Understanding The Role of Big Data Management During Crisis

Eze, B. E & Olaiya, O.O.
Department of Computer Engineering
The Federal Polytechnic Ilaro,
Ogun State, Nigeria.
E-mails: ebereblessing247@gmail.com, yinkakol@gmail.com

ABSTRACT

The rapid relevance of data has begun the process of interrelated changes of the whole society in today's world. Borders lost their importance in economic, social, political and cultural relations as a result of globalization. Due to this fact; a crisis emerging in a country affects other countries; and also a crisis or fluctuations especially in large companies affects other companies and the others in relationship with them. The rapid development of information and communication technologies occurs also in the problematic of crisis management. Since we live in a dynamic world, it is important to be ready to the changes that life brings, responding and adopting new technologies. One of them is crisis management information system. Data becoming a tool for information support. Data in general are very important and indispensable part of planning, organizing, managing and controlling. This definitely applies to crisis management, therefore emergency measures should be implore in planning used as well as in crisis situations. Crisis management is an activity, which can help us to save life, health and property in the whole world. In this study, after stating the concept of crisis, its stages, the theoretical framework of crisis management, importance crisis management, which is a more complex model than disaster management, how to create real-time epidemic situation awareness and analyzing ways big data is revolutionizing emergency crisis management.

Keywords: crisis, crisis management, information support, data, emergency, awareness

23rd iSTEAMS Conference Proceedings Reference Format

Eze, B. E & Olaiya, O.O. (2020): Understanding The Role of Big Data Management During Crisis. Proceedings of the 23rd iSTEAMS Conference, American University of Nigeria, Yola. April, 2020. Pp 177-186 www.isteams.net/yola2020

1. INTRODUCTION

The old saying goes, into each life some rain must fall. Likewise, we might say, into each business some crisis must occur. Whether loss of data from a computer glitch, loss of equipment, or life due to a full-scale natural disaster, adversity strikes businesses with alarming frequency and little warning. Just as individuals save for rainy days to mitigate their ill-effects, businesses can benefit from employing a proactive strategy toward potential crises. Crisis management entails minimizing the impact of an unexpected event in the life of an organization (Spillan & Hough, 2003). In the modern world, we are inundated with data as the massive amounts of public data is being generated on a daily basis (James et al. 2011). The glut of data is further increasing exponentially due to the rapid proliferation of mobile phones and the increased digitization of all aspects of modern life due to technologies such as the Internet of Things (IoT); which deploy sensors, for example in the shape of wearable devices, to provide data related to human activities and different behavioral patterns.

The commoditization of data collection with the advancement in digital technology has led companies to collect all kinds of data, such as the digital trail of an online user, the transaction history of a customer, and the call details record (CDR) of a mobile-phone user. Companies such as Facebook, Google, Twitter, Yahoo, and Microsoft routinely deal with petabytes of data on a daily basis. It is estimated that we are generating an incredible 2.5 quintillion bytes per day (Siegel 2013). According to (Mats 2018) he described data as pieces of information. Big data is large amounts of small facts/information units. Big data are data sets that are too voluminous or complex for traditional methods of analysis. Big data can be characterized as "the overwhelming volume of information produced by and about human activity, made possible by the growing ubiquity of mobile devices, tracking tools, and online texts." (Neuendorf, 2017, p.143).

Big data is not something new, information has always been there, it has just been hard to collect, systemize and analyze. Someone who used big data early was U.S navy officer and navigator Matthew Maury. By utilizing big data sets from logbooks, nautical maps, records of wind, water, and weather about specific locations on specific dates. When putting all this information together he discovered new ways to navigate the seas and more efficient routes. His "computers" were people who calculated the data from the logs. He divided the Atlantic into five parts, were he noted the weather, waves and month. He wanted more data, so he had every US navy ship use a standard way of logging shipping data, which in turn gave better routes. In 1855, he published "the physical geography of the sea. He plotted 1,2 million data points. He was one of the first to utilize the value of large amounts of data. It just took a lot more time and effort than it does today (Cukier & Mayer-Schönberger, 2013).

