Extended Essay

World Studies - Science, Technology & Society
(Geography & ITGS)

The use of social media and technology for disaster relief.

Research Question:

To what extent can social media help with disaster relief in Japan? How might it have helped the rescuers and victims during the Tohoku disaster?

Word Count: 3996

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Introduction

A natural disaster is a calamitous event that happens due to the “natural processes of the Earth”, such as hurricane, flooding and drought ("Natural Disasters"). They happen all the time in almost every part of the world, and more often than not, they happen unpredictably. Specifically, Asia seems to be the most vulnerable to natural disasters due to its sheer size of population, thus the continent will have a larger casualty than any other parts of the world when disasters strike. Located on the Ring of Fire (seen in figure 1), it also makes some parts of the continent, especially East & South-East Asia extremely exposed to natural disasters like volcanic eruptions and earthquakes.

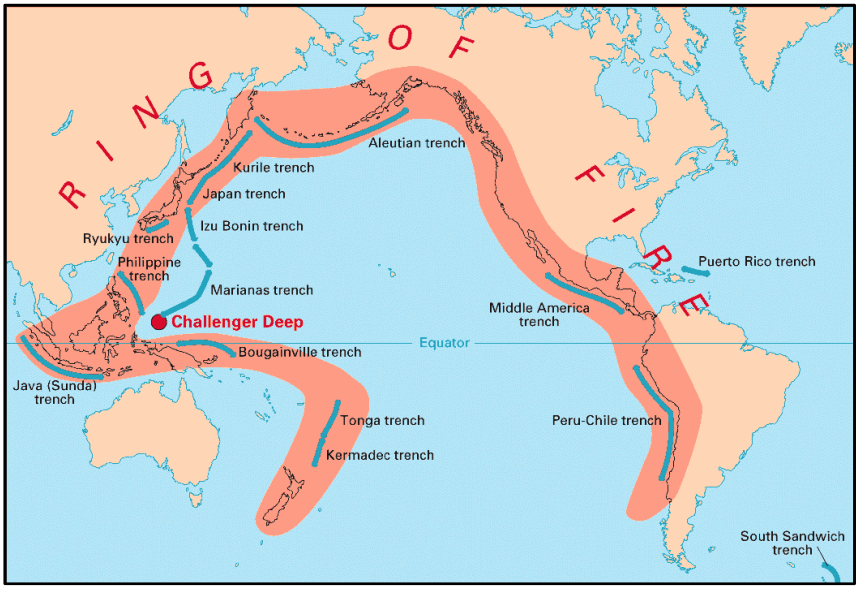

Figure 1: Areas in the Ring of Fire

Source: “This Dynamic Earth.” Ring of Fire [This Dynamic Earth, USGS], US Geological Survey, https://pubs.usgs.gov/gip/dynamic/fire.html.

Naturally, there have been a lot of new technology proposed and used to reduce the casualties by making the process of disaster response and recovery more effective. It is interesting to note that social media appears to play a big role in disaster relief, especially in the 2000s, when the access to internet has become easier and increasingly common due to the rapid advancement of technology, making it cheaper and more user-friendly for non-technical users. In fact, mobile user internet has increased by 12.8% in 6 years alone, as shown in figure 2.

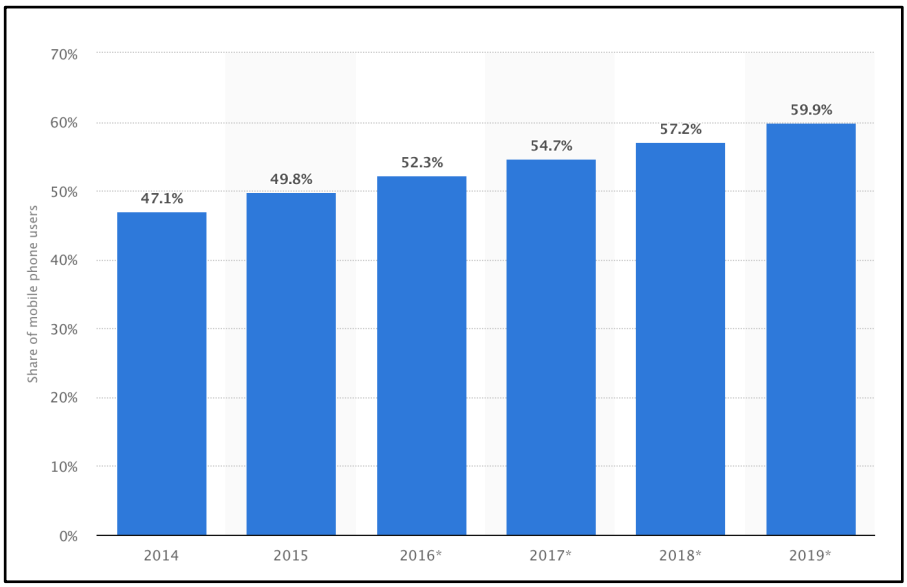

Figure 2: Mobile phone Internet User Penetration Worldwide

Source: Statista Research Department. "Global Mobile Phone Internet User Penetration 2019." Statista, 31 Aug. 2015, https://www.statista.com/statistics/284202/mobile-phone-internet-user-penetration-worldwide/.

