The impact of information dissemination on public's risk perception in metro emergencies

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Abstract
To study the impact of information dissemination on public's risk perception in metro emergencies, we carried out an empirical study among Shanghai Metro passengers. Though an investigation of passengers' response to the frequency, type and channel of information dissemination, we developed a Logit model measuring public response for future manipulation.

Keywords: Metro emergency, Risk perception, Information dissemination

Introduction
During the past few decades, researches of metro emergencies were mostly carried out from technical angle, including emergency planning system, emergency information system and emergency response system and so on (Zhao et al. 2012). These research findings constitute an essential part of emergency management but not sufficient. In real practice, accurate grasp of the variation of public's risk perception is thought to be one of the sufficient conditions of effective respond to metro emergencies (Sun 2005). On Sep.27th, 2011, a train of Shanghai Metro Line 10 had a rear-end collision, leading to 271 passengers injured and related traffic jammed for more than 10 hours. Occurred soon after the "7·23" Wenzhou Accident, this metro crash aroused again social doubts and worries about safety problems of public traffics.

Lack of experience and access to detailed history records, the majority of publics would rely on the official departments and news media to get emergency information, which is the main basis for them to make decisions and evaluate risks. Consequently, information dissemination becomes an important influence over the variation of public's risk perceptions in emergencies (Glik 2007, Liu and Chen 2012, Pennings and Grossman 2008, Sorenson 2000, Walker et al. 1998). To study the relations between information dissemination and public's risk perception in Shanghai metro emergencies, we conducted an empirical study of Shanghai Metro one year after the "9·27 Accident", based on which we established a Logit model measuring passengers' risk perception under the influence of information dissemination.

Literature review and hypothesis development

Public's risk perception

The direct consequence of a specific risk event is usually caused by itself, but public's perception of the risk event will depend in part on the information released or converted by the emergency information system (Slovic 1987). Actually, individuals at risk can't always make rational decisions though they try to do so. To reduce the complexity of decision making process, public will evaluate and select information according to the characteristics of emergencies, which is diffused by family, friends, and neighbors (Rogers and Sorensen 1988). Results of information processing along with some other factors, such as emergency attributes, personal ability to avoid risks, familiarity with dangers, social response, etc. constructs public's risk perception of emergencies (Liu 2010). Social scientists have identified general and specific factors that affect public response (both risk perception and behavior) during information dissemination， which are summarized in Table 1 (Sorensen,2000):

Table 1 –Major Factors of Information Dissemination Co-varying with public response

Factor	Response due to factor increase	Level of empirical support
Channel: Electronic	Mixed	Low
Media	Mixed	Low
Message specificity	Increases	High
Number of channels	Increases	Low
Frequency	Increases	High
Message consistency	Increases	High
Message certainty	Increases	High
Source credibility	Decreases	High
Source familiarity	Increases	High

We can see from Table 1 that many of these factors have significant impact on public response in emergencies, physically or psychologically, externally or internally. Specifically, public's risk perception and behavior can be affected in the process of information dissemination by the emergency planner. Based on these findings, we hypothesize that, in aggregate, information dissemination has an ambiguous impact on public's risk perception in metro emergencies.

Factors that affect public's risk perception during information dissemination

Frequency Dissemination frequency is geared to the dynamics of the emerging risk and its severity. However, frequency is still best dictated by the needs of the public at risk (Mileti and Sorensen 1990). In general, people want updates of information even when there's little change in the content. There're a number of potential advantages of frequently recurring warning information. It makes people focused on official warnings, reduce rumors and increase public confidence in the validity of the resource. In protracted emergencies, however, the frequency of dissemination should diminish after the initial warning period. Excessive release of the same kind of emergency information may not only lead to channel plugging, but also unduly psychological and behavioral response of public (Liu and Zhang 2011, Vasterman et al. 2005).Consequently, we bring the factor of frequency into consideration and test the following non-directional hypothesis:

- Information frequency has a significant impact on public risk perception in metro

emergencies.