The volume of data is the main attribute of big data that is why it's called big data (Mats 2018). Laney (2001) introduced what today is the common definition of big data through the three V's, volume, variety, and velocity (Sited from Wiesenberg, Zerfass, & Moreno, 2017, p. 96). Volume is as mentioned the defining attribute, and can be seen in terabytes, records, transactions, tables or files. Using millions of data units to make large data sets. Variety makes these data sets bigger, this data can be structured, unstructured, semi structured or a mix of all of them. This variety of data increases the volume, variety is different sources of information. Variety in big data can exemplified by weather; If you only measure temperature, then the data only tells you something about the temperature, but if you also measure wind then your dataset not only gives more information, but one can also map the probability of the temperature being affected by the wind and give you a better understanding of the weather.

The third defining aspect of big data is velocity. Velocity is speed, or the frequency of data delivery. Volumes grow fast when analyzing everything written online for example. Media content both from traditional and social media is also sources for big data (Russom, 2011) (Wiesenberg, Zerfass, & Moreno, 2017) (McAfee & Brynjolfsson, 2012). In the first day of a crisis, the writings in the media and on the internet, - grow fast. Still, an important aspect is that big data is not directly useful. Big data sets need to be analyzed, systematized, visualized and interpreted. This process, combined with the massive data power made available by modern computers, is where big data is turned into insights. The term big data is therefore not sufficient, a better term might be advanced analytics on big data sets. This means that when using the term big data, it essentially means analytics on large datasets and the visualization of those insights. A crisis can be many things. Corruption, a plane crash, a terrorist attack, hacking or other misdeeds. They happen all the time, but some of them are discussed by the news media and by people. Why? Some crises are in the public interest and on the news media agenda. An organization in crisis is faced with challenges, solving the problem and minimizing reputation loss. Solving the problem will hopefully help salvage the reputation, still the reputation is potentially damaged (Mats 2018).

Fig. 1: Crisis Analysis Framework
Source: https://jhumanitarianaction.springeropen.com/articles/10.1186/s41018-016-0013-9#Fig2

The objective of this study is to envisage on cities across the world how they made infrastructure innovation a priority to safeguard their physical systems so they can stay robust and antifragile. To integrate and streamline digital infrastructure at various stages, particularly in the context of epidemic forecasting and decision-making. In the 17 years since SARS, a new age digital era has emerged; artificial Intelligence and the Internet of Things (IoT) could be instrumental in keeping this crisis within reasonable limits.

2. LITERATURE REVIEW

Crises can emerge due to; not only organizational structure clumsiness and insufficient management, but also general economic uncertainty and volatility, technological developments, political, legal, social and cultural changes, strong competition arising from the disadvantages and effects from international environment. A strategic gap emerges, if organization experiencing constant change of environment cannot keep up and handle with that. The occurrence and severity of the crisis, depends on the degree of dependence between the organization and its environment, crisis perception level of the organization, and the response of the organization to the crisis (Omer 2014).

Crisis management is characterized by a diverse range of activities and stakeholders, and is more fragmented in terms of the composition of stakeholders than other thematic areas. Crisis management should be addressed in some areas, including (i) terrorism attacks, (ii) humanitarian crises, (iii) natural disasters and (iv)major industrial/technical accidents. According to ESRIF 2011 stakeholder consultation developed a working definition of crisis management: "A complex discipline incorporating managerial, organizational, and technical facilities to assist in managing the return to normal life in case of major incident as quickly and swiftly as possible". A key principle underpinning this definition is 'prepared to react' and involves bolstering society's capacity to manage the response and recovery phases of a crisis. While "technology substantially influences crisis management, it is nonetheless regarded as a management process with decision-makers at the center of the process, rather than a technical undertaking".