Social media is "websites and applications that are designed to allow people to share content quickly, efficiently, and in real-time" (Hudson 2019). The most common social media platforms are applications such as Facebook and Twitter. Social media has greatly transformed the way we communicate and obtain information. However, can this change in lifestyle influence the way we deal with emergencies?

This topic is worthy of an investigation because it is relevant to our current society where social media exposure has increased tremendously in the 2000s, during which global warming has resulted in more natural disasters such as droughts, which increases vulnerability and exposure to risk. In fact, more than 45% of the world's population has at least one social media account, with the most popular being Facebook, which was initiated in 2004, with 2375 billion users currently (Smith 2019). This topic is important because if proved useful, there may be a possibility that social media will greatly reduce disaster casualties by helping to make the rescues more efficient.

In particular, "To what extent can social media help with disaster relief? How might it have helped the rescuers and victims during the Tohoku disaster?", this essay aims to explore the extent of the effectiveness using social media as a tool in the process of disaster relief. The Tohoku disaster in Japan will be studied, as a focus of a natural disaster in Asia for this essay.

It is chosen due to its application of social media during the event and also due to its sheer impact nationally and beyond, hence there are sufficient information to carry out the investigation. It also allows a more current investigation into the effectiveness of using social media for disaster relief since it happened in the 2000s, and it also places the context of this essay in a more manageable local scale.

Also, from ITGS's strand, big data analytics will be explored to evaluate social media's usefulness during a disaster, which will enable further exploration to the extent of whether the use of big data analytics with social media could be helpful in the Tohoku disaster. Then, the topic will be explored from a more geographic perspectives, looking at economic and social factors, in order to explore how the use of social media may be limited by those factors during the Tohoku disaster since they have direct correlation to the access to social media. Lastly, the ethical implications will be briefly investigated to identify any potential issues of using social media, as it is important to consider that all IT applications contain ethical issues since users are involved. This interdisciplinary approach from both ITGS and Geography is necessary since the benefits from one discipline may be compromised by another, especially in this topic of global significance influenced by various disciplines.

Brief Introduction to the Tohoku Disaster & Use of Social Media

The Tohoku disaster was a serious natural disaster that took place in Japan on March 11, 2011 off the north-east coast (Tohoku region) of the country. The locational context is shown in figure 3. The underwater megathrust earthquake in the Pacific Ocean caused a 9.1 magnitude earthquake, which then resulted in a 30-foot waves tsunami and radiation leakage that struck Japan, and other nearby Asian countries. Over 22,000 were confirmed deaths or missing due to the initial strike and post-disaster health conditions ("2011 Japan Earthquake - Tsunami Fast Facts.").

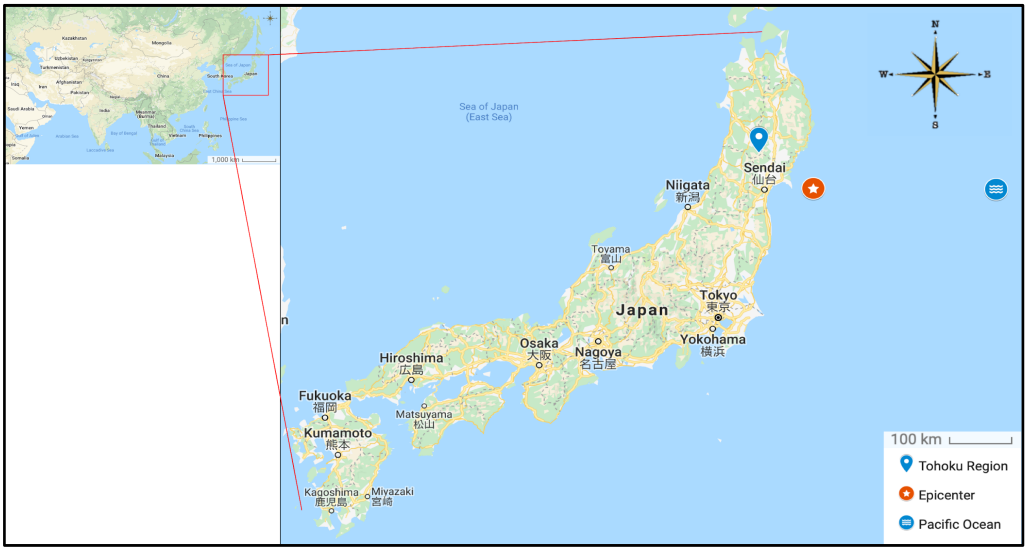

Figure 3: Map showing the epicenter and Tohoku region in relation to the rest of the continent

Source: Google Map, Google, https://www.google.com/maps/d/u/0/viewer?mid=1-R2F20L2fr8kLYNehxWBiahdkt3vyFk8&hl=en&ll=38.72270198220918,142.8350949999999&z=8.