Type A well constructed information prototype for an emergency is important to the quick dissemination of information. The style and content of emergency information can have a dramatic effect on public response. Previous research has been conducted to discern a piece of poor information from a good one and even a good one from one that reflects state-of-the-art practices (Sorensen and Mileti 1988).The style aspects that are important to include in a piece of good information are specificity, consistency, accuracy, certainty, and clarity (Mileti and Sorensen 1990).To ensure that emergency information can be correctly understood, believed, personalized and acted upon, the information must be specific about the character of risk, location and protective actions as well as consistent and certain. In terms of transparency, however, there used to be a wider debate about whether the public information should be performing a 'right to know' or 'need to know' function—the latter implying an emphasis on _what to do in the event of an accident, the former a broader right to be informed about sources of hazard and levels of risk (Gow 1990, Walker 1999). Base on these comprehensive findings，we build up the following three hypotheses：

- Information specificity has a significant impact on public risk perception in metro emergencies.
- Information consistency has a significant impact on public risk perception in metro emergencies.
- Information accuracy has a significant impact on public risk perception in metro emergencies.
- Information transparency has a significant impact on public risk perception in metro emergencies.

Channel Emergency information should be diffused through as many channels as possible to ensure people in different places of home, school, mall, workplace and traffic can receive it (Perry 2007). With the development of Web 2.0, social net tool such as Twitter and Micro-blog has become an important source of informal information. After ―Shanghai Metro 9·27 Accident‖, official Micro-blogs of Shanghai Metro and some other traditional media updated frequently to make tracking report for the public. With more than 200 messages released in 12h, Micro-blog became a primary information source for the public (Wang 2012).

Another aspect of channel worth of our attention is channel credibility. No single source is credible for everyone. People at risk would verify the credibility of a specific piece of emergency information though a variety of channels (Perry and Lindell 1990). Traditionally, emergency information is labeled as coming from a panel of officials, scientists, and experts to enhance its credibility (Mileti and Sorensen 1990). Distrust of official channels leads to overreliance on informal ones, which devotes much to the high risk perception of public (Sun 2005). In order to examine the links between information channel and public's risk perception, we test the following non-directional hypothesis:

- Number of channels has a significant impact on public risk perception in metro emergencies.
- Channel credibility has a significant impact on public risk perception in metro emergencies.

Additional factors In addition to information dissemination, public response to emergencies also have connections with emergency features、personal attributes and social orientation, etc (Helsloot and Ruitenberg 2004). First, how people under emergencies feel and what they do is usually determined by the presentation and types of risks (Stone and Yates 1991).
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Second, public‘s demand for emergency information varies with their personal attributes such as gender, age, income and education (Lindell and Hwang 2008, Peacock et al. 2005). Due to differences existing in experience, knowledge and comprehensive ability， ordinary public distinguished obviously from professionals in their perception of risks (Slovic et al. 1979). Moreover, social and culture factors play a significant role in developing someone‘s ability of understanding and using information (Douglas and Wildavsky 1982). Last but not least, from the perspective of cognitive psychology, there are various psychological deviations in the process of dealing with emergency information, such as representativeness、habitualness、anchoring and adjustment, which simplify the information processing and decision making for the public, but lead to evaluation offset of emergency risks at the same time (Sun 2005).

Thus it can be inferred that public‘s risk perception under metro emergencies is the result of mixed factors. To study the impact of information dissemination on passengers‘ risk perception, we can‘t ignore these non-information factors. As our investigation is based on metro cash accidents and has Shanghai Metro passengers as our interviewees, we take the emergency features and the social and culture factors influencing public‘s risk perception as control variables of our model. Moreover, psychological deviations as internal factors can hardly be measured simply by questionnaire research, thus they are considered as error terms in the model. Consequently, under the background of metro emergencies, we‘d like to consider personal attributes along with information dissemination as variables of our model and hypothesize that personal attributes have significant impact on public‘s risk perception in metro emergencies.

Methodological approach

As we all know, public‘s risk perception is the result of mixed factors. Sometimes we need to identify the dominant ones though quantitative analysis before further studies. SEM and Logit modeling are two kinds of effective methods in this small field. Scholars have studied public‘s risk perception in SARS by setting up a SEM or Logit model (Shi et al. 2003, Sun 2006).