ESRIF 2011 opined that the growing number of topics that fall under crisis management and shifting conceptual boundaries mean that the issues that arise continue to be very diverse. This leads to significant overlapping in governance structures. In spite of a consensus that clearer governance structures are needed, the variety of agencies and the roles they play in crisis management continue to make the achievement of this objective extremely challenging.

3. 1 Stages of a Crisis

Below is a block diagram depicting the stages of crisis management

Fig. 2: Stages of a Crisis Management

Source: Https://Searchdisasterrecovery.Techtarget.Com/Tip/Roles-And-Responsibilities-Of-A-Crisis-Management-Team

3.1.1 Warning and risk assessment

As important as it may be to identify risks and plan for ways to minimize those risks and their effects, it is equally important to establish monitoring systems that can provide early warning signals of any foreseeable crisis. These early warning systems can take a variety of forms and differ widely based on the identified risks.

Some early warning systems might be mechanical or electronic. For instance, thermography is sometimes used to detect a build-up of heat before a fire starts. Other early warning systems may consist of financial metrics. For example, an organization might be able to anticipate a substantial drop in revenue by monitoring its customers' stock prices. The key to effective pre-crisis planning is to involve as many stakeholders as possible. That way, all areas of the organization are represented in the risk identification and risk planning process. Corporate crisis response teams often include representatives from the organization's legal, human resources (HR), finance and operations staff. It is also customary to identify someone to act as a crisis manager.

3.1.2 Crisis response and Managemen

When a crisis occurs, the crisis manager is responsible for directing the organization's response in accordance to its established crisis management plan. The crisis manager is usually also the person who is tasked with communicating to the public. If a crisis affects public health or safety, then the crisis manager should make a public statement as quickly as possible. In a public crisis, the media will inevitably seek out employees for comment. It is important for the organization's employees to know ahead of time who is and is not authorized to speak to the media. Employees who are allowed to speak to the media must do so in a manner consistent with what the crisis manager is saying.

3.1.3 Post-crisis and Resolution

After a crisis subsides and business begins to return to normal, the crisis manager should continue to meet with members of the crisis management team, especially those from the legal and finance departments, to evaluate the progression of the recovery efforts. At the same time, the crisis manager will need to provide the latest information to key stakeholders to keep them aware of the current situation. Following a crisis, it is also important for the crisis management team to revisit the organization's crisis management plan with the goal of evaluating how well the plan worked and what aspects of the plan need to be revised based on what was learned during the crisis.

3.1.4 Crisis Management

Crisis management is the application of strategies designed to help an organization deal with a sudden and significant negative event. A crisis can occur as a result of an unpredictable event or an unforeseeable consequence of some event that had been considered as a potential risk. In either case, crises almost invariably require that decisions be made quickly to limit damage to the organization. The nature of the potential damage varies based on the nature of the crisis. In most cases though, a crisis can affect health or safety, the organization's finances, the organization's reputation, or some combination of these. A devastating fire could be a crisis that puts the organization's finances in jeopardy. However, if the fire occurs during business hours, then the fire might also jeopardize health and safety since employees may find themselves in harm's way.

3.1.5 Crisis Management Goals

Crisis management seeks to minimize the damage a crisis causes. However, this does not mean crisis management is the same thing as crisis response. Instead, crisis management is a comprehensive process that is put into practice before a crisis even happens. Crisis management practices are engaged before, during and after a crisis.

3.1.6 Recovery crisis management vs. risk management

Before a crisis begins, pre-crisis planning aims to identify risks and then find ways to mitigate or lessen those risks. It is important to note, however, that crisis management and risk management are two different things. Risk management means looking for ways to minimize risks. Crisis management involves figuring out the best way to respond when an incident does occur. As such, risk management is an important part of crisis management, but crisis management covers incident response, whereas risk management usually does not.

