

# A Study on Plan to Improve Illegal Parking using big Data

Keon Won Kim<sup>1</sup>, Won Joon Park<sup>2</sup> and Seong Taek Park<sup>3\*</sup>

<sup>1</sup>Department of Management, Sogang University, Korea; dark-kgw@hanmail.net

<sup>2</sup>The Korea Association of Software Manpower, Korea; pikapika722@nate.com

<sup>3</sup>Department of Management Information Systems, Chungbuk National University, Korea; solpherd@cbnu.ac.kr

## Abstract

Recently, the value of big data is being considered important. Also, the government, public institutions and private enterprises began to be interested in big data. Now, data has a lot of values, unlike the past. With the emergence of various planning and analysis techniques which are based on this data, big data is being established as a foundation for new high-level information creation and decision making advancement. This study aims to find an alternative for illegal parking using this big data. For achieving this purpose, this study attempted an approach to the plan to improve illegal parking using public data of Goyang City. In this study, public data of Goyang City was analyzed using open source R. Based on the analysis result, this study presented an alternative to improve illegal parking by installing CCTVs in Deogyang-gu, Goyang City.

**Keywords:** Big Data, CCTV, Disaster, Illegal Parking, Parking

## 1. Introduction

Fire accidents take away lives, assets, forests, and many other things in an instant. As well as all disasters, it is very important to control fire accidents in initial timing.

However, illegally parked vehicles block access ways of fire trucks or emergency transport vehicles which can bring disasters. Actually, an accident that occurred last January in an urban type house in Uijeongbu lost the “golden time” because illegally parked vehicles had delayed entrance of fire truck.

Also, vehicles owned by residents are parked on both sides of narrow roads near as parking lot installation standards have become relieved in urban type houses. This not only applies for the case above, but is commonly known that arrival time to fire accident scenes becomes longer due to illegal parking<sup>1</sup>.

Also according to an article in a fire fighting technical journal 119 Magazine (2007), “29 minutes have passed due to a house deep in a narrow road in Hongjae-dong in which the fire golden time had ended. The fire truck arrived during the inside ending fire finishing step that all situations on fire had already ended” and “Actually

looking back until now, fire scene commanders without professionalism had indirectly killed most firemen who have died in line of duty”<sup>2</sup>.

There are no specific accident statistics due to illegal parking, but traffic related non-governmental groups are estimating an annual number of 15,000 traffic accidents are concerned with parking. Traffic professionals recommend never to stop or park on roadsides because they become the cause of big traffic accidents. Also, increasing traffic congestions due to illegal parking are severe. Professionals analyzed that traffic congestion situations have increased a maximum of 20% due to illegally stopped or parked cars on roadsides<sup>1</sup>.

Seoul City has input a 830 million won budget among the 1.3 billion won parking control budget standard of 2015.03.14 in maintaining parking control CCTVs<sup>1</sup> and Yangsan new city is controlling illegal parking with parking and stopping car control CCTV installation as the number of car users is increasing due to the population influx standard to 2014<sup>3</sup>.

This study searches a plan CCTV installation for control as an alternative to relieve illegal parking in Gyeonggi-do Goyang City. For this, present CCTV

\*Author for correspondence

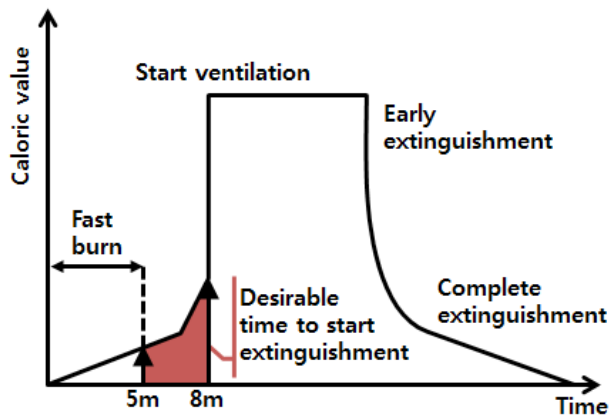


Figure 1. Fire accident growth curve<sup>4</sup>.

