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Effects of ICT and media information on collective resilience after disasters – from a virtual crowd to a psychological crowd – Part 1 - ICT and media information and collective resilience in an emergency situation

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Effects of ICT and media information on collective resilience after disasters –from a virtual crowd to a psychological crowd – Part 1 - ICT and media information and collective resilience in an emergency situation [Draft paper]

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Abstract

This paper is the first part of a two-part study that aims to examine the relationship between collective resilience and ICT and media information. Previous studies find that in disaster and emergency situations, most people are capable to remain coherent and to offer mutual help. Referred as collective resilience, this kind of collective behaviours has become an essential element in disaster resilience development. However, despite many studies show that ICT and media information can also motivate people in disasters, currently there are few studies that connect collective resilience with ICT and media information.

This paper focuses on the relationship between collective resilience and ICT and media information in an emergency situation using the 2011 Great East Japan Earthquake as a case study. Specifically, it focuses on the tens of thousands of commuters who were stranded at the train stations for long hours because of the earthquake. Using a cluster analysis of data collected from an original questionnaire survey in Japan, we found that information from different media sources can contribute to people's collective resilience behaviours. In particular, under the external threats posed by the disaster, people who were better informed were more likely to be associated with others, and also to give and receive help.

Introduction

The understanding of people's collective behaviours in disasters and the underlying mechanisms has become an important aspect of disaster resilience development. This is because many studies, for example, Mawson (2005) and Drury, et al. (2009), have found that citizens can become a source of help in disasters. In fact, some governments have realised this fact and begun to incorporate citizen involvement into their disaster resilience policy (Linnell, 2014).

In recent years there has been growing interest in 'collective resilience' in disasters. This concept is put forward by Drury et al. (2009) to show that in disaster and emergency situations, crowds can provide mutual aid and other features of resilience that enable individuals to cope with the disaster psychologically. Currently, however, studies on collective resilience mainly focus on the survivors who experienced the event directly, and few have investigated its implications in a societal level. Owing to ICT advancements, many disasters in recent years were also experienced indirectly by the public outside the direct disaster areas through media information. Thus, a question that needs to be raised is –can the concept of collective resilience be extended to the society at large, in particular through ICT and media information?

The purpose of this study is to answer this question, and by doing so to derive some practical implications for policy makers on the development of a more disaster resilient society. This study is divided into two parts. This first part –the focus of this paper– is to examine the role of media information in an emergency situation, in particular on its relationship with collective resilience at a micro level. After identifying the relationship, we will move on to the second part to expand the concept to a societal level in a future paper.

This study uses the 2011 Great East Japan Earthquake as a case study because of two main reasons. First, it is one of the few major natural disasters that could be experienced vividly by the society at large through vast amounts of ICT and media information. Second, despite the unprecedented scale of the damages, the Japanese public had demonstrated a high level of resilience and solidarity. In this case study, we focus on the greater Tokyo area –a metropolitan area with a population of 37.8 million people– that was deeply affected by this disaster in different levels.

Background – the 2011 Great East Japan Earthquake

At 2:46pm JST on the 11th March, 2011, Japan was struck by one of the most severe natural disasters in history –the Great East Japan Earthquake. A 9-magnitude undersea earthquake occurred at the north-east coast of Japan caused massive tsunamis that devastated the north-east coastal areas; moreover, the tsunamis also triggered one of the worst nuclear accidents in history –the Fukushima nuclear power plant accident. The earthquakes and tsunamis had claimed more than 15,800 lives and cost more than 177.7 billion US dollars of direct damages (Reconstruction Agency, 2013).

Despite Tokyo –the capital of Japan– was 373 km away from the epic centre, it was also hit by strong seismic waves that measured up to 5-Upper in the Japan Meteorological Agency seismic intensity scale. Compared with the north-east region, the direct physical damages in Tokyo were minor, that said, being the centre of a metropolitan area of 37.8 million inhabitants, the social impacts were substantial (Ueno, 2013).