Interestingly, social media acted as an important lifeline for many people affected. On Twitter, for example, users can hashtag their post to classify them into different topics, and more importantly, this allow users and rescuers to differentiate the posts relating to the disaster from other unrelated posts. Besides, Twitter had published a mobile phone website during the event to allow non-smart phone users to access to the social media on the internet that they would otherwise not be able to, in order for them to access to crucial information regarding the event. Facebook, despite not as popular as Twitter in Japan, allowed victims to get in touch with friends and family, especially outside Japan since Facebook was a lot more popular in many foreign countries. More importantly, "Group" and "Disaster Relief"

functions on the platform allowed volunteers and relief support organizations to help with the relief effort, whether direct or non-direct. (Peary, Shaw, & Takeuchi 2012)

Social media, so far, may seem beneficial to disaster relief, but it does have its relative disadvantages. First, there are possibilities of rumors and incorrect information. The hashtag may filter out tweets that are unrelated to the events, but it cannot filter out false information. Similarly, with Facebook, there are too many unfiltered information, and it can be unclear which ones would be useful (Acar & Muraki 2011). Ideally, social media needs to have a high efficiency, speed and capacity to cope with variety of different data in order to be useful for disaster relief. Thus, it is crucial to look into big data analytics to explore how the technology can achieve these criteria.

Big Data Analytics

One method to process huge amount of information quickly and efficiently in times of emergencies is through big data analytics. Big data are complex data that can be categorized according to 3Vs: high Velocity, Volume, and Variety ("What is big data"). High velocity means that the information must be processed at a synchronous, or a very fast rate; High volume refer to that there is a large amount of information; High variety means that there are many different types of data to be processed.

Big data analytics, which employ analytical tool to discover the "hidden patterns, correlations and insights" among information collected, is a useful tool in a disaster to let all the stakeholders to understand the situation for a better rescue plan to take place (Dadhe & Jugele 2016). It is normally used by businesses to analyse the preference of the customers and the markets needs, so it is clear that big data analytics is very useful for businesses to create customized experiences for the users – which is the most important stakeholder in this case (Loon 2017). However, can big data analytics be useful with emergency rescues to help the stakeholder – which are the victims in a disaster? This section will discuss how big data analytics work, and how it can be applied to social media, which will be Twitter in this essay, to help the disaster relief during the Tohoku disaster. Twitter is used as it is the 2nd most popular social media in Japan, behind Line, but Line is less suitable since it is a communications app that allows users to send messages or voice calls, unlike Twitter, which allows information posted to be seen publicly. ("An Overview of Social Media in Japan")

Comparing the information from Twitter during the Tohoku disaster and the 3Vs aspect of big data, following analysis can be made:

1. During the Tohoku disaster, there was a 500% increase in the number of tweets in (Abdul 2011).

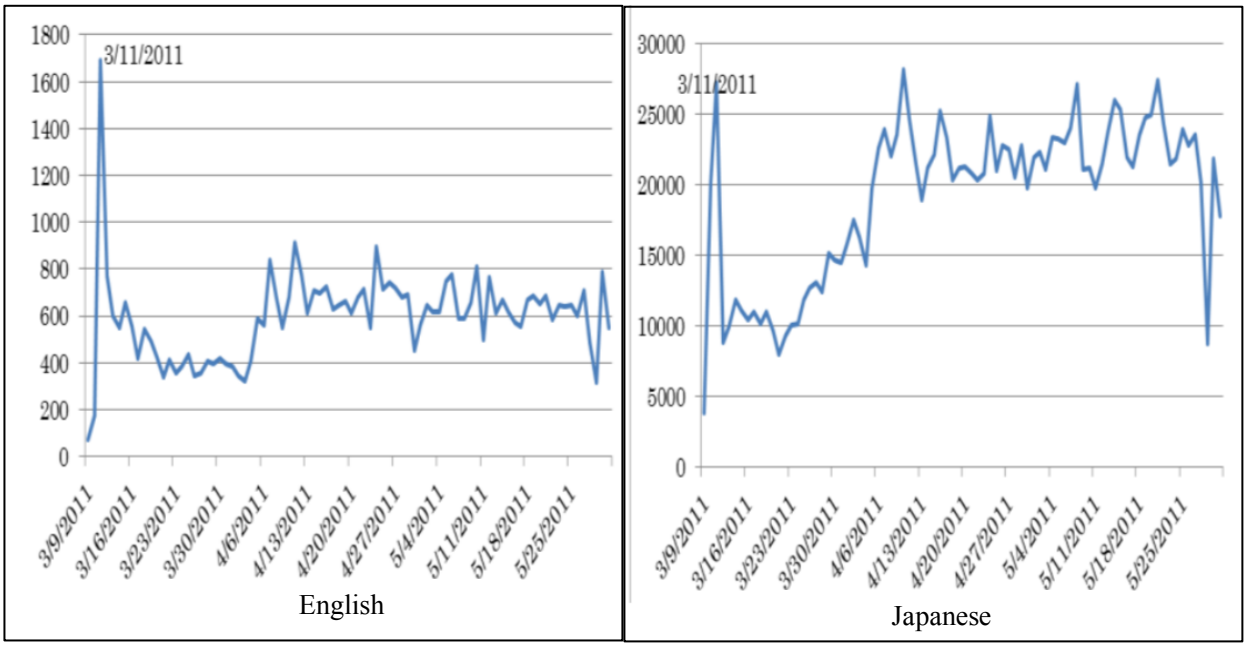

Figure 4 Tweets number in English compared to Japanese

Source: Doan, Son, et al. "An Analysis of Twitter Messages in the 2011 Tohoku Earthquake." Sept. 2011, https://www.researchgate.net/publication/51935829_An_Analysis_of_Twitter_Messages_in_the_2011_Tohoku_Earthquake

This can be observed from figure 4, which shows significantly more tweets in Japanese than English during the period from March to May, which is the period that Tohoku disaster lasted. The maximum tweets in Japanese during the period reached 28000 counts, while the maximum number of tweets in English was only 1700. This infers that there are more tweets from Japan likely due to the Tohoku disaster. From here, it can be concluded that there is high volume of data generated in Twitter during the disaster.

2. As mentioned earlier, many types of disasters happened during the Tohoku event, and emergency rescuers would have different rescue strategies for different events. Tweets are very useful sources for rescuers as most of them contained real life updates of the disaster, thus allowing the rescuers to obtain the most up-to-date information. However, users use different hashtags and words to describe different events. For example, when earthquakes happened, there would be more keywords like "tremor" and "shake", while there would be more keywords like "explosion" and "meltdown" during the radiation event (Doan, Vo, & Collier 2011). There were also a variety of information posted, such as pictures and videos and even different types of information. For example, some tweets could be asking for help, some tweets could be informing about the surrounding, while some could just be

warnings (Acar & Muraki 2011). Some of those tweets were more useful for rescuers, especially the surrounding information and requests for helps, as they are directly related to rescues. Basically, this means that there were a lot of different types of information to search through for rescuers to identify the most appropriate information. From here, it can be said that there were a high variety of information.

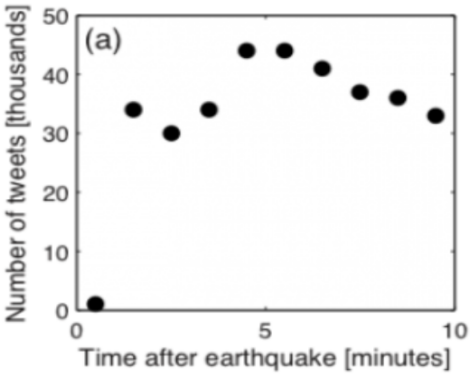

Figure 5 Number of tagged tweets containing an earthquake keyword per minute after the event. Source: Zadeh, Reza. "Using Twitter to Measure Earthquake Impact in Almost Real Time." Twitter, Twitter, 2 May 2014, https://blog.twitter.com/engineering/en_us/a/2014/using-twitter-to-measure-earthquake-impact-in-almost-real-time.html.

3. Figure 5 suggests that the tweets are posted at an extremely fast rate. At merely 5 minutes after the earthquake happened, 45000 tweets have been posted. Just merely 10 minutes after the earthquake happened, roughly 342,000 tweets have been posted on twitter. Therefore, the data must be processed quickly and efficiently to identify useful information for the rescuers in a short amount of time, hence tweets during the disaster is a high velocity information.

Concluding from all above, tweets generated during the Tohoku disaster are high velocity, variety and volume information, thus they are constituted as big data. So, they can be analyzed via the methodology applied in the big data analytics.