3. 2 How To Create Real-Time Epidemic Situation Awareness

3.2. 1 Mapping citizens

Governments across the globe are gradually developing the digital infrastructure and engineering capabilities to face the pandemic and alleviate the spread of COVID-19 through community-driven contact-tracing technologies. These enable citizens to react assertively and promptly to pandemic diseases with a set of digital tools to help spread timely and precise information to its citizens. Many governments are encouraging private companies to develop innovative tools that make use of hundreds of millions of facial recognition cameras and people reporting their body temperature and medical condition. Through this authorities can quickly identify suspected coronavirus transporters and identify anyone with whom they have come into contact. An array of mobile apps warns citizens about their proximity to infected patients.

3.2. 2 Roadmap for a better future

The virus has provided a new start for digital infrastructure development. Using the cloud, big data and AI applications creates room for industries to develop and build new business models that help citizens understand the severity of pandemic disease and ensure preventive measures. A coalition of stakeholders (private and governmental) are supporting pharmaceutical enterprises with millions in funding to find a vaccine for the virus. To modernize, upgrade and update our digital infrastructure and to tackle this and future pandemics, different financial models will evolve such as Public-Private Partnership and consumption/outcome-based models to alleviate the financial crisis during the development phase. It is now the moment for countries to fast-track the construction of new digital infrastructure, such as IoT along with AI, in addition to the hastening of vital projects and major infrastructure construction that's already included in countries' financial stimulus plans.

4. ANALYZING WAYS BIG DATA IS REVOLUTIONIZING EMERGENCY MANAGEMENT

Analyzing and observing Big Data patterns is not only a beneficial practice within businesses, it can also improve the efficiency and effectiveness of emergency and disaster management organizations. Thanks to the availability and usage of smartphones and social media, disasters can be measured with real-time information and met with a rapid, accurate and precise response. Big Data has the ability to enhance disaster recovery by utilizing community information and connecting victims with emergency responders and family.
Emergency personnel can minimize their search time and maximize their recovery time when they have access to real-time information emphasizing the areas most affected. Working along with professional insight and satellite imagery, Big Data has started trends that have already saved lives and proven effective within the emergency management field.

4. 1 Crisis Mapping

Ushahidi, a non-profit company that creates open-source software for gathering information, developed and utilized an interactive mapping platform in 2008 that plotted violent areas following the Kenyan presidential election. They gathered information from eyewitness sources via online platforms, and plotted them on a Google map to help those in danger navigate their way to safety.

Ushahidi was experimenting with crisis mapping: the real-time creation and display of reports submitted through email, text message and social media on interactive geographical maps. They implemented it again during the 2010 earthquake in Haiti, and it resulted in many victims being rescued by first responders. The U.S. Marine Corps, who was first on the scene, felt that the crisis mapping assisted them in quickly locating and recovering victims. In order for crisis mapping to be effective, those in disaster zones have to partake in Big Data collection by providing as much reliable information as they can so that organizations like Ushahidi can make it publicly available. Disasters can separate people from their families, and trends like crisis mapping just may help emergency responders find them.

4. 2 Connecting Missing People with Their Families

Companies like Google and Facebook are also interested in helping communities during emergency situations, particularly in reducing recovery time. They have implemented online systems specific to connecting people with their loved ones during and after disasters in real-time. Immediately following the 2010 earthquake in Haiti, Google released its "Person Finder" feature. This allows for an immediate way to reconnect post-disaster. In short, anyone can enter information related to missing people in an attempt to connect themselves or others with those they are looking for. Within the first two days after the earthquake, Person Finder was updated 5,300 times as people searched for friends and family caught in the affected area. Another example is Facebook's "Safety Check Service". It's an active service that reaches out to people who are near disaster areas to discover if they are safe and to ask for more real-time information regarding the situation. These services employ Big Data as a recovery tool.