As Ueno (2013) describes, the social impacts caused by the disaster to the citizens of Tokyo can be divided into 4 phases. The first phase was the day the when earthquake struck, specifically when the strong seismic waves shocked the city and paralysed its communication and public transportation systems. The second phased was the following two days of unusual quietness, when everyone was nervously watching the Fukushima nuclear power plant accident unfolded. The third phase was the following 2 weeks of excessive confusions and social disruptions because of the Fukushima nuclear accident and the subsequent rolling blackouts. Finally, the fourth phase was the following months when the public attempted to adjust to the uncertainties.

This paper focuses on the first phase, especially on the emergency situation faced by the tens of thousands of stranded commuters. Soon after the first seismic wave hit the city on the 11th March, all train and subway services –the main transportations for the inhabitants of Tokyo and the neighbour areas– were suspended as part of the safety mechanism. As the city was continued to hit by strong aftershocks, the suspensions had continued until after midnight. Since it was a typical Friday afternoon, a large number of commuters were affected. Later reports estimate that 5.15 million commuters were affected –30% more than what the city government had anticipated previously (Hiroi, et al., 2011; Tokyo Metropolitan Government, 2011).

Despite the government had made several public announcements advising the public to remain where they were and to refrain from rushing home, yet large crowds of people were still amassed quickly near all the major stations attempting to go home (Suzuki, 2013). Abe (2014) calculates that there were at least 320,000 commuters stranded near the major transportation hubs in Tokyo on that day. For example, outside the west gate of Shibuya station –one of busiest transportation hubs in Tokyo– alone, it is calculated that there was an average of 50,000 commuters stranded there between 4pm to 11pm. The number peaked at around 7pm, when 66,000 persons –two and a half times more than the number of people during the peak hours- were amassed. This number was equivalent to a crowd density of 6 persons per square meter. Similar situations were also found in all other major transportation hubs all around Tokyo.

According to literature of crowd disasters, for example, Fruin (1993) and Helbing & Mukerji (2012), 6 persons per square meter is an alarmingly high level of crowd density, any mishaps can trigger a snow ball effect and cause a tragedy. In addition to the intense crowd density, Abe (2014) also points out that the stranded commuters were under excessive stresses. Many people were stranded for long hours; they were suffering from physical stress

such as coldness and tiredness, psychological stress like fear and anxiety, and environmental stress from staying in an extremely crowded environment.

The situation was reaching the break point, as Masahiko Kumasaka –the stationmaster of Shibuya station– said in an interview describing the situation in the station ‘...many people were feeling sick, but they had to wait 6 hours for the ambulance. At the same time, I was getting police reports of people fighting [in the station]. Despite the police were doing their best to control the situation, I thought anything more would be beyond their limit...¹’ (NHK higashinihon purojekuto, 2014, p. 491)

That being said, despite under such a highly stressful situation, most of the commuters had remained calm and behaved orderly. Eventually, the crowds dispersed slowly when the train services gradually resumed around midnight. Although around 20% of the affected commuters could not return to their home until the next day, overall, no serious injuries or accidents were reported (Hiroi, et al., 2011).

On top of the large crowds of stranded commuters, another remarkable aspect in this event was the role ICT and media had played. First of all, mass media, specifically television, served the role of the most trusted and useful information source for the stranded commuters even most of them were staying outdoor (Hiroi, et al., 2011; Suzuki, 2013). This owed to the large numbers of large outdoor television screens in Tokyo, and also the high diffusion of the One-Seg digital broadcasting service that can used by mobile phones.

Other than functioning as a television receiver, mobile phones, the main communication tool for most people in Japan², had served another critical role for the stranded commuters. After the disaster, most people could not make voice calls or send messages because the mobile telephony networks were totally congested. However, as mobile data communication was still available, mobile Internet including social media such as Twitter became the main communication channel for many of people (Kaigo, 2012). For example, Abe (2014) finds that within first 24 hours after the earthquake, more than 35 million tweets were sent over Twitter on the subject related to Shibuya station alone.

Overall, both mass media and ICT provided the stranded commuters with critical information such as their family’s status and traffic information. This information helped them to make crucial decisions such as to continue to wait, to return to where they were, or to take an alternative route (Takada, et al., 2012; Hara, 2013).