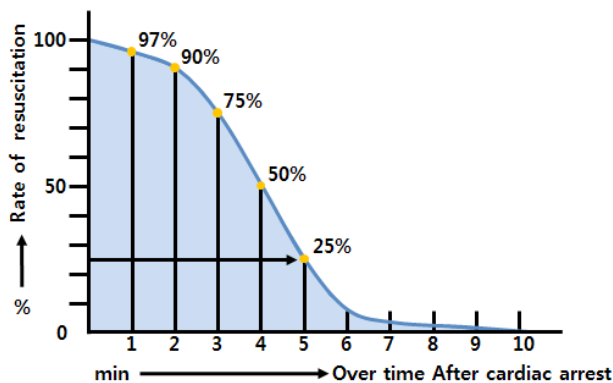


Figure 2. Survival rate of cardiac arrest patients<sup>4</sup>.

conditions by each gu of Goyang City and number of fire accident occurrences by building type were analyzed to propose a plan to relieve illegal parking focusing on areas with high frequency of fire accidents. By using big data analysis tool R, analysis between fire accident locations and CCTV is performed, and related visualization functions are to be used.

## 2. Theoretical Background and Preceding Researchers

### 2.1 Golden Time

Quick initial correspondence during disasters is the most important factor in reducing life and asset damage that the golden time system, a goal time for disaster correspondence was adopted.

Golden time is the initial 5 minutes of fire accident or patient occurrence to improve initial fire suppression and recovery rate of emergency patients.

According to analysis results of fire growth curves, serial spreading speed and damaged areas rapidly increase if fire suppression does not start within 5 minutes of fire occurrence. In case of emergency patients with cardiac arrest, survival rate rapidly decreases to under 25% if appropriate emergency measures are not taken within 5 minutes<sup>4</sup>.

There various reasons for not keeping the golden time such as illegal stopping or parking, congested roads, and unsecured entrance routes, but the most common reason is because fire trucks cannot enter roads due to illegal stopping or parking. Due to delayed fire suppression, fire trucks cannot arrive within desirable time and citizens receive damage of precious property or life. The reason illegal stopping or parking is because parking lot area is lacked in comparison with currently registered vehicles.

### 2.2 Preceding Researchers

Park used an AHP analysis method subject to 8 professionals with firefighting duty derived through a firefighting school education training program according to disaster management steps to derive importance of disaster management of firefighting duty<sup>5</sup>. Jung and Kim<sup>6</sup> conducted a study on efficient, reasonable fire truck dispatch driveway planning methods and quantitative assessment methods on the influence of type of fire truck dispatch route and management system on the improvement of preventing regional disasters. By understanding disaster preventing properties of the Daegu Gyeongbuk area, present conditions of the disaster preventing infrastructure were understood to assume occurrence of disasters. A network interpretation method was applied to build a disaster preventing infrastructure and management system fitting actual area conditions<sup>6</sup>. Kim et al. proposed a method to develop mini fire trucks equipped with a waterproofing system with effective fire suppression ability using ATV (All Terrain Vehicle)<sup>7</sup>. It can be said that studies on mini fire trucks that can be valuably used in cases where quick approach to fire areas is difficult to obstacles such as illegally parked and stopped cars or road conditions.

Lee et al. conducted an analysis on the reason of illegal parking and its influence factors based on the decision tree model to understand the influence on illegal parking<sup>8</sup>.

Preceding researchers examined until now have mainly handled analysis on influence factors such as importance of disaster management, building disaster preventing infrastructure, mini fire trucks, and illegal

parking, but there are no examples that have used big data. In this study, big data (CCTV) was used to prevent illegal parking and a new exploratory approach method to secure golden time is aimed to be proposed<sup>5-7</sup>.

### 3. Study Method and Procedure

In this study, the correlation between present condition of illegal parking CCTVs and number of occurring fire accidents by building type was analyzed. After definition, analysis methods to use information data for searching alternatives to solve this problem were planned. Open source tool R was then used to realize analysis and visualization and the procedure to interpret this was performed.

#### 3.1 Definition of Problem

Quickly arriving at scenes at fire occurrence within golden time is ideal for fire suppression. One of the problems is illegal parking. Increase of traffic congestion due to illegal parking cannot be left out and life damage is occurring by impractical fire suppression orders as dispatch time is delayed. Therefore this study defines “what is the plan to solve illegal parking”.