4.3 Social Media Mining

Emergency management organizations like FEMA and Red Cross have noticed Big Data can help fill in gaps of information that may be crucial to a rapid response. When disasters like a flood hit communities hard enough to cause an evacuation, it's important to know what roads are open, where gas is available and if anyone is trapped. Although satellite imagery is effective, it isn't always available and may not show the whole picture. Eyewitness level pictures and posts via social media from the affected area, however, can be extremely effective in showing potential hazardous locations. Utilizing satellite and social media information in tandem provides responders with a clearer picture of the situation that may not be as easily seen from one point of view.

4.4 Event Simulations

Emergency management organizations also practice for when actual disasters occur. Unfortunately they have suffered in the past from a lack of realistic statistics that feed the simulations. With big data, safety professionals can better prepare these disaster simulations for more accurate implementations. Large batches of data improve emergency preparedness by analyzing previous disasters' statistics. They assist organizations in visualizing what worked and didn't work with more precise data. Until recently, emergency action plans often had to wait until an actual disaster occurred to test their effectiveness because the simulations didn't accurately represent the possible results. Now big data is helping organizations understand exactly what they are up against before it happens. Whether it is through crisis mapping or event simulation, Big Data is pioneering new methods of emergency management. It uses the analysis of information gathered from the community in real-time to assist those in need and those looking for loved ones lost in disasters. Big Data and emergency management's newfound progressive relationship opens up new career opportunities for those who want to find innovative ways to help others. In recent years, the world has witnessed the rise of SARS, Zika virus, Ebola and now COVID-19. Epidemics are a rising threat.

Governments are now relying on ubiquitous instruments (sensors) and powerful algorithms instead of flesh-and-blood spooks. In the war against COVID-19, several governments have implemented these new surveillance tools.