Generally, there are 5 steps to big data analytics: Collect, Process, Cleanse, Analyse & Operationalize (Pickell 2018). They can be easily be applied in the context of disaster management. The first **collection** stage involves collecting data from Twitter, classifying them into structured data and unstructured data. Most information collected during the Tohoku disaster are unstructured data, as the information generated by human in the form of social media posts potentially contains audio, video and messages. This type of data is harder

to process, because unlike structured data, it is not linear and organized. Unstructured data is random and diverse, thus making them harder to be analyzed by big data analytics software, as there is no clear pattern to them (Pickell 2018). However, this limitation could potentially be countered through the hashtag attribute of Twitter. Only tweets containing hashtag of disaster-related keywords are collected, thus greatly reducing the amount of time and difficulty needed to process the information otherwise.

The next step would be to **process** the collected data. "Stream processing" processes data in real time as they are generated, thus able to provide instant results, while batch processing stores data first then analyses the collection of data afterwards (Vaseekaran 2017). The one more suitable in this case would be stream processing. It is important to remember that the tweets during the Tohoku event were posted at a very rapid pace, so stream processing allows the data to be processed at almost no delay time, which means that the data could be processed much faster than batch processing, which would take hours to days to process the same amount of data. This is a very huge advantage to all stakeholders during disaster relief – rescuers and victims alike, as it could greatly reduce the time for rescues, which in turn allows faster rescues to take place.

The next step, **cleansing**, would be extremely useful during disaster relief. There were a lot of information on Twitter in the event of Tohoku disaster, but not all of them were useful. Tweets that could be constituted as useful usually were tweets containing real-life updates or help requests. Therefore, being able to filter out poor information, the cleansing process proved to be an extremely helpful addition to big data analytics. There are several steps that could be taken to cleanse the data. Perhaps the most important step is the ability to manage data and remove duplicates, or referred to as "dirty data". For example, a big data analytics program could automatically identify and merge two similar data in a process referred to as blocking and pairwise matching. Through this, it can present the data in a more clustered and concise form. During the process, it can also check for the validity and consistency of data by comparing how many data collected reflect similar information (Le 2019). However, there is no 100% guarantee that the cleansing could identify the accuracy of data, as some information can be incorrect but deemed appropriate by the processing system (Pickell 2018), such as when users posted incorrect detail about their location. Despite this, it is still useful for the rescuers to quickly identify relevant information that would speed up the process of

rescues. In the future, however, it is possible that big data analytics could become better and faster due to more efficient machine learning (Tagiev 2016).

Before the operations can take place, an **analysis** must take place to identify the best course of action to keep the survival rate of victims high. This is possible through "prescriptive analysis" in big data analytics. This type of analysis requires high level of machine learning and is very complex (Pickell 2018). However, it is extremely helpful for rescuers to decide on the best rescue methods for the safety of both the rescuers and victims. The result may be wrong due to the potential wrong information that has not been filtered, but at a very minimum, big data analytics is able to provide rescuers with a solution quickly. There is also "descriptive analysis" through which rescuers can obtain an overview of what actually happened in the site of disaster from analyzing a huge amount and variety of information. Lastly, the rescue **operations** can take place in the best possible way.

All in all, it can be concluded that tweets during the Tohoku disaster can be viewed as big data, thus can be put through big data analytics software to aid in the process of disaster relief. As mentioned, there are several potential errors that the analytics can have, such as inability to identify inaccurate information, but big data analytics is able to provide a feasible rescue plan to the rescuers quickly, thus allowing them to carry out rescues safely as early as possible. So, big data analytics is very useful to all stakeholders, and thus it can be argued that social media can help with disaster relief to quite a large extent, through the help of big data analytics, which is likely to improve in the future with better machine learning.

Geographical Factors and Possibilities

It is established that information from social media could be extremely useful for disaster relief, through the help of big data analytics. However, this can be limited by the access to social media. The hypothesis that will be tested is "the lower the amount of people has access to smartphones with mobile network to access Twitter, the lower the chance for social media to be useful due to a smaller number of tweets". Therefore, this section explores the geographical factors and possibilities regarding the use of social media in Japan, a high-income country. Different economic and social factors that may hinder, or improve, the usage of social media in the country during the Tohoku disaster will be discussed.