We conduct our study with Logit modeling to analyze the relations between information dissemination and passengers’ risk perception of metro emergencies. We take passengers’ risk perception as the dependent variable Y, a binary random variable with values of 0 and 1. Specifically, Y=1 indicated by the appearance of panics means that passengers have high risk perceptions; on the other hand, Y=0 indicated by the appearance of panics means that passengers have high risk perceptions. We take X_1, X_2……X_{10} as the independent variables in the model, composed of some information dissemination indicators and personal attributes. In a Logit model, the probability of Y=1 is P, thus the probability of Y=0 is 1-P. Here we get the following equation:

$$\text{Logit } P=\alpha+\beta_1 X_1+\beta_2 X_2+\ldots\ldots+\beta_{10} X_{10} \quad (1)$$

Different from Multiple Regression, the error items in a Logit model obey the binomial distribution instead of normal distribution. Therefore, we use Maximum Likelihood (ML) to estimate parameters of the model. Parameter α is the constant term, representing the logarithm value of the ratio of P(Y=1) and P(Y=0); Parameter is the Logistic regression coefficient, describing the change of the logarithm value of the ratio when variable Xi increase one unit with other variables remain unchanged.

Research setting and data

As we can see in the discussions above, the emergency features and the social and culture factors influencing public's risk perception have been considered as control variables of our model. Also, psychological deviations are included in error items. Consequently, to set up a Logit model measuring public's risk perception in metro emergencies, we selected two types of variables: information dissemination indicators and personal attributes, which are listed in Table 2.

Table 2 –Summary of variables in the Logit model

Variables	Name	Original value	Encode	Ratio
Frequency	X_1 (Dissemination frequency)	outdated	0	26.1%
		updated	1	73.9%
Type	X_2 (Information specificity)	simplified	0	31.7%
		detailed	1	68.3%
	X_3 (Information consistency)	inconsistent	0	19.4%
		consistent	1	80.6%
	X_4 (Information accuracy)	inaccurate	0	33.2%
		accurate	1	66.8%
	X_5(Information transparency)	non-transparent	0	43.6%
		transparent	1	56.4%
Channel	X_6 (Channel credibility)	incredible	0	34.6%
		credible	1	65.4%
	X_7 (Number of channels)	≤2	0	32.2%
		＞2	1	67.8%
Personal attributes	X_8 (Gender)	male	0	67.3%
		female	1	32.7%
	X_9 (Age)	aged	0	26.1%
		young and middle	1	73.9%
	X_{10} (Education)	under-educated	0	30.3%
		well -educated	1	69.7%
Dependent variable	Y (Risk perception)	low	0	48.8%
		high	1	51.2%

Combined with previous studies of Shanghai Metro emergencies, we choose frequency, type and channel as three indicators of performance of information dissemination (Liu and Ma 2006, Zhang 2003, Zhou and Li 2012). From column 5 of Table 2 we can see that Shanghai Metro has overall good performance in emergency information dissemination. For example, as much as 80.6% passengers think that the emergency information they got from Shanghai Metro and other channels respectively are consistent. Even information transparency, the prior weakness link in emergency information dissemination due to the impact of Wenzhou 7 • 23 Accident, also got positive views from 56.4% interviewees.

In addition, some typical social and psychological attributes of passengers including gender, age and education are also included into our model. The inclusion of personal attributes helps us avoid omitted variable bias, as several of them have explanatory power. For example, individuals with well education background may take rapid response to the warnings they received (Sorensen 1991). As to the dependent variables of this model， we measure an individual's risk perception by whether he or she is panic or not. That is to say, if one passenger states that he became panic in some metro emergency, we conclude that he has a high risk perception of that particular accident, and vice versa. Finally, it's worth to be noted that some

variables like age, dissemination frequency, number of channels are not measured as binary in real investigation. However, considering the convenience of processing data and statistical analysis, we transfer all 10 variables into binary type without missing the representative of original data.

Results and managerial implications

This paper tests the whole fitting degree of model though logarithmic likelihood statistic. Given a 5% significant level, if the test of significant indicator P_i turns out to be < 0.05, then we conclude that variable X_i has significant impact on Y. We conduct statistical analysis on SPSS17.0 using the Backward: LR method in binary Logit regression. After four rounds of testing and optimization, we have the following results and implications.

The impact of information dissemination on public's risk perception

As is shown in Table 3, after a series of Logit regressions, we find that Dissemination frequency plays a positive role in reducing public's risk perception with statistical significance (β = -1.794, sig. =0.000). Frequent updates of emergency information would help to lower individual's perception of risk. In less than 24 hours after ―9·27 Accident‖, the micro-blog of Shanghai Metro diffused more than 200 messages to meet the demand of the public for authority information, which seized the opportunity to reduce rumor immediately.