#### 3.2 Information Required for Problem

Goyang City is composed of 3 gus which are Deogyang-gu, Ilsandong-gu, Insanseo-gu. A total of two fire stations are installed in Goyang Fire Station and Ilsan Fire Station in which Goyang Fire Station is in charge of Deogyang-gu and Ilsan Fire Station is in charge of IlsanSeo-gu. Therefore, there is necessity to look into which areas require additional illegal parking control CCTVs following present conditions of fire accidents and CCTV installation by each gu.

#### 3.3 Data Required to Derive Information

Related data is required to derive information needed to recognize problems. Present conditions of 1. CCTV installation check by gu; 2. fire accidents by gu; and 3. parking lots within the area and car registration that give indirect influence to prevent illegal parking are required to recognize problems.

#### 3.4 Analysis Method to Derive Information

First, visualization using gauge charts to find rates by analyzing present condition of public parking lots and

car registration by each gu will be performed and Goyang City, Gyeonggi-do, South Korea will be set as the subject of analysis.

Also, linkage analysis by housing and cost of damage was performed to understand the necessity of CCTV installation by number of occurring fire accidents. It is because linkage analysis gives help in understanding the relation between two or more variables. Also, CCTV location visualization using ‘ggmap’ was also conducted. Data is first collected and the data was organized through pre-processing procedure for analysis. Only data required for analysis was gathered to make one new data group subject to analysis. Lastly, analysis tool ‘R’ was used to calculate desired information.

## 4. Data Collection and Analysis

### 4.1 Data Collection and Preprocessing

Data required for analysis can be found in Table 1.

Data of present condition of fire accidents and car registration could be obtained through the national statistics portal. Present condition of Goyang City illegal parking control CCTV installation could be gained from a public data portal and parking lot information could be collected by the Goyang City Hall.

Collected data was pre-processed and changed into analyzable form and the data used in analysis was transformed into CSV for analysis use. Also for cases where address information exists but no coordinate information is available, a coordinate conversion program was used to trace coordinates to complete the pre-processing.

### 4.2 Awareness of Present Condition of Goyang City Parking Lots

First, the gauge function in the R program ‘googleVis’ package was used for visualization of data to look into the present condition of Goyang city parking lots.

Deogyang-gu showed the highest Public Parking Lot and Car Registration ratio among the 3 Goyang City gus. Based on the average value of areas in charge such as Goyang City Ilsan Fire Station responsible of Ilsan

**Table 1.** Source of data collection

<b>National Statistics portal</b>	<a href="http://kosis.kr">http://kosis.kr</a>
<b>Public data portal</b>	<a href="http://www.data.go.kr">http://www.data.go.kr</a>
<b>The City Hall of Goyang</b>	<a href="http://www.goyang.go.kr">http://www.goyang.go.kr</a>

Dong-gu, Ilsanseo-gu and Goyang Fire Station responsible of Deogyang-gu although there was not much difference with Ilsanseo-gu, this study selected Deogyang-gu as the main area for analysis and aimed to search a method to relieve congestion with illegal parking control CCTVs.

### 4.3 Awareness of Present Condition of CCTV Installation and Fire Accidents

Linkage analysis was performed to look into the relation of CCTV installation, number of fire accidents and cost of damage.

Data for linkage analysis are 1. number of fire accidents by dong for during the past year; 2. installation of CCTV by dong; and 3. cost of damage by fire accident. Fire fighting was performed on appropriate timing by inserting cost of damage data and expectation values could be gained.