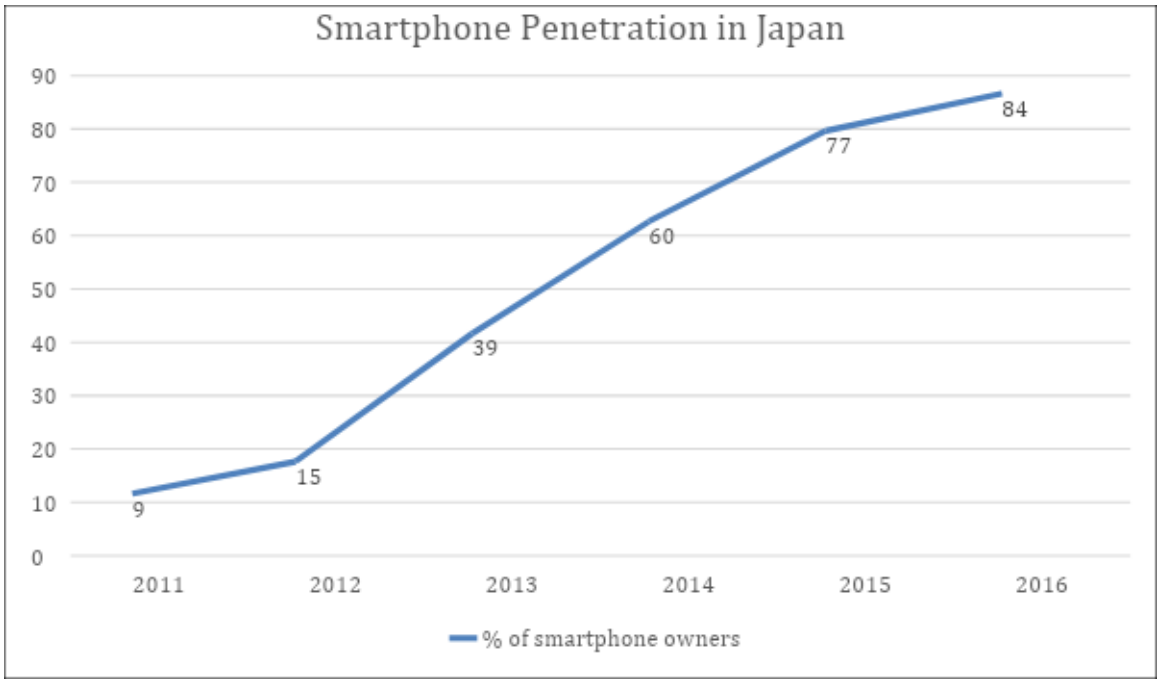

Figure 6 Graph showing smartphone penetration in Japan from 2011 to 2016

Source: Fujii, Ray. "Japan's Smartphone Surge and Its Impact on the Mobile Marketplace." XVIII, no. 37, https://www.lek.com/sites/default/files/insights/pdf-attachments/1837_Japans Smartphone_impacts_on_mobile_marketplace_0.pdf.

From figure 6, it can be seen that there were only 9% of population in Japan that have access to smartphones in 2011, when the Tohoku disaster happened. This means that the maximum potential of using social media as an emergency response method couldn't be reach as the low number of smartphone owners suggest that only small population had access to social media, which is Twitter in this case. Therefore, there would only be a small number of tweets to be collected. This may prove the hypothesis to be true, hence limiting the potential of social media.

However, this is contradictory to the previous section where it is stated that there were around 28,000 tweets posted just 10 minutes after the earthquake. This means that the 9% of that population having access to smartphones had produced a large number of tweets. Therefore, although the smartphone penetration was low, it is not directly correlated to the number of tweets produced. This is also understandable in the event of a disaster, where one would be desperate to post many tweets in order for rescues to arrive quickly. This proves the hypothesis wrong, as the number of users does not correlate with the number of tweets produced, and social media can still be useful nonetheless.

