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Research on Timing the Crisis Information Releasing via Televisions

by

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Abstract

This article builds the audience coverage model of crisis information releasing based on recursive methods. According to the data of Household Using TV (HUT) in Hefei City, China in 2007, we come up with the optimal combination of broadcasting sequence between 1 and 8 using implicit enumeration method. This model is useful for the accurate transmission of crisis information and reduction of interference during the normal transmission process.

Key words: crisis information, information releasing, television broadcast, audience coverage model

1. Introduction

Crisis information corresponds to any information related to specific crisis events. It is a whole package including the information within the precaution, dealing and recovery processes. The involved laws and regulations, contingency planning, researches, early warning report, order reports, assessment reports and conclusions during the crisis process usually contains more or less information describing or dealing with crisis events, and they can be all included in crisis information. Meeting the public's information needs and providing timely support is vital in crisis situations (Alla,2005). Emergency communications may counter some of the damaging effects of crises and help individuals and communities return to a normal way of life (CDC,2001).

Timely, proper and efficient crisis information will help to make a smart decision dealing with the crisis. In the "SARS" event in China in 2003, a certain level of social panic was caused because of the shortage of accurate information and the spread of gossip. In another instance in China, the huge strand situation caused by the snow hazard in 2008 was mainly due to miscommunication of crisis information which made it pretty difficult for the public to get the related traffic information. So it would be meaningful to improve the regulations of crisis information management and information communication channels for the prevention and loss control in a crisis.

One important task of crisis information management is the release of crisis information, which field has not been quantitatively studied yet. Government releases crisis information in many ways including television, newspaper, internet and radio. Television is the first and foremost information source for the public to get crisis information because of its easy access, quick spread and vivid description, which is helping television become the most popular media for the Chinese. According to the survey conducted by China Bureau of Statistics, the quantity of people above 4 years of age who watch television is 1,205,000,000 in 2007, which is 90,000,000 more than 1,115,000,000 in 2002 and double of the amount of 20 years ago.

A survey conducted by the University of Virginia shows people's choice of information channel under crisis situation (Monnica T. et al, 2005). We also investigated the Chinese public in December 2007, and it shows that most people in China choose television as their first source of crisis information, similarly as in America. Table 1 shows the specific data of two countries' choice of information source.

[Here insert Table 1]

Americans always choose local TV, local radio and national TV as their primary source of information in recent years (Monnica T. et al, 2005; Pavica,2006). Contrarily, as shown in Table 1, national TV and local radio are often chosen by Chinese people. However, television is the foremost information source to get crisis information both in America and in China, since the wide spread of television makes it possible to transmit crisis information most effectively.

Currently, there are many methods to spread crisis information via television such as news report, scrolling subtitles and government statements. The content of issued information contains traffic, weather forecast, food safety and progress of incidents. After the information has been released, the public could be quickly informed. How and how often to release crisis information by TV is a serious topic. Normally the regular television programs should not be interrupted except for extremely urgent situations, or else it is necessary to arouse public resentment by broadcasting scrolling subtitle information on the screen. Secondly, crisis information should not be overreleased. The public would probably get tired of the same crisis information again and again which would lead to the deprecation of transmission value. Furthermore, if too much crisis information flows into TV screen, the information overload may lead to information decision-makers or public focus only on selected sources, and it will result in information distort (Tung, et al., 2000).

Therefore, the right time for releasing the information is very crucial for the effective transmission of crisis information. The appropriate time would help the public get the information at the maximum level, as well as lower the possible influence the crisis information might have upon regular TV routines. If the related information is allowed to be broadcasted once only, we should definitely choose the time when most people are watching. If the related information is allowed to be broadcasted more than once, we should use a planning model to work out a strategy to determine the release time.

This article is organized as follows: Section 2 reviews literature about crisis information releasing. Section 3 presents the television transmission model of crisis information. Section 4 describes the data analysis of Hefei City, China in 2007 and uses nonlinear programming (NLP) method to study the best broadcast time and frequency. Finally, conclusions are provided in Section 5.

2. Literature review

Crisis information plays an important role in crisis management (Studeneister,1998; Vandenbosh, Higgings,1995). In many of the crises or disasters in recent history, if the crises information was available and shared at some level, some crises or disasters could be prevented or destruction could be minimized. However, in other crises or disasters, lucky results have not been obtained, especially if the information was held by those with authority to act upon it but did not do so; or the information was held by those who did not share it with other people who have the power to act. The lack of sharing crisis information can be negative to disaster assistance (Tung, et al., 2000). BOND (Board on Natural Disasters, USA, 1999) has found out the influence of disasters could be effectively controlled if the public is aware of the right methods to prevent or avoid the disaster. Helsloot and Ruitenberg (2004) analysis the psychological and behavioral effects crisis information have forced on different social groups in terms of crisis attribute, former experiences of dealing with the crisis, gender and social orientation.