	A	B	C	D	E	F	G	H
1	investgati	local_name	police	address	installati	number	LAT	LOn
2	12-Feb	Deogyang-gu	Goyang Police Station 588-1, Juyoo-dong,	Deogyang-gu, Goyang-si,	2006	5	37.65963	126.833
3	12-Feb	Deogyang-gu	Goyang Police Station 585-2, Juyoo-dong,	Deogyang-gu, Goyang-si,	2006	4	37.65314	126.836
4	12-Feb	Deogyang-gu	Goyang Police Station 557-5, Juyoo-dong,	Deogyang-gu, Goyang-si,	2009	5	37.66371	126.8377
5	12-Feb	Deogyang-gu	Goyang Police Station 309-5, Juyoo-dong,	Deogyang-gu, Goyang-si,	2009	5	37.66274	126.8314
6	12-Feb	Deogyang-gu	Goyang Police Station 296, Juyoo-dong,	Deogyang-gu, Goyang-si,	2011	5	37.66344	126.8344
7	12-Feb	Deogyang-gu	Goyang Police Station 296, Juyoo-dong,	Deogyang-gu, Goyang-si,	2011	5	37.66286	126.8292
8	12-Feb	Deogyang-gu	Goyang Police Station 561, Juyoo-dong,	Deogyang-gu, Goyang-si,	2011	4	37.66532	126.8357
9	12-Feb	Deogyang-gu	Goyang Police Station 561, Juyoo-dong,	Deogyang-gu, Goyang-si,	2011	5	37.66006	126.8347
10	12-Feb	Deogyang-gu	Goyang Police Station 615-8, Juyoo-dong,	Deogyang-gu, Goyang-si,	2011	5	37.65785	126.835
11	12-Feb	Deogyang-gu	Goyang Police Station 194-1, Wonheung-dong,	Deogyang-gu, Goyang-si,	2011	4	37.64562	126.8713
12	12-Feb	Deogyang-gu	Goyang Police Station 434-8, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2011	4	37.65657	126.8444
13	12-Feb	Deogyang-gu	Goyang Police Station 519-61, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2011	5	37.6599	126.8403
14	12-Feb	Deogyang-gu	Goyang Police Station 702-29, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2011	5	37.65501	126.8379
15	12-Feb	Deogyang-gu	Goyang Police Station 199-2, Jichuk-dong,	Deogyang-gu, Goyang-si,	2011	3	37.66171	126.8402
16	12-Feb	Deogyang-gu	Goyang Police Station 494-1, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2006	5	37.65772	126.816
17	12-Feb	Deogyang-gu	Goyang Police Station 506-40, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2009	4	37.65696	126.8399
18	12-Feb	Deogyang-gu	Goyang Police Station 404-4, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2009	5	37.65602	126.8422
19	12-Feb	Deogyang-gu	Goyang Police Station 408-17, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2009	5	37.65417	126.8422
20	12-Feb	Deogyang-gu	Goyang Police Station 405-8, Seongsu 1-dong,	Deogyang-gu, Goyang-si,	2010	5	37.65577	126.8406
21	12-Feb	Deogyang-gu	Goyang Police Station 621-3, Juyoo-dong,	Deogyang-gu, Goyang-si,	2010	4	37.65889	126.8385
22	12-Feb	Deogyang-gu	Goyang Police Station 736, Seongsu 2-dong,	Deogyang-gu, Goyang-si,	2009	4	37.65184	126.833

Figure 3. Present condition of Goyang city CCTVs.