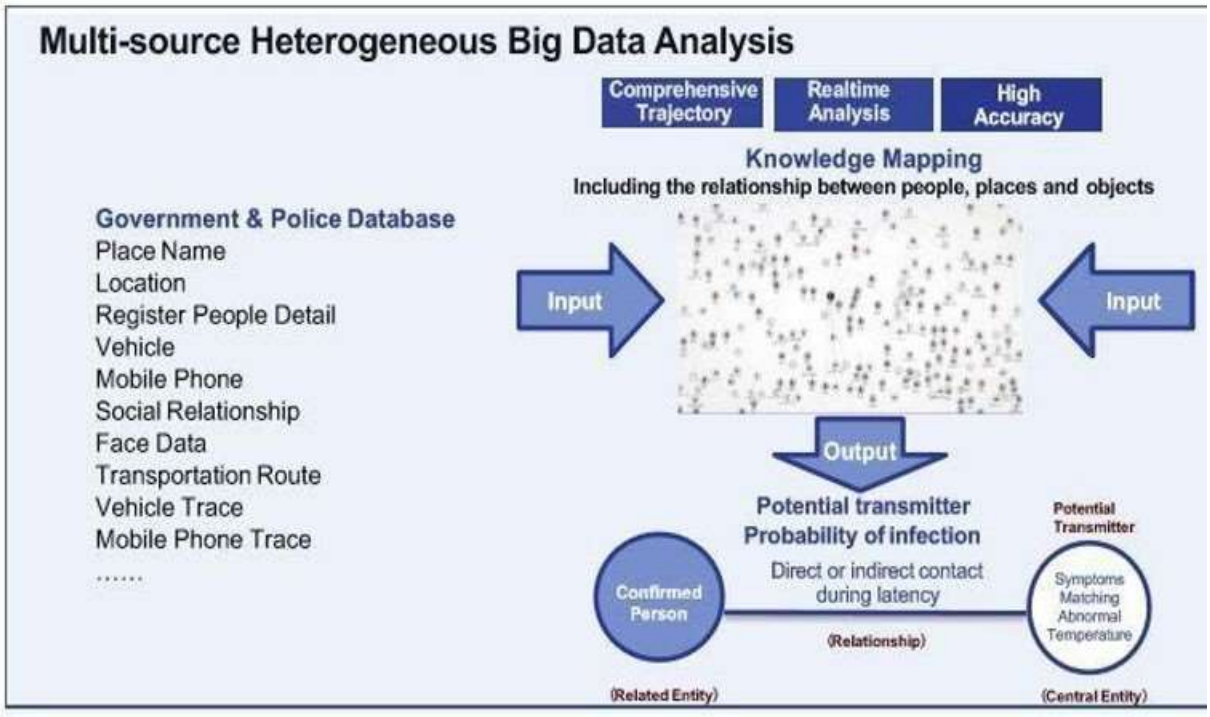

Fig. 3: Multi-source Heterogeneous Big Data Analysis
Source: Https://Www.Weforum.Org/Agenda/2017/09/Governments-Develop-Digital-Infrastructure-Vodafone

Maps of the world show how the decrease in the transportation of people has drastically reduced carbon emissions across different countries, but what's the case for emissions from digital technologies? Will the volume of people working from home or using digital devices in quarantine cause an increase in emissions from other sources? What is being done by the large cloud-providers to address the capacity issue?

- Using big data to fight pandemics
- Predicting and modelling outbreaks

In the ongoing covid-19 pandemic, we are witnessing three major occurrences across the globe:

1. Wider acceptance of online services;
2. A humongous requirement for internet services for conventional industries;
3. Boosted connectivity among diverse types of industries.

These three data streams provide important, real-time data about travel patterns that spread disease and longitudinal alterations in populations at risk, which until recently have been very difficult to quantify on schedules related to a fast-moving pandemic. With an exponential rise in mobility and growing global connectivity, this information will be critical to planning surveillance and containment strategies.

Some researchers and private entities along with their respective state governments are developing a digital platform, HealthMap, which visually represents the disease outbreaks according to location, time and the type of contagious virus, bacterial disease that is being carried while entering into the city. Big data plays a pivotal role in predicting and modelling outbreaks. Take AI-supported services for a lung CT scan: the AI is premeditated to quickly detect lesions of likely coronavirus pneumonia; to measure its volume, shape and density; and to compare changes of multiple lung lesions from the image. This provides a quantitative report to assist doctors in making fast judgements and thus helps expedite the health evaluation of patients.

