR (chemical, biological, radiological) accident, environmental pollution accident or similar causes that are bigger in size than what are stipulated under Presidential Decree, paralysis of national critical infrastructures such as energy, telecommunication, traffic, finance, medicine, water supply, or infectious diseases that are specified in Infectious Disease Control and Prevention Act, or proliferation of livestock contagious diseases as specified in Act on the Prevention of Contagious Animal Diseases.

At present, the reason why disaster crisis management through social media of big data becomes an issue is that support for prompt response is possible since situations of a disaster site can be shared with other users in almost real time. Also, since social media is characteristically a bi-directional service wherein everyone is information provider and information consumer at the same time, connection is possible anytime and anywhere so that access to a disaster site becomes easy, enabling reception and delivery of information possible to reinforce disaster response capability to a breakthrough level (Choi, *et. al.,* 2015).

3. Traditional Security Crisis

Traditional security crisis can be divided into crisis by neighboring countries and crisis from North Korea. Included in the crisis by neighboring countries are invasion of national territory by other country, military threat or challenge, terror, conflict between neighboring countries, war, conflict, and collision. Traditional security crisis from North Korea includes military threat from North Korea, non-military threat, local conflict, sudden change in North Korea, and development and proliferation of mass destruction weapons (Lee, *et. al.,* 2012: 87).

The US Government uses various types of big data (including structured and unstructured) as an important source for national defense and security programs in order to improve predictability of traditional security crisis. Especially, big data is utilized for predictive analysis and monitoring of homeland security, military operation, anti-terror measures, and strategies for amelioration of disaster and restoration. In 2015, it appropriated a budget of 33.3 billion dollars for national defense and supplementation utilizing big data (LLC, 2015).

4. National Critical Infrastructure Crisis

National critical infrastructure can be defined as essential political, economic, social, and cultural core elements and values that are necessary for operation and maintenance of a nation state. And national critical infrastructure facilities refer to facilities continuous management of which is recognized for protection of the national critical infrastructure (Cho, 2015). Crisis of national critical infrastructure signifies a situation wherein material, human, and functional systems, which can affect national security, essential functions of the government, national economy, and social vitality, are paralyzed by large-scale demonstration, strike, disaster, terror, and riot (Lee, *et. al.,* 2012: 88).

To manage national critical infrastructure crisis, it is necessary to share information and construct a warning system for operation. Also, for protection of national critical infrastructure, securing of nation's trust is required through enhancement of

awareness and social consensus of the nation. Accordingly, real time monitoring and utilization of a warning system using big data look quite useful (Lee, *et. al.*, 2012; Choi, *et. al.*, 2015).

Ⅳ. Big Data-Based Management Systems by Crisis Typology

Examples of big data that are applied to public sector, both in Korea and abroad, were chosen in the literature review part. These examples were classified by crisis type into national living safety crisis, disaster crisis, traditional security crisis, and public critical infrastructure crisis. A brief explanation of each example is followed by its implication.

1. National Living Safety Crisis

1) Utilization Example of Public Order Living Crisis

By constructing a big data-based crime map, San Francisco, US was able to patrol a wide area with limited police manpower and develop a crime prevention system in its effort to realize a safe local society. Also, through on-going observation of past criminals and crime type with social networks, related criminal organizations and crime could be prevented. The city of Memphis, Tennessee, also succeeded in reducing crime rate by 30% using similar methods. By predicting areas with high crime occurrence rate and occurrence time through an analysis of related data, crimes were prevented with shifting deployment of police personnel (Hankyung Business, 2013. 03. 22).

2) Utilization Example of Vulnerable Social Group Crisis

Korea has variously attempted to manage national living safety crisis utilizing big data. The County of Pyeong-chang has promoted big data-based Pyeong-chang Decrepitude Prevention Management Project with vulnerable senior citizens as target. From 2014, the County pursued a two-track decrepitude prevention project entitled "Big Data Construction and Tracking Management of the Elderly Health Survey, a big data-based Comprehensive Mediating Program for Vulnerable Social Group." The program was carried out in 2015 for six months with 43 persons in two areas as target. And as a result of this program, volume of muscles and sense of balance were enhanced, showing excellent efficacy in preventing fall accidents of the elderly. When combined with intake of special nutritious drink for the elderly and exercise, imbalance in nutrition was noticeably improved (Gukjenews, 2016. 02. 21).