After the disaster, the mass emergency situation caused by the large number of stranded commuters raised major alarms in the government and it became one of the main concerns of the city’s preparedness of future disasters. As a result, the city government issued a new set of guidelines on the risk and prevention of stranded commuters, and also on the use

¹ Originally in Japanese, translated by the authors.

² In 2011, the mobile phone penetration rate in Japan was 94%, and one third of them were smartphones (MIC, 2012).

of media and ICT information in the wake of a major earthquake (Tokyo Metropolitan Government, 2012).

Literature review – collective resilience and media information in disasters

In disaster literature, an emergency refers to an unexpected situation caused by external forces such as natural or manmade disasters that poses threats to people's life and/or property. In the case that large numbers of people are involved, it is referred as a mass emergency, which could escalate into a crowd disaster such as a stampede (Mawson, 2005).

That being said, recent studies, for example, Mawson (2012) and Drury, et al. (2009), find that in most cases of mass emergency, instead of panicking, people in crowds are capable to maintain coherent, to self-organise, and to offer mutual aid. From a social psychology perspective, Drury et al. (2009) explain this phenomenon through the concept of 'collective resilience'. They contend that 'crowds can provide the mutual support, co-ordinated activity and other features of resilience that enable people to cope psychologically with mass emergencies and disasters' (Drury, 2012, p. 195).

The core component of collective resilience, according to Drury et al. (2009), is the sense of shared identity and shared fate created by the common threats posed by a disaster. That is, when people face a common threat, they will shift from seeing themselves as unique individuals to seeing themselves as fellow members of a group. This shift creates a strong sense of togetherness and subsequently forms a group-based shared identity. Having a shared identity encourages people to work together towards a mutual goal, and subsequently alter their behaviours collectively. People will become more interdependent with each other, and more willing to help. This interdependence increases their level of coordination, reduces their level of fear, and ultimately helps them to overcome the difficult situation.

Later studies, however, find that shared identity alone cannot fully explain the mechanism in people's collective resilience behaviours. For example, Vezzali, et al. (2015), find that after a disaster, some minority groups in a society (immigrants in their case) felt much less united than the majority. Moreover, Templeton, et al. (2014) also point out the fact that even within the same physical crowd in a disaster, there could be more than one psychological crowd. In fact, Drury et al. (2009) themselves also find that the level of shared identity varies among individuals. In a later study (Drury, et al., 2015), they find that having a high level of shared identify does not necessarily equal to a high intention to help. They point out that there might be other factors affecting people's collective resilience behaviours in parallel to their shared identity and shared fate.

Indeed, Gilles, et al. (2013) find that in disasters, media information can influence how individuals perceive themselves as being an 'in-group' or an 'out-group' with others. Furthermore, Wessely (2005) argues that information can directly affect individuals' behaviours in disasters and emergencies. In particular, when people do not have sufficient

information or cannot establish communications, they tend to behave differently and are also more prone to panic. Indeed, studies on crowd disaster, for example, Zhen, et al. (2008) and Helbing & Mukerji (2012), identify that poor information communication is one the main causes of mass panics.

Furthermore, many studies show that in disasters and emergencies, information from different media can contribute to people's resilience behaviours. For example, ICT and media information can help people to make critical decision (Hiroi, et al., 2011), to increase their situation awareness (Yin, et al., 2012), to encourage altruistic behaviours (Mitomo, et al., 2015), and to obtain emotional supports (Katz & Rice, 2002; Kaufmann, 2015).

Theoretical framework

Based on the literature review, we could assume that in an emergency situation –the stranded commuters in this case, most people will display the characteristics of collective resilience. Specially, the common threats posed by the disaster will create a sense of shared identity and shared fate, and encourage mutual help (help given and help received). In this case, the external threats faced by the stranded commuters were physical stress from coldness and hunger, psychological stress from fear caused by continuous aftershocks, and environmental stress from staying in an extremely crowded environment (Hiroi, et al., 2011).