At present, some research on crisis information communication has been made. The goal of crisis information communication is to facilitate compliance with protective measures and to foster psychological resilience (Alla,2005). When a crisis hits an entire community or nation, most people experience the event through the media (Rasinski, Berktold, et al, 2002), especially through the television(Pavica,2006).

During the crisis period of Hurricane Danny, local TV coverage and local radio reports were major sources of information and news for the public (Piotrowski, Armstrong,1998). Under crisis situation, mass media became a substitute for personal contact (Perez-Lugo,2004). Media offers social support to individuals who might suffer social isolation. Dominick (1996) also concluded that media, apart from transmitting information, also has a "linkage" and "a social utility" function. A survey of national (American) and international students in LSU(Louisiana State University) in the aftermath of Hurricane Katrina showed that both groups of students agreed that local TV did the best job in reporting on the storm(Pavica,2006). Duggan and Banwell(2004) construct the information communication model which separates the factors affecting the transmission into the inside elements and the outside elements, and coding rules of messengers that play the main part in the communication process. The model Duggan and Banwell built is helpful in understanding the factors affecting the information diffusion. But little is mentioned about the right way to release crisis information timely and accurately.

Current studies on crisis information comprehension describe how individuals integrate the information from various sources to construct mental representations of situations. These representations are often discrepant from the information contained in the source text/discourse. Moreover, a number of studies demonstrate a relationship between the amount of exposure to TV coverage of terrorist acts and psychological distress (Schuster,2001;Ahern et al,2002). Therefore, individuals should be professionally exposed to crisis news in order to avoid overloading crisis information or too much violence. It refers not only providing crisis coverage that the public needed, but also issuing information in a professional method or manner. Some aspects of a theoretical and methodological framework was outlined for research on lay comprehension of crisis information (Alla,2005). During the last decade, news media organizations have faced the growing need to train their professionals in effective crisis communication and disaster coverage. They have developed guidelines, training courses and work shops to report crisis information in an accurate, effective, and memorable manner (William & Roger, 2002). But there is a paucity of work that deals directly with the optimal model of crisis information release based on television or other media. Mullainathan(2002) first developed a memory model grounded in the principles of recency, similarity and repetition. In Mullainathan's work, the focus is on an agent's own memory imperfections and on how these can explain often-observed decision-making biases or empirical puzzle. Following this study, Yianis (2007) showed that the problem of a rational agent who releases information to a forgetful assessor could be modeled as a standard dynamic optimization problem and described the properties of the optimal profile for releasing information. These researches are not directly concerned with crisis information releasing, but show that it is important to study on how to transmit crisis information effectively via mass media, such as television.

3. Transmission model of TV crisis information

We should know the laws of public viewing first in order to study the best broadcast time of TV crisis information. Different audiences may have different habits of watching TV programs. The time and length of watching might differ much. The best timing for broadcasting means the least frequency of broadcasting and the most audiences. So we need to construct the model of the startup time as well as the new startup quantity.

3.1 Time length of audience watching TV programs

Wide spread of televisions makes the audience independent individuals who have little relations with each others. So we assume the time length of audiences watching meets the normal line (as shown in Figure 1). According to the normal distribution, F(t) is the distribution function of the time length of audience watching TV programs.

[Here insert Figure 1]

3.2 Quantity of new startup televisions at certain moment

People may turn on or off the televisions at certain moment. In order to measure the quantity of individuals receiving the released information, we should know the principle that audiences watch TV. In the field of media management, Households Using TV (HUT) is an important index to measure the TV Rating. HUT is total percentage of homes in a design market area watching TV during any day part, such as morning, primetime, and late night (Sissors & Barron, 2002). It is a guideline for calculating the number of TV viewers. Although measurement methods are expected to change continually as new technologies are developed, broadcast media usage is measured using diaries (surveys), meters (observation), and telephone surveys (Jan & George, et al, 2003). The data of HUT can be provided by media forecasting company, such as SQAD (www.sqad.com).

In different time of one day, though the HUT is different, part of the audiences may be invariant because some audiences watch TV for a long time. Therefore we need to omit the number of the audience who repeatedly watch the news in order to get the effective number of audience watching the news for the first time. But what we mention above need us to identify the quantity of new users television (QNUT) in different period time. QUNT refers the total quantity of audiences that just turn on the television in one short period of time, such as 15 minutes.

Let $u(t)$ denote the total quantity of audiences using television in period t. It can be accessed by professional media Investigation Company.