2. Disaster Crisis

For fast and effective disaster response, Federal Emergency Management Agency (FEMA) of the United States supports information sharing among public institutions and related persons, delivery of business status, and cooperation system. In fact, in March 2010, thanks to the detection of heavy rain in New York which was forwarded via early warning system, damage to the citizens could be minimized through delivery of emergency situation and sharing of current information using smart phones and SNS of the managers of 15 core facility management agencies that include electric and other communication networks and related persons

(Park & Jung, 2010). Also, National Aeronautics and Space Administration (NASA) of the US predicted the moving route of hurricane Sandy via climate satellite TRMM and the timing of when it would reach the mainland by analyzing satellite pictures, microwave and radar sensor data, which enabled the advance response system (Shin & Kim, 2014).

In preparation for uncertain future due to frequent terrors and epidemics, the Government of Singapore has promoted from 2004 a big data-based risk management plan, constructed RAHS (Risk Assessment & Horizon Scanning) system in order to collect and analyze all national risks such as diseases and financial crisis for anticipative management. Collected risk information were analyzed through simulation and scenario techniques, so that risks can be predicted in advance to enable appropriate response measures (National Informatization Policies Committee, 2011).

The National Disaster Management Institute, Ministry of Public Safety and Security of Korea, has developed a disaster management system that integrates, when a disaster or safety accident occurs, all information such as CCTV, climate information, satellite image, electronic map information, and disaster history, and monitors, analyzes, and responds to actual situation of the sites as well as Smart Big Board that grasps disaster situation tri-dimensionally using real time monitoring system such as unmanned aerial vehicle. This Disaster Management System has been introduced to many cities and counties of the nation for actual utilization or test operation (Ministry of the Interior, 2014). Also, Ministry of Science, ICT and future planning has developed a system that can link and analyze KAHIS (Korea Animal Health Integrated System) data and telephone conversation log data of KT (Korea Telecom) that can predict proliferation route of AI (Avian Influenza) (Ministry of Science, ICT and Future Planning, 2015).

3. Traditional Security Crisis

Since 9.11 Terror, Department of Homeland Security (DHS) of the US paid special attention to terrorism and prevention of crimes. As part of this effort, Directorate for Science and Technology of DHS has introduced a government-wide prediction system by collecting and analyzing big data through blogs, social medias, and model examples. Especially, for cyber security, it has built a cloud security infrastructure using big data and organized NCTC (National Counter-terrorism Center) (Kim & Cho, 2013).

The Ministry of Defense, Korea has established National Defense Big Data Center and is now trying to construct an integrated a big data analysis system for national defense, create an environment for sharing and converging data for each business system, visualize the state of barrack security, and develop a model for efficient military operation. However, plans for responding to new types of threat, terrorism, and traditional security crisis still remain elementary (Etnews, 2016. 01. 06).

4. Critical Infrastructure Crisis

1) Utilization Example Related to Traffic and Transportation

In the US, New York city uncovered examples of violation in 13% of NY buildings by linking and analyzing data from 900,000 buildings and 19 public institutions (Shin & Kim, 2015).

The Intelligent Traffic Guidance System of Japan provides optimum traffic information to users by analyzing GPS data in real time using sensor data. It supplies optimum routes from a point of departure to an intended destination in real time after a comprehensive analysis of data that have been obtained from navigator users who agreed to provide taxi and information. It has succeeded in mitigating traffic jam while providing optimum information on traffic and traffic routes to users (Kim & Cho, 2013).