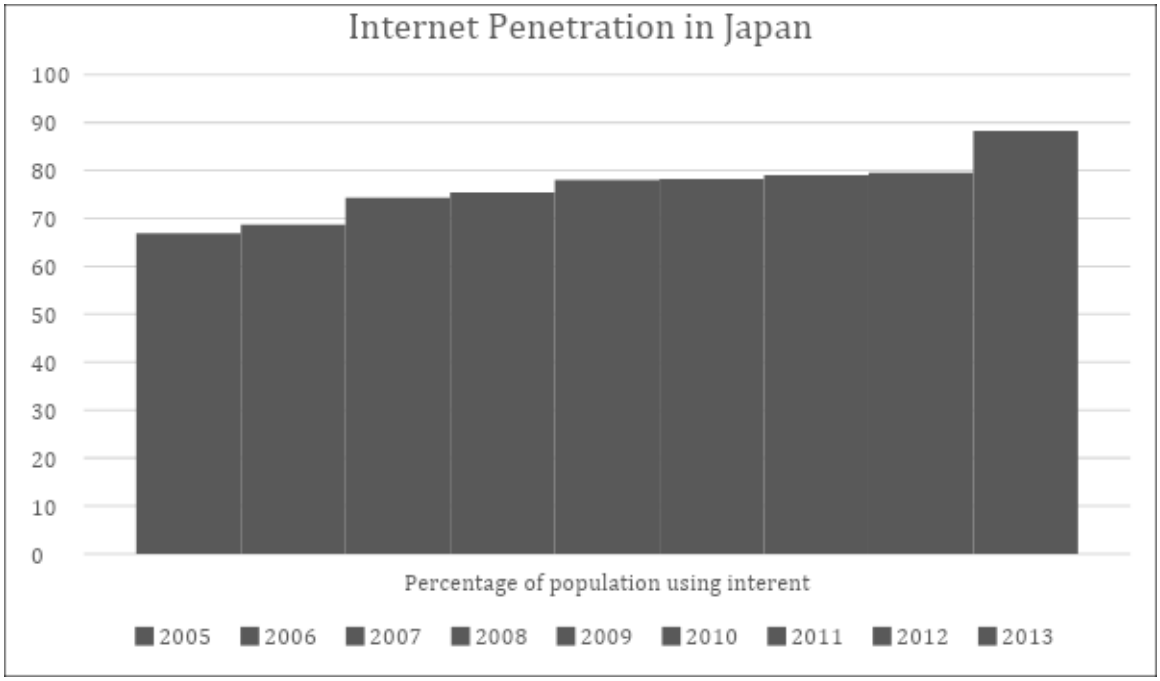

Figure 7 Graph showing internet penetration in Japan from 2005 to 2013

Source: Engelmann, Julia. "Percentage of Population Using the Internet in Japan from 2000 to 2017." Statista, 15 Oct. 2018, https://www.statista.com/statistics/255857/internet-penetration-in-japan/.

Also, internet users were around 79% of the population in 2011 (seen in figure 7). This means that despite not many people having a smartphone, a lot of them did have access to internet through other methods like on a laptop, where it is also possible to access social media sites. As mentioned earlier, Twitter, for instance, released an internet website for people to access Twitter without a smartphone. Therefore, this could also account for the difference between the low number of smartphone owners and the high number of tweets. So, it can be seen that smartphone penetration didn't really affect greatly on the potential of using social media as a source of information for disaster relief.

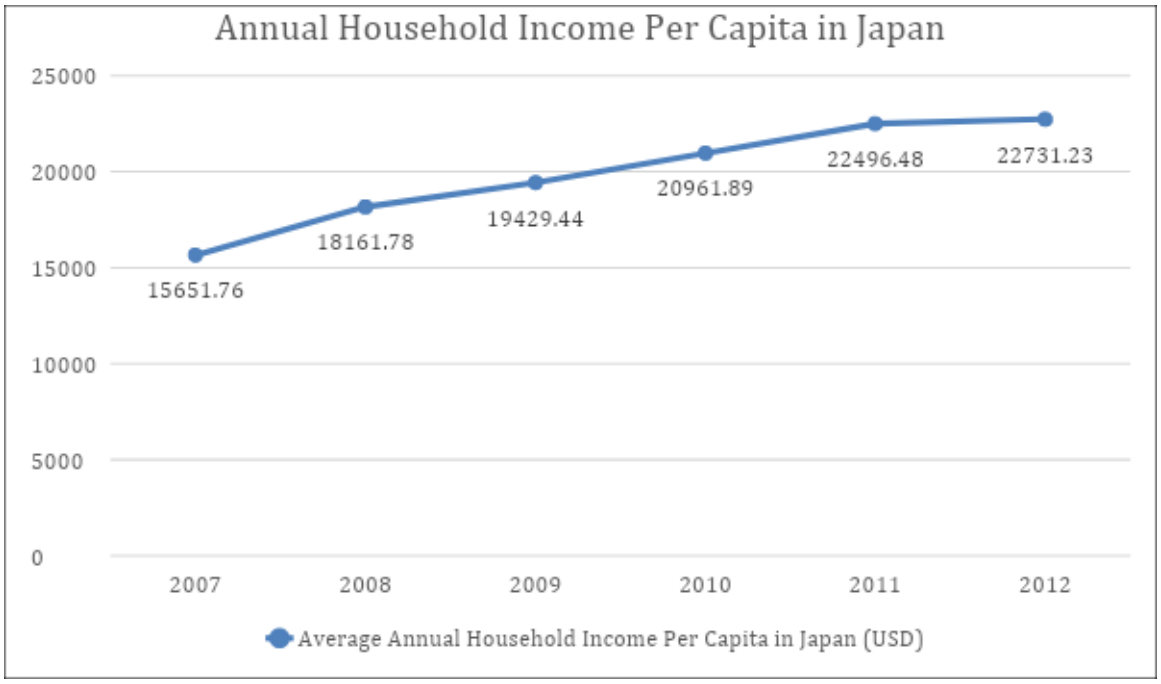

Figure 8 Graph showing household income in Japan from 2007 to 2012

Source: "Japan Household Income per Capita [2000 - 2019] [Data & Charts]." [2000 - 2019] [Data & Charts], https://www.ceicdata.com/en/indicator/japan/annual-household-income-per-capita.