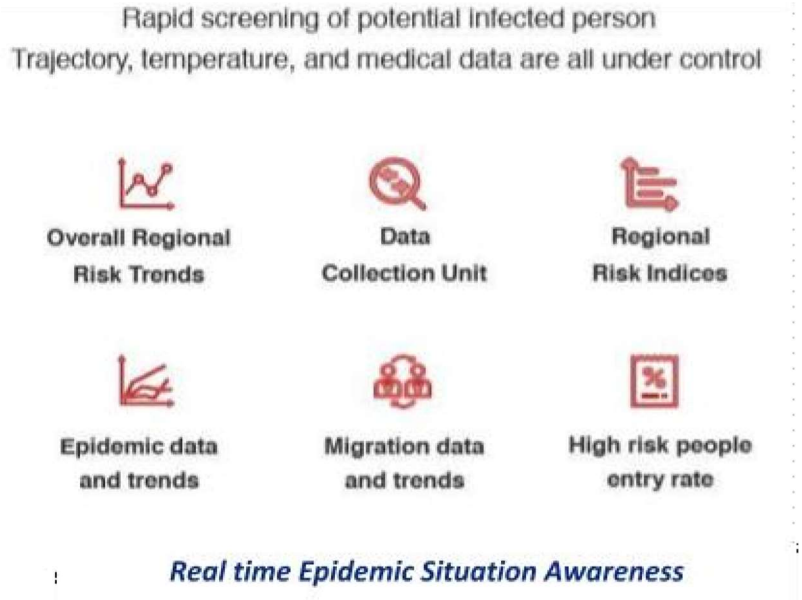

Fig 4: Real Time Epidemic Situation Awareness
Source: https://healthmap.org/en/

5. CONCLUSION

The field of crisis management is generally considered to have originated with Johnson & Johnson's handling of a situation in 1982, when cyanidelaced Tylenol killed seven people in the Chicago area. The company immediately recalled all Tylenol capsules in the country and offered free products in tamper-proof packaging. As a result of the company's swift and effective response, the effect to shareholders was minimized and the brand recovered and flourished. Today, virtually all major corporations, nonprofit agencies and public sector organizations use crisis management. Developing, practicing and updating a crisis management plan is a critical piece of ensuring a business can respond to unforeseen disasters. The nature of the crisis management activities can vary however, based on the organization type. For instance, a manufacturing company will likely need a crisis management plan for responding to a large-scale industrial accident, such as an explosion or chemical spill, whereas an insurance company would be far less likely to face such risks. Of course, it doesn't take something as dramatic as an industrial accident to require the activation of a crisis management plan. Any event that has the potential to damage the organization's finances or reputation, may be cause for putting the crisis management plan into action.

REFERENCES

1. Chang, F, Dean J, Ghemawat S, Hsieh WC, Wallach DA, Burrows M, Chandra T, Fikes A, Gruber RE (2008) Bigtable: a distributed storage system for structured data. ACM Trans Comput Syst (TOCS) 26(2): 4.
2. Cukier, K., & Mayer-Schönberger, V. (2013). Big data, a revolution that will transform how we live, work, and think. New york: Houghton Mifflin Harcourt publishing Company.
3. DeCandia, G, Hastorun D, Jampani M, Kakulapati G, Lakshman A, Pilchin A, Sivasubramanian S, Vosshall P, Vogels W (2007) Dynamo: amazon's highly available key-value store In: ACM SIGOPS Operating Systems Review, 205–220.. ACM, Stevenson, Washington, USA.
4. ESRIF (2011) Ex-post Evaluation of PASR Activities in the field of Security Interim Evaluation of FP7 Research Activities in the field of Space and Security. Center for Strategy & Evaluation Services. Sevenoaks, Kent TN!$ 5WT United Kingdom www.cses.co.uk
5. James, M, Michael C, Brad B, Jacques B (2011) Big data: the next frontier for innovation, competition, and productivity. The McKinsey Global Institute. http://www.mckinsey.com/business-functions/business-technology/our-insights/big-data-the-next-frontier-for-innovation
6. Laney, D. (2001). 3D data management: Controlling data volume, velocity and variety. META Group Research Note 6 (70).
7. Leavitt, N (2010) Will nosql databases live up to their promise? Computer 43(2): 12–14. Available from URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber= 5410700&isnumber=5410692
8. Mats Winther Maltby, (2018). Can big data change crisis management and communication? An exploratory analysis of three Norwegian reputational crises. Universitetet I Oslo. Available from http://www.duo.uio.no/
9. McAfee, A., & Brynjolfsson, E. (2012, October issue). Big Data: The Management Revolution. Harvard business review.
10. Omer Faruk Tekin, (2014). Importance of Crisis Management for Public Administration: The Practice in Turkish Public Administration. The 2014 WEI International Academic Conference Proceedings Budapest, Hungary. Selcuk University, Vocational School of Social Sciences, Specialist.
11. Russom, P. (2011). Fourth quarter, Big data analytics. TDWI best practices report.
12. Siegel, E (2013) Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, Or Die. John Wiley & Sons.
13. Spillan, J. & Hough, M. "Crisis Planning in Small Businesses: Importance, Impetus and Indifference," European Management Journal, 21, 3(2003): 398-407.
14. Wiesenberg, M., Zerfass, A., & Moreno, A. (2017). Big data and automation in strategic communication. International journal of strategic communication, p. 95-114.