In Korea, the city of Seoul introduced an optimum late-night bus line by converging and analyzing transient population data of KT based on the volume of mobile phone conversation and traffic data possessed by the city. It reflects the result of convergence and analysis of big data that is composed of 3 billion cases of mobile phone call used by citizens from mid-night to 5:00 am and 5 million cases of boarding and unboarding data of late-night taxi used by citizens. Next, an analysis was carried out using data of existing bus routes and time, number of transient population by weekday, and traffic demand pattern, which was followed by a re-analysis involving weighted value calculation of transient population near bus routes in an effort to derive optimum routes and allocation interval. This is a notable case of big data utilization in urban traffic policy and has meaning in that it represented a conversion of conventional urban policy based on administrative data and big data that has been constructed by joint efforts of civil sector and official sector (Kim & Cho, 2013).

V. Big Data-Based Management Systems by Crisis Typology

The examples of big data-based management system by crisis type, both domestic and foreign, discussed above have been briefly summarized in the following table. The scope in the table is the utilization range of big data in local or central government.

As presented in the above table, it is clear that the big data-based management system by crisis type was utilized more by the central government rather than local governments by the ratio of 7 to 4. Out of those research results, the big data-based management system by crisis type can be summarized as follows:

First, the big data based management system was developed more in the area of disaster management, both in terms of incidence and utilization throughout the world. In the case of disaster crisis, development through cooperation between the private sector and the government sector and the central government oriented developments are being carried out actively. And the programs developed by the central government are being distributed actively to local governments for utilization.[2)]

Second, development of a disaster-type system using big data was carried out more by the central government throughout the world. Both in the US and Korea, although development of the system is also being carried out by local governments, the emphasis is more on central government oriented research, except in the field that is closely related to everyday life of citizens.

2) The Seoul Shinmun (2015.08.18); CCTV News (2015.12.01); Digital Times (2015.01.06)

Table 2. Big data based management system by crisis type: case analysis

Crisis Management Type	Example	Description	Scope (Government)	Country
National Living Safety Crisis	Living public order crisis	Crime rate declined after mapping of crimes utilizing big data	Local	US
	Vulnerable social group crisis	Health crisis prevented with operation of the comprehensive mediating program for vulnerable social group	Local	Korea
Disaster Crisis	Natural disaster, social disaster	An advance response system was made possible with detection of heavy rain and prediction of hurricane moving route	Central	US
		Methods to predict and respond to a disaster to be managed in advance through collection and analysis of national disasters	Central	Singapore
		Smart Big Board developed that is capable of grasping a disaster situation tri-dimensionally with the aid of monitoring equipment	Central	Korea
		Prediction of AI (Avian Influenza) proliferation route was made possible	Central	Korea
Traditional Security Crisis	Traditional security crisis	Cloud security infrastructure established for cyber security using big data	Central	US
		The state of barracks visualized through utilization of big data	Central	Korea
Critical Infrastructure Crisis	Utilization examples in traffic and transportation	Safety management of buildings analyzed utilizing big data	Local	US
		Traffic jam reduced through optimum provision of traffic information by introducing an intelligent traffic guidance system that utilized sensor data for real time analysis of GPS data	Central	Japan
		Optimum late-night bus was introduced through convergence and analysis of traffic data	Local	Korea

Third, as for Korea, analyses utilizing big data are still not available in view of the fact that big data analysis related to traditional security crisis is important. Although development of big data is being carried out for transparency of barrack operation, multi-faceted research using big data is seriously needed when considering that Korea is involved in challenges and danger of a war at all times and that building of an effective response system is badly needed to counter increasing terrorist threats throughout the world.

VI. Conclusion

In order to managing future-type disasters that are becoming increasingly larger, diversified, and more complex effectively, a shift to a new paradigm from the existing disaster management is necessary. The emphasis should be placed on enhanced capability of analysis in disaster management which is based on accumulated data rather than the central government oriented one-directional disaster management (Choi, *et. al.*, 2014).

This research focused on exploring ways to construct a crisis management system by crisis type for the future, to meet a new need for constructing crisis management systems utilizing big data (Digital Times, 2015). For accomplishing the purpose of this research, we have analyzed basic concepts of big data and crisis by type, introduced examples of disaster management by type that used big data, and figure out their implications. As one of implications out of this research, a development plan using big data in the field of crisis management

can be described as follows:

First, expanding non-utilization fields is necessary. The fields that require expansion in customized big data service include the following. Living economy crisis, vocational life crisis, school life crisis, living foodstuffs crisis, household items crisis, living facilities crisis, living environment crisis, war, local provocation, sudden change in North Korea, development and proliferation of WMD (weapons of mass destruction), military threat from neighboring countries, electric power, telecommunication, energy, nuclear power, dam, government facilities, public safety, public health, industrial complex, and historical relic and remains, commercial facilities, daily necessity, social conflict, and hazardous material crisis.