Figure 8 suggests a general incline in the household income in Japan, reaching at around USD 22496.48 in 2011, which is an increase of around USD 6944.72 since 2007. This process potentially means that there was a higher disposable income in each family to invest in a piece of technology that can access to the internet. Establishing earlier that Twitter can be accessed via any technology with access to the internet, this could elicit that a lot of people did have access to Twitter. This, again, supports that the possibility that social media was very helpful during the Tohoku disaster.

Lastly, the changing demographics may have also made maximized the benefit the use of social media for disaster relief. Tohoku disaster took place in 2011, a time when the demographic composition has evolved greatly. Since the 2000s, the baby boomers (born between 1946 and 1964) have increasingly moved out of the working workforce as they are replaced by the millennials (born between 1990s and early 2000s). Millennials are more used to technology as mobile smartphone started to develop in 1992, which is around the time when millennials are born. And in 2007, the first iPhone with 3G mobile network able to access social media applications rolled out (Owen 2018). The year was when the eldest millennials born in 1990 start to enter the workforce at the age of 17. This means that millennials will spend a lot more time using smartphones, thus will be more adept in using

social media than the baby boomers (Pratap 2018). This will effectively help to maximize the potential of using social media as a tool to relieve the impact of Tohoku disaster.

To summarise, it can be concluded that the social and economic factors allow the use of social media to be maximized, thus there is a possibility that social media was indeed a useful disaster relief tool during the Tohoku disaster. Furthermore, since there is a general increase in all the trends, suggesting a possibility that the social and economic factors are likely to improve, social media could have an even bigger power in disaster relief in Japan in the future. Hence, this concludes that social media could definitely help with disaster relief to a great extent.

Ethical Considerations

Lastly, it is important to consider the ethical implications between stakeholders behind the use of social media during a disaster, and how it can affect its uses during disaster relief during the Tohoku disaster.

Ethics is always the biggest issue when comes to using technology, and perhaps the biggest concern is privacy of the users, who are the most important stakeholder in a disaster. Social media may contain a lot of personal information like name, age, phone number and etc. They may be minor during the event of a disaster, where the lives of people are way more important. However, some people may not be comfortable sharing this information at all. Also, some people may post tweets regarding their emotional status online during the disaster, which are highly personal. Therefore, there is a huge ethical issue behind using social media as a disaster relief tool, thus this may limit the potential of using social media to aid in the relief process during the Tohoku disaster.

Unfortunately, there are only limited ways to counter this as it is impossible to control what kind of information is on social media. Yet, upon registering a social media account, users must agree on the Terms and Conditions. In Twitter, it is called “Twitter Terms of Service”. There is one term in the documentation stating that by posting content using their services, Twitter have the rights to process and distribute those information “in any and all known or later-developed media” (“Twitter Terms of Service”). This will grant the rescuers, another important stakeholder, to use the information posted on Twitter lawfully.

To summarise, while there is a term of service giving rescuers rights to access user’s information on social media to help with disaster relief, its extent is limited as it may be uncomfortable for the users.

Conclusion

To conclude, from ITGS's perspective, data from social media like Twitter is big data, so big data analytics can be very valuable as it can quickly and efficiently filter out useful information to use in order for the rescuers to identify the best course of action to increase the victims' survival rate, despite some limitations such as inability to differentiate incorrect information. From a geographic perspective, the social factors minimizing the potential of social media for disaster relief is low as there has been a significant increase in internet penetration despite the smartphone penetration remained low when Tohoku disaster strikes. The changing demographic and improved economy also help to maximize the usage of social media during disaster relief.

The only downside of using social media as a disaster relief tool is the ethical concern which is unavoidable, and can make the victims, an important stakeholder, uncomfortable. However, this can be countered limitedly as users sign the terms of services of social media, allowing the rescuers to access the information rightfully.

All in all, focusing on the Tohoku disaster, social media is definitely very helpful, hence proving social media can help with disaster relief to a great extent. In terms of global significance, the strategy is to use the Tohoku disaster as a case study to explore the extent to which social media could be useful during a disaster as serious as the Tohoku. However, it is important to recognize that the geographic factors may not be able to fit well with a more global context, where there is a larger variety of geographical influences at different places. Therefore, to explore the global significance of this issue better, it would be beneficial to consider different places. Nonetheless, this essay still manages to prove the effectiveness of using social media as a tool during disaster relief. Even though the essay only focuses on one particular case study, it is possible that this conclusion could be of global significance since global exposure to social media is increasing fast, as stated early in the introduction, hence social media could still be useful in any disaster around the world.

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