In parallel, we also hypothesised that the characteristics of collective resilience among the stranded commuters were related with the level of information they received from different media sources. Accordingly to Hiroi, et al. (2011), the main information sources for the stranded commuters were mass media (television and radio) and mobile phones (voice, messages and mobile Internet). In addition, considered that some of the stranded commuters might be able to access the Internet via portable PC, we also included the Internet and social media as other media sources. We also included the railway/subway station staff as one of the information sources. Finally, we included demographic factors such as age and gender as well. The overall framework is shown in Figure 1.

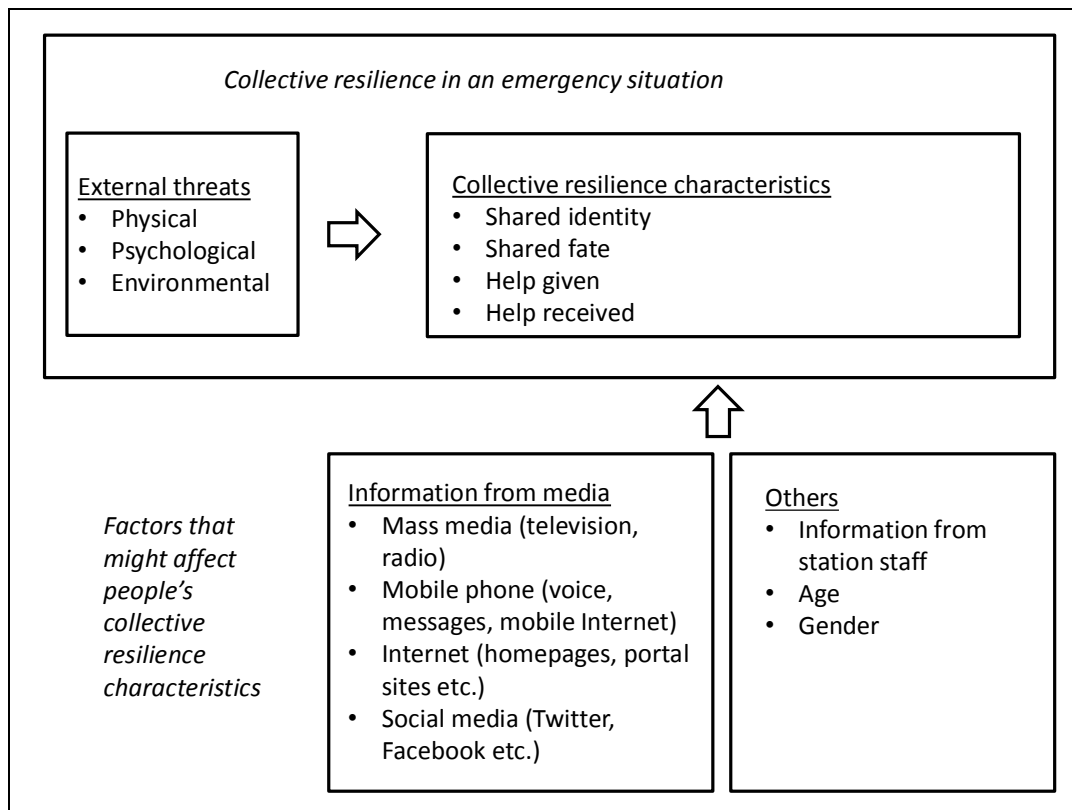


Figure 1 Theoretical framework

Methodology

In this study, we adopted an exploratory approach. Specifically, our aim was to examine whether the differences in the level of collective resilience characteristics among the stranded commuters were related to the levels of disaster information they received from different media. Thus, we employed a two-step cluster analysis to separate a sample population (the stranded commuters) into a number of statistically distinct groups (clusters) based on the clustering variables, and then evaluate the differences between the different groups using a set of evaluation variables. The advantage of the two-step cluster analysis method is that it combines the hierarchical and partitioning methods to provide an auto-clustering mechanism. That is, instead of pre-determining the number resulting clusters, this method calculates the number of clusters based on the measures-of-fit parameter. In this case, we selected the commonly used Bayes Information Criterion (BIC) (Sarstedt & Mooi, 2014).