J	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S		
1	local_name	area_name	total	fire	origin	natural	arson	unknow	origin	natural	arson	unknow	total	death	injury	total	property	movable	aburnt	areaburnt	area
2	Deogyangtotal		299	236	4	15	4	2612	154	579	154	9	3	6	967,096	436,023	55,879	165	51,769,04		
3	Deogyang	lujoo-dong	15	12	0	0	0	9231	769	0	0	0	0	0	0	9104	5100	3184	7	1199,90	
4	Deogyang	Wondan-dong	10	6	1	3	0	60	10	30	0	0	0	0	0	13,251	4028	9223	5	24,198	
5	Deogyang	sinwon-dong	2	2	0	0	0	100	0	0	0	0	0	0	0	5,724	2125	2209	1	34,78	
6	Deogyang	Wonheung-dong	7	7	0	0	0	100	0	0	0	0	0	0	0	13,126	12147	3979	7	59,69	
7	Deogyang	Donae-dong	8	8	0	0	0	100	0	0	0	0	0	0	0	142,867	43,118	99,749	10	1,108	
8	Deogyang	Seongsu 1-dong	17	14	1	2	0	6235	588	1176	0	0	0	0	0	42,744	32,246	16,696	10	177,6	
9	Deogyang	Bukhwa-dong	1	1	0	0	0	100	0	0	0	0	0	0	0	5,444	0	5,444	1	1,609	
10	Deogyang	Hyeja-dong	1	1	0	0	0	100	0	0	0	0	0	0	0	1,323	1,084	299	1	18	
11	Deogyang	Jichuk-dong	8	6	0	1	1	75	0	125	125	1	1	0	0	72,341	30,194	42,147	5	337	
12	Deogyang	Ogum-dong	6	6	0	0	0	100	0	0	0	0	0	0	0	33,096	15,264	17,832	8	1,992	
13	Deogyang	Samsong-dong	4	4	0	0	0	100	0	0	0	0	0	0	0	15,968	11,394	4574	3	765	
14	Deogyang	Dongam-dong	5	5	0	0	0	100	0	0	0	0	1	0	1	8,809	5,113	3,696	2	510	
15	Deogyang	Yongdu-dong	6	6	0	0	0	100	0	0	0	0	0	0	0	105,600	40,057	65,543	4	1,071	
16	Deogyang	Byeokja-dong	14	14	0	0	0	100	0	0	0	1	1	0	1	148,498	93,726	54,772	10	14,956,14	
17	Deogyang	Jichuk-dong	3	2	0	1	0	6667	0	3333	0	0	0	0	0	6,666	1,336	4,750	4	14,68	
18	Deogyang	Goyang-dong	5	5	0	0	0	100	0	0	0	0	0	0	0	3,844	30	3,814	1	0	
19	Deogyang	Daegu-dong	15	15	0	0	0	100	0	0	0	1	1	0	1	63,856	20,717	43,139	6	3,065,50	
20	Deogyang	Seongsu 2-dong	13	14	0	1	1	9847	0	847	847	0	0	0	0	21,218	26,799	12,489	9	6123	
21	Deogyang	haeu-dong	11	10	0	1	0	9031	0	909	0	0	0	0	0	16,637	6,492	11,145	8	563,5	
22	Deogyang	Tellang-dong	14	12	0	1	0	6221	0	749	0	0	0	0	0	6,191	2162	2,042	7	30	
23	Deogyang	haepok-dong	3	2	0	0	1	6667	0	3333	0	0	0	0	0	9,761	1,346	8,415	2	96,4	
24	Deogyang	Daegu-dong	2	2	0	0	0	100	0	0	0	0	0	0	0	1,551	0	1,551	0	0	
25	Deogyang	Hwajong-dong	23	22	0	1	0	9365	0	435	0	2	1	1	1	34,738	17,983	16,755	14	193,1	
26	Deogyang	Seongsu 2-dong	5	5	0	0	0	100	0	0	0	0	0	0	0	6,670	1,989	4,681	5	36	
27	Deogyang	haengnam-dong	4	4	0	0	0	100	0	0	0	0	0	0	0	6,597	1,862	4,735	2	0	
28	Deogyang	haengju-dong	4	3	0	1	0	75	0	25	0	0	0	0	0	30,591	13,575	16,016	4	167	
29	Deogyang	Deogyang-dong	5	5	0	0	0	100	0	0	0	0	0	0	0	17,271	0	17,271	0	0	

Figure 4. Present condition of fire accidents in Goyang city.

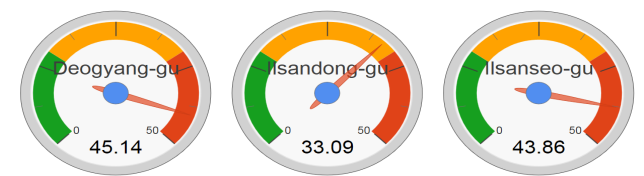


Figure 5. Ratio of public parking lot and car registration present condition.

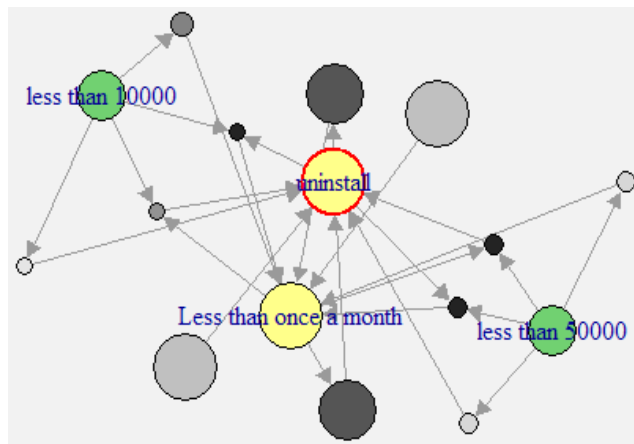


Figure 6. Linkage analysis between fire occurrence, CCTV installation, and cost of damage.