In terms of information type, Information specificity is important to public's risk perception (β = -1.535, sig. =0.001) because specific information may help to reduce the uncertainty of accidents and enhance passengers' familiarity with emergencies, which are the two adjustable factors influencing public's risk perception (Covello and Merkhoher 1994).

Information consistency also plays a significant role in passengers' evaluation of emergency information (β = -1.980, sig. =0.003). Faced with sudden emergencies, passengers would seek information from different channels (the ratio of passengers choosing more than 2 channels is 67.8%). When the emergency information they achieved appear not consistent, passengers would undergo psychological contradiction with their emotions more vulnerable to cognitive biases and panics. In the "Shanghai Metro 9·27 Accident", the official Microblog ever used the word "friction" to describe this accident, which contradicts with the description on the Internet. Consequently, Shanghai Metro obtained lots of negative comments and doubts. 16 minutes later, the official Microblog replaced "friction" with "crash", the latter word is more consistent with descriptions on the Internet, to remove the dispute.

In addition, Information transparency is also a significant factor influencing public's risk perception (β = -2.613, sig. =0.014). From coefficient β we can conclude that nowadays passengers prefer a more frank and comprehensive information dissemination. Nevertheless, if official departments over-blow the uncertainty and situation of emergencies without any reservation, which usually ends with information explosion, the probability of public overestimating emergency risks would correspondingly increase. How to release emergency information frankly and responsibly without causing any unnecessary panic among publics has become one of the challenges in information dissemination.

It turns out that Channel credibility has a positive impact on public's risk perception (β = -2.286, sig. =0.007) for strong credibility of official departments would enhance the reassurance influence of official information on passengers. On the other side, once there's little trust between officials and the public, rumors would spread and come into effect. Forty minutes after the accident happened, the official Microblog released a message confirming the happening of

this crash. In the initial stage of emergency, providing official and credible information can obtain public‘s trust and support. Statistics from authoritative media also proved this by showing that the credibility score of Shanghai Metro is as high as 4.1 points (score area are -10 to 10 points) (News 2011).

Table 3–Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step1	Dissemination frequency	-1.774	.442	12.788	1	.001	-1.754
	Information specificity	-1.524	.422	11.043	1	.002	-1.519
	Information consistency	-1.933	.533	9.088	1	.003	-1.920
	Information accuracy	-.369	.379	.946	1	.331	-2.561
	Information transparency	-2.575	.460	4.134	1	.028	-2.266
	Channel credibility	-2.295	.453	4.572	1	.027	.371
	Number of channels	.166	.409	.165	1	.685	-1.823
	Gender	.429	.386	1.233	1	.267	-1.867
	Age	-1.778	.419	7.481	1	.005	4.329
	Education	-1.876	.456	6.695	1	.014	-1.794
	Constant	4.408	.753	3.735	1	.030	-1.535
Step2	Dissemination frequency	-1.798	.440	13.895	1	.000	-1.980
	Information specificity	-1.541	.420	11.697	1	.002	-2.613
	Information consistency	-1.982	.521	11.014	1	.002	-2.286
	Information accuracy	-.371	.379	.957	1	.328	-1.758
	Information transparency	-2.621	.448	5.497	1	.019	-1.892
	Channel credibility	-2.304	.453	7.307	1	.007	4.498
	Gender	.418	.385	1.177	1	.278	-1.754
	Age	-1.790	.418	6.070	1	.012	-1.519
	Education	-1.900	.453	5.496	1	.020	-1.920
	Constant	4.512	.715	3.765	1	.030	-2.561
Step3	Dissemination frequency	-1.754	.436	14.214	1	.000	.173
	Information specificity	-1.519	.419	10.176	1	.003	.219
	Information consistency	-1.920	.514	11.985	1	.001	.147
	Information transparency	-2.561	.442	6.617	1	.010	.077
	Channel credibility	-2.266	.449	8.472	1	.006	.104
	Gender	.371	.380	.952	1	.329	1.449
	Age	-1.823	.416	6.160	1	.011	.162
	Education	-1.867	.450	5.233	1	.021	.155
	Constant	4.329	.681	4.431	1	.026	75.898
Step4	Dissemination frequency	-1.794	.433	13.123	1	.000	.166
	Information specificity	-1.535	.417	11.567	1	.001	.215
	Information consistency	-1.980	.510	10.052	1	.003	.138
	Information transparency	-2.613	.439	5.418	1	.014	.073
	Channel credibility	-2.286	.448	8.067	1	.007	.102
	Age	-1.758	.409	8.485	1	.006	.172
	Education	-1.892	.449	7.743	1	.009	.151
	Constant	4.498	.665	5.719	1	.013	89.793