After we identified the different groups, we interpreted their characteristics by comparing the means of their clustering variables using one-way ANOVA. Then, we further evaluated the differences between the groups by comparing the means of their evaluating variables with the same method.

In this study, the sample population was those who were stranded in a train/subway station for long hours in the great Tokyo region on the 11th March, 2011. The samples were collected from an Internet based questionnaire survey.

The clustering variable were represented the levels of external threats felt by the stranded commuters and their levels of collective resilience characteristics. First, the levels of external threats were represented by asking the respondents the levels of physical, psychological, and environmental stresses they felt when they were stranded at the station using a 5-level Linkert scale (1=lowest and 5=highest). Specifically, these stresses were described as physical stress from hunger and coldness, psychological stress from the fear from the aftershocks, and environmental stress from staying in an extremely crowded environment. Second, the levels of collective resilience were represented by asking the respondents their sense of shared identity, shared fate, as well as their levels of help given and help received to/from others in the same 5-level Linkert scale as above.

The evaluating variables were represented by the respondents' level of information received from different media sources also in the same 5-level Linkert scale. Specifically, we asked whether they think that they had received useful information related to the situation from i) mobile phone (voice and messages); ii) mobile phone (mobile Internet); iii) television (public, outdoor, and mobile phone television); iv) radio (public and portable radio); v) social media (Facebook, Twitter etc.); vi) the Internet (homepage, search engines etc.).

Finally, we also asked the respondents whether they received useful instructions from the station staff in the same 5-level Linkert scale as above. In addition, we also asked them their age and gender.

Data and results analysis

The data was collected from an Internet survey conducted in August 2015³. In total, 2,073 samples were collected from the greater Tokyo area⁴. Among them, 432 respondents fit our criteria of 1) were living in the greater Tokyo area on the 11th March, 2011, 2) could remember what happened, and 3) were stranded near a train or subway station for long hours on that day. The average age of this group was 43.95 years old with a standard deviation of 17.78. 42% of this group were male and 58% were female. The means, standard deviations, and range of the respondents' answers to the questions are summarised in Table 1.

³ This survey was sponsored by the Japan Commercial Broadcaster Association. It was part of a larger survey project on people's usage of ICT and media related to disasters. The survey was conducted by one of the largest professional research companies in Japan –Micromill Inc., which has a survey panel of more than a million people across the country.

⁴ Tokyo and the 6 surrounding prefectures – Ibaraki, Tochigi, Gunma, Saitama, Chiba and Kanagawa

Table 1 – Answers to survey questions

	Variable		Mean	Standard deviation	Min	Max
Clustering variables	External threats	Physical stress	3.60	1.07	1.00	5.00
		Psychological stress	3.94	1.03		
		Environmental stress	3.72	1.02		
	Collective resilience	Shared fate	3.92	0.91		
		Shared identity	3.06	1.18		
		Helped given	2.59	1.21		
		Helped received	2.46	1.15		
Evaluating variables	Information from different ICT and media sources	Mobile phone (voice and messages)	2.61	1.28		
		Mobile phone (mobile Internet)	2.27	1.16		
		Television	2.93	1.30		
		Radio	2.38	1.29		
		Social media	2.31	1.24		
		Internet	2.47	1.29		
	Others	Information from station staff	2.81	1.21	1.00	5.00
		Age	43.9	17.78	15	77
		Gender	1.42	1=male; 2=female		

Next, we conducted a two-step cluster analysis using SPSS version 22. Based on the clustering variables, a three-cluster solution was formed. The Silhouette measure of cohesion and separation was 0.3, indicated a fair cluster quality.

We then interpreted the characteristics of these three groups by comparing the means of the clustering variables. Specifically, we compared their cross-group differences using One-way ANOVA, and their pairwise differences using Post Hoc Multiple Comparison with Tukey HSD criterion (George & Mallery, 2013). The ANOVA results indicated that the three groups were significantly different in all clustering variables. However, there were also some similarities between different pairs of groups in some variables. For example, group 1 and group 3 felt similar levels of physical and environmental stresses. The results are summarised in Table 2.