For installation of CCTV standard to dong, it was researched that 2/3 area of Deogyang-gu was uninstalled in which installed and uninstalled areas were divided. Number of fire accidents were divided standard to an average of 1 accident a month and cost of damage was set by random standards for analysis.

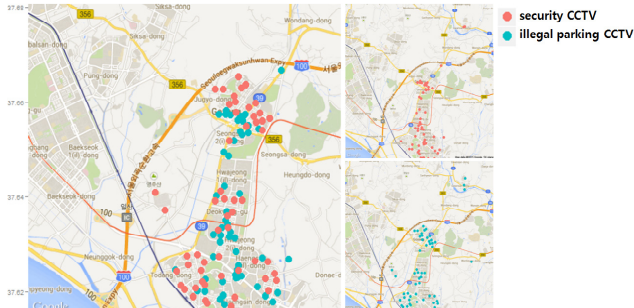
As result of linkage analysis, there was not much relation with frequent fire occurring sections because there were not many places by dong of more than 1 fire accident a month, but it could be seen that there was much relation in sections where CCTVs were not installed.

## 5. Plan to Improve Illegal Parking through CCTV

Among the gus in Goyang City subject to this study, Deogyang-gu had the highest ratio in present conditions such as public parking lots and vehicles in which analysis was conducted on Deogyang-gu. As result of linkage analysis on fire accident occurrence, CCTV installation, and cost of damage, there was much relation with no installation of CCTVs in which additional installation of CCTVs can prevent factors that hinder golden time.

However, many various variables such as CCTV budgets and privacy related civil complaints due to CCTV installation exist and it is ideal to install illegal parking control CCTVs in all areas. However, it is realistically difficult that crime prevention CCTVs can be used to control illegal parking and 12 additional dong may become installed areas to fit the results of the linkage analysis in which expectation values reaching golden time can increase by reducing areas without installations.





**Figure 7.** Plan to improve illegal parking.

Not only this, but illegal parking can be controlled if a CCTV operation management system is built by each area and CCTVs can be used during fire accidents to use the contact system with neighborhood watches. It is expected that fire truck dispatch routes can be predicted to prevent hindering factors (illegal parking, etc.).

The fundamental reason of illegal parking is because of lack of parking lot ratio, but lack of parking lots is not the only problem. Even though there are vacant public parking lots, there are several illegally parked vehicles along roads. In Japan, there was much effect of reducing illegal parking vehicles to a number of 1/5 after enforcing the 'parking lot proof system'. An institution to satisfy lacked parking lots is needed, but improvement of perception is also significant<sup>1</sup>.

## 6. Conclusion

As many CCTVs have been installed nowadays, much change has occurred in our everyday lives. Especially, they are being frequently used in various disaster fields such as crime or control of parking and stopping. However, control is well performed in large roads but residential areas and allies are having difficulty due to illegal parking and stopping. Due to this, fire trucks cannot enter roads due to illegal parking and stopping during firefighting and golden time is being lost.

This study uses public data to propose a plan to improve the reduction of illegal parking and stopping in Goyang City. First is the plan to recommend installing CCTVs to control illegal parking and stopping. This not simply installing illegal parking and stopping control CCTVs, but is for searching plans to use crime prevention

CCTV usage to expect higher installation rate of additional CCTVs due to freeness of budgets and civil complaints of installation. Second is real-time corresponding of urgent situations such as fires by building a CCTV operation management system. Not only Goyang City, but other autonomous districts (city, gun) can expect improvement of golden time arrival during fire accidents.

However in this study, there are many restrictions in realizing the proposed alternative. First, the analyzed data was simple public data that variables are limited. Various variables such as type of housing area and time of departure to fire scene must be complexly considered for CCTV installation, but only public data was used in this study for analysis that limitations exist. In future studies, it is seen that wider big data planning and methodology must be systematically built and various raw data must be used for efficient and effective response plans through big data analysis.

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