Second, infrastructure for utilization of big data should be constructed. It should be completed together with organization, hardware, software, manpower and related state analyses that are required together with development of big data in the field of crisis management. Especially, in terms of technological infrastructure, a thorough understanding of big data platform, big data analytical skill, and data analysis skill of crisis management experts should be preceded so that big data can be utilized with benefit in the field of crisis management.

Third, social media should be utilized actively in analyzing big data in the field of crisis management. In a gun fire accident at random that occurred in the U. S. army base at Fort Hood, Texas, in 2009, there were more than 40 casualties. At that time, a Facebook user created a page entitled "Prayers for Fort Hood" and posted information related to the accident together with his comments. Subscribers shared information on the safety of the affected family using Twitter and shared sorrow of the victims. Social media helped clear uncertain rumors on the incident within a few hours after the incident (Lee, 2013). As seen from the above, social media in crisis management and related fields are very diversified. When a crisis occurs, not only for diffusion of information and distribution of response measures, but social media as well can be utilized as a communication route for the responding organization.

To be sure, when big data is used in the field of crisis management, there are virtues in that more prompt response and prediction of a crisis are possible. At the same time, however, since a large-scale disaster occurs infrequently, there is a limit that related information can be utilized for statistical purpose. Furthermore, in case a prediction system with lower exactitude issues unverified information randomly, trustworthiness of the prediction declines to cause helplessness of possible counter-measures when a disaster actually occurs (Media It, 2014. 10. 15).

Despite these limitations, however, if future big data can be used for a meaningful integrated analysis of the past disaster history, results of related causal analyses, satellite images, and simulation, the entire process of disaster management can be implemented more scientifically. But more than anything else, if social media that can grasp the state of a nation are utilized in disaster management, a bi-directional disaster management could be realized that goes beyond the government-centered propagation of disaster responses (Choi, *et. al.*, 2015).

감사의 글

이 논문은 2016학년도 The 9th Sino-Korea International Conference on Crisis and Emergency Management in Chungbuk National University, Korea에서 발표한 논문을 수정 보완한 것임.

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Received: Jul. 28, 2016 / Revised: Aug. 29, 2016 / Accepted: Sep. 23, 2016

빅데이터 분석활용을 통한 위기관리분야 연구의 발전방향

국문초록 첨단과학기술의 발전과 함께 등장한 빅데이터는 스마트혁명 시기에 혁신과 경쟁력 강화, 생산성 향상을 위한 중요한 원천으로 간주되고 있고, 이를 재난분야에서 활용하는 것 또한 세계적인 흐름이다. 본 연구는 이러한 시대적 흐름에 맞추어 위기 유형별로 위기관리 체계를 구축할 수 있는 방안을 모색하고자 한다. 연구결과는 다음과 같다. 첫째, 현재 빅데이터의 위기관리 분야는 재난영역에 발달이 집중되어 있어, 비 활용분야의 확대가 필요하다고 본다. 둘째, 빅데이터의 활용을 위한 인프라가 구축되어야 한다. 셋째, 위기관리분야의 빅데이터를 분석하는 데 있어서 소셜미디어를 적극 활용하도록 한다. 아직 위기관리 분야에서 빅데이터를 적극적으로 활용하기에는 대규모 재난재해 사고는 발생 빈도가 매우 낮아 관련 데이터를 통계적으로 활용하기에는 한계가 있다. 그러나 이러한 한계에도 불구하고 앞으로의 빅데이터를 활용해 과거 재난이력 및 원인분석결과, 위성영상, 시뮬레이션 등을 의미적 통합분석을 한다면 재난관리 전 과정이 과학적으로 수행될 수 있을 것이다.

주제어 : 위기관리, 포괄적 위기유형, 빅데이터, 소셜미디어

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