Group 1 represented 42.1% of the respondents. Among the three groups, they felt the highest levels of threats (stresses) and also had the highest levels of collective resilience characteristics. This pattern was in line with the literature of collective resilience, which predicts that external threats induce collective resilience. Thus, we interpreted this group as the ‘collective resilient’. In other words, this group felt threatened by the physical, physiological, and environmental stresses. At the same time, they had a relatively higher sense of shared fate and identity, as well as relatively higher levels of help given and help received.

Group 2 (36.6% of the respondents) in comparison felt the lowest levels of external threats and also had the lowest levels of collective resilience characteristics. This pattern was also in line with the literature of collective resilience. This group did not feel a strong sense of external threats which implied that they were probably staying in a relatively safe location, and as a result, the driving factor for collective resilience was absent. Hence, this group can be interpreted as the ‘unaffected’.

Group 3 (21.3% of the respondents), unlike the first two groups, presented a puzzling pattern. Although they felt similarly high levels of threats as the ‘collective resilient’ (group 1), their levels of collective resilience characteristics were quite low relatively. This pattern was contradictory to what the literature of collective resilience predicts. In particular, their high level of psychological and environmental stresses had no significant differences from the ‘collective resilient’. However, for some reasons, they did not display the characteristics of collective resilience. Specifically, they did not seem to associate themselves with others, which could be seen from their relatively low level of shared identify, help given, and help received. Thus, we interpreted this group as the ‘isolated’.

Table 2 – Two-step cluster analysis results

Clustering Variable		Group 1 N=182 (42.1%)	Group 2 N=158 (36.6%)	Group 3 N=92 (21.3%)	Total N=432 (100%)	Three groups difference	Pairwise difference
		Mean				Significance	
External Threats	Physical stress	4.05	2.52	3.70	3.60	***	1-2*** 1-3*** 2-3***
	Psychological stress	4.32	2.74	4.20	3.94	***	1-2*** 1-3NS 2-3***
	Environmental stress	4.07	2.52	4.00	3.72	***	1-2*** 1-3NS 2-3***
Collective resilience	Shared fate	4.19	3.13	4.08	3.92	***	1-2*** 1-3NS 2-3***
	Shared identity	3.76	2.34	2.66	3.06	***	1-2*** 1-3*** 2-3**
	Helped others	3.54	2.34	1.65	2.59	***	1-2*** 1-3*** 2-3***
	Helped by others	3.32	2.30	1.56	2.46	***	1-2*** 1-3*** 2-3***

After interpreting the characteristics of the different groups, we moved on to evaluate their differences by comparing the means of their evaluating variables. In this case, they were the levels of related information the respondents received from different media sources. We compared the means of the evaluation variables of the three groups using the same methods as we compared the clustering variables. The results are summarised in table 3.

Based on the evaluation results, the level of information received by the three groups could be classified into two types. First was the better-informed, who reported to have received a relatively higher level of useful information that was related to their situation from all different media. The second type was the less-informed, who reported the opposite.

First of all, the 'collective resilient' (Group 1) appeared to be the better-informed. Compared with the other two groups, they received more useful information regarding their situation from all media sources. This implied that the respondents who displayed relatively higher levels of collective resilience characteristics were also relatively better informed about their situation from different media sources.

In comparison, the 'unaffected' (Group 2) and the 'isolated' (Group 3) appeared to be the less-informed. They reported to have received relatively lower levels of useful information about their situation from all different media sources. For the 'unaffected' (Group 2), it was understandable because they were assumed to be in a less threatening situation. Thus, we could also assume that their need for information was lower than those who were in a more stressful situation.

For the 'isolated' (Group 3), having a relatively lower level of received useful information could provide a possible explanation to their puzzling pattern of collective resilience characteristics. That is, this could imply that under a similar level of external threats, those who were better informed (group 1 - 'collective resilient') had a higher level of collective resilience characteristics than those who were not (group 3 - the 'isolated'). This interpretation was further supported by the comparing the two groups' age and gender, which we found no statistically significant differences.