There are two variables about information dissemination removed in four rounds of optimization (Table 4). Information accuracy was removed from model in step 3 and Number of

channels in step 2. As to information accuracy, it‘s not easy for the public to judge whether the information is accurate or not in a short time due to lack of experience and professional background. Similarly, with rapid development of modern communication technology, seeking information through multiple channels has become a normal behavior. Various channels can realize the diversification of emergency information and meet the varied information demand of passengers. Nevertheless, too much amount and type of information may also increase the complexity of decision making, which has certain negative impact on public‘s risk perception (β=.166) though without statistical significance (sig. =0.685).

Table 4–Variables not in the Equation

			Score	df	Sig.
Step 2	Variables	Number of channels	.165	1	.684
	Overall Statistics		.165	1	.684
Step3	Variables	Information accuracy	.961	1	.327
		Number of channels	.176	1	.675
	Overall Statistics		1.126	2	.570
Step4	Variables	Information accuracy	.733	1	.392
		Number of channels	.122	1	.727
		Gender	.957	1	.328
	Overall Statistics		2.075	3	.557
a. Estimation terminated at iteration number 5 because parameter estimates changed by less than 0.001. b. The cut value is .500.					

According to our investigation, just in the collision, 85.3% of the respondents said they appeared panic in the first reaction with high risk perception. However, one hour after the emergency information dissemination, only 51.2% of the passengers remained a high risk perception (decreased by 34.1%), which means information dissemination of Shanghai Metro generally plays a positive role in alleviating passengers‘ tension and anxiety, contributing to lower public‘s risk perception.

The impact of personal attributes on public’s risk perception

In agreement with previous studies (Sorensen 2000), Age (β = -1.758, sig. =0.006) and Education (β = -1.892, sig. =0.009) turn out to have positive role in lowering passengers’ risk perception in our test. Exp (B) of age is 0.172 (Table 3), which means the probability of passengers older than fifty overestimating emergency risks is nearly 6 times as that of young passengers. At the same time, education difference is mainly embodied in individual‘s ability of seeking and utilizing information, leading to people with different education background respond respectively to emergency information. Moreover, the variable Gender was eliminated in step 4. Although prior studies have shown that men and women differ greatly in comprehending information, it remains questionable whether this difference would further affect individuals’ cognitive psychology. Obviously, in our case there‘s no significant difference between men and women in the perception of risks under the same information environment.

Explanatory Power of Model

It is worth noting that, although we observed statistically significant relationships between the information dissemination and public‘s risk perception, a small portion of the variation in a public‘s risk perception remains unexplained by factors accounted for in our model. This is

evidenced by the relatively low Cox & Snell R2 (0.333) and Nagelkerke R2 (0.445) values, as with missing of some factors implicit in prior research but actually effective in the specific case of metro emergency. In terms of predicting accuracy, when the model doesn‘t contain any argument, the general accuracy is 51.2%; however, after four rounds of optimization, the predicting accuracy of model is up to 82.0%, which suggests that the introduction of co-variables has improved the prediction power of our model.

Conclusions

Enlightenments of this research for the metro operation unit includes: 1. It‘s an important link in the emergency rescue to make information frequently, specifically, consistently and transparently spread to public so that passengers‘ risk perception can remain at a rational level. 2. It is crucial to establish trust between public and official departments. With the government credibility loss, even if there‘s various official information released constantly, the expected time for passengers to restore rational will still delay. 3. In the management of metro emergencies we need to pay special attention to the evacuation and comfort work of vulnerable group like old man and undereducated people.

Nevertheless, there existing some problems to be improved in the future. One potential limitation of this study is its focus on the metro crash accidents case like “Shanghai Metro 9·27 Accident”, which preclude us from analyzing other types of metro emergencies such as fire or stampede. Actually, context within which public‘s evaluation of emergency information and perception of risks takes place, has always been a crucial premise of studying individuals‘ psychology and behavior (Walker et al. 1999). The driven power behind risk perceptions varies substantially between different kinds of metro emergencies, which apart from their common accident potentials, present an enormously diverse set of functional and physical characteristics. As future extension, it would be worthwhile to study the relations between information dissemination and risk perception under other contexts and broaden the adaption of our study.

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