Table 3 – Evaluating variables of the three groups

Evaluating Variable		Group 1 – the ‘Collective resilient’ N=182 (42.1%)	Group 2 – the ‘unaffected’ N=158 (36.6%)	Group 3 – ‘the Isolated’ N=92 (21.3%)	Total N=432 (100%)	Three groups difference	Pairwise difference
		Mean				Significance	
Information from different ICT and media sources	Mobile phone (voice and messages)	3.03	2.38	2.26	2.61	***	1-2*** 1-3*** 2-3NS
	Mobile phone (mobile Internet)	2.63	2.14	1.94	2.27	***	1-2*** 1-3*** 2-3NS
	Television	3.22	2.75	2.70	2.93	***	1-2** 1-3*** 2-3NS
	Radio	2.80	2.37	1.91	2.38	***	1-2** 1-3*** 2-3**
	Social media	2.69	2.26	1.90	2.31	***	1-2** 1-3*** 2-3*
	Internet	2.96	2.54	2.42	2.68	***	1-2** 1-3*** 2-3NS
Others	Information from station staff	3.16	2.50	2.58	2.81	***	1-2*** 1-3*** 2-3***
	Age	41.8	46.8	44.8	43.9	**	1-2** 1-3NS 2-3NS
	Gender	1.49	1.24	1.44	1.42	***	1-2*** 1-3NS 2-3***

Discussion and conclusion

The aim of this study is to examine the relationship between collective resilience and ICT and media information in an emergency situation using the stranded commuters in Tokyo caused by the 2011 Great East Japan Earthquake as a case study. Using a cluster analysis, we have identified three different groups of stranded commuters according to the levels of external threats reported by them and their level of collective resilience characteristics. We have identified two key findings by evaluating the levels of disaster information received by these three groups from different media sources.

First, we found strong evidence of collective resilience in an emergency situation, and also its positive relationship with media information. In particular, we found that the respondents who felt threatened by the situation also had a relatively higher level of shared identity and shared fate, and also had given and received more helps from to/from others. Furthermore, this group of 'collective resilient' also received a relatively higher level of useful information about their situation from different media sources. In parallel, we also found a second group –the 'unaffected', who felt relatively less threatened by the situation, and had relatively lower levels of collective resilience characteristics. At the same time they also received a relatively lower level of useful information from all different media sources. Therefore, by contrasting these two groups, we could argue that in an emergency situation, those who felt threatened also showed a higher level of collective resilience, and were also better informed about their situation from different media sources.

The second key finding is an extension of the first one. Specifically, we contend that being informed helped the respondents to feel more empowered to interact and to help others in an emergency situation. This finding was illustrated by the third group –the 'isolated', who's collective resilience behaviours deviated from what the literature of collective resilience predicts. Despite the fact that they felt similarly high levels of external threats as the 'collective resilient', they displayed a relatively much lower level of shared identity, help received, and help given. At the same time, they also had received relatively much lower levels of useful information about their situation from different media sources.

We argue that their low levels of shared identity and mutual help were related to the fact that they did not receive sufficient useful information. This is because from the literature, we know that in disasters and emergencies, information can help people to reduce uncertainties and to increase situation awareness. Thus, without sufficient information may cause people to be confused and feel overwhelmed by the situation, and become less inclined to associate with others and as a result, breaks the collective resilience mechanism. Indeed, from a behaviour psychology perspective, Midlarsky (1984) argues that perceived competence is a main precursor of helping behaviours. That is, before one can turn his/her attention to the needs of others, he/she must have the strength and freedom from person concerns.

Based on these findings, we contend that information is indeed an important component in collective resilience. Thus, in today's digital society, ICT and media can play an

important role to promote collective resilience behaviours in disaster and emergency situations by providing useful information. There being said, since samples were collected from a self-reported online questionnaire survey, sampling bias must be taken into consideration when interpreting the results. Moving forward, our next step is to further elaborate the policy implications of these findings. Specifically, we will focus on the utilisation of ICT and media on the development of citizen participation and disaster resilience in emergency and disaster situations. Furthermore, this paper is only the first part of this study. The next step is to expand the scope from a micro level (an emergency event) to a societal level.

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