Divide one day into n time segments. There are a_i audiences watching TV at time segment i. Some of them are new using televisions which is b_i , while others are old audiences which is a_i-b_i. If the start time is $i=0$, $b_0=a_0$, which means all the audiences are new using televisions.

In time segment 1, $b_1=a_1-b_0(1-F(1))$. For $b_0(1-F(1))$ represents QNUT at the beginning time which still remains on at time segment 1. $F(1)$ represents the cumulative probability of audiences watching TV less than 1 period time.

In time segment 2, $b_2=a_2-b_1(1-F(1))-b_0(1-F(2))$. For $b_1(1-F(1))$ represents QNUT at time segment 1 which still remains on at time segment 2. $F(2)$ represents the cumulative probability of audiences watching TV less than 2 period times.

In time segment i, the total QNUT from time segment 0 should be:

$b_i=a_i-b_{i-1}(1-F(1))-b_{i-2}(1-F(2))-\ldots-b_j(1-F(i-j))-\ldots-b_0(1-F(i))$

$$=a_i-\sum_{j=0}^{i-1} b_j(1-F(i-j)) \qquad (1)$$

According to Formula(1)we could get the quantity of new using TV in certain time periods.

3.3 Audience coverage model of crisis information Releasing

We can calculate the quantity of the coverage audience in time period *i* using the model of watching time length and quantity model of new using TV.

Assume crisis information is broadcasted *i* times, and the releasing time is time $k_1,k_2,\ldots k_i$($k_1<k_2<\ldots<k_i$, $k\epsilon[1,n]$). Then the accumulated quantity of audiences is $N(k_i)$. We do not take the time length of crisis information into account to facilitate the calculation of the model. Because different televisions might be on for different time length, so:

$$N(k_i)<\sum_{j=1}^{i} a_{k_j} \qquad (2)$$

In order to calculate $N(k_i)$, we could not add the numbers of audiences directly because of the audiences of repeating watch. Consider the following recursive model:

At time 1,

$$N(k_1)=a_{k_1} \qquad (3),$$

which means $N(k_1)$ equals with a_{k_1} when the information is released at time k_1.

At the second broadcasting time when the news is released at time k_2, the accumulated quantity of audiences receiving crisis information $N(k_2)$ equals with QNUT between time k_1 and time k_2, which means:

$$N(k_1,k_2)=N(k_1)+b_{k_1+1}(1-F(k_2-k_1-1))+b_{k_1+2}(1-F(k_2-k_1-2)+\ldots+b_{k_2-1}(1-F(1))+b_{k_2} \qquad (4)$$

Formula (5) is the recursive form and the general form of $N(k_i)$ is:

$$N(k_1,k_2,...,k_i) = N(k_{i-1}) + b_{k_{i-1}+1}(1-F(k_i-k_{i-1}-1)) + b_{k_{i-1}+2}(1-F(k_i-k_{i-1}-2) + ... + b_{k_i-1}(1-F(1)) + b_{k_i} \tag{5}$$

$$N(k_1,k_2,...,k_i) = a_{k_1} + b_{k_1+1}(1-F(k_2-k_1-1)) + b_{k_1+2}(1-F(k_2-k_1-2) + ... + b_{k_2-1}(1-F(1)) + b_{k_2}$$

$$+b_{k_2+1}(1-F(k_3-k_2-1)) + b_{k_2+2}(1-F(k_3-k_2-2) + ... + b_{k_3-1}(1-F(1)) + b_{k_3}$$

$$+... +b_{k_{i-1}+1}(1-F(k_i-k_{i-1}-1)) + b_{k_{i-1}+2}(1-F(k_i-k_{i-1}-2) + ... + b_{k_i-1}(1-F(1)) + b_{k_i}$$

$$= a_{k_1} + b_{k_1+1} + b_{k_1+2} + ... + b_{k_2} + ... + b_{k_i}$$

$$-b_{k_1+1}F(k_2-k_1-1)) - b_{k_1+2}F(k_2-k_1-2) - ... - b_{k_2-1}F(1) - ... - b_{k_i-1}F(1)$$

$$= a_{k_1} + \sum_{j=k_1+1}^{k_i} b_j - \sum_{s=1}^{i-1} \sum_{j=1}^{k_{s+1}-k_s-1} b_{k_s+j} F(k_{s+1}-k_s-j) \tag{6}$$

Formula (6) is the model for universal coverage for releasing of crisis information.

We could understand formula (6) following these steps:

Introduce Matrix $B_{n\times n}$=

$$\begin{pmatrix}
b_{1,1} & b_{1,2} & b_{1,3} & \cdots & b_{1,i} & \cdots & b_{1,j} & \cdots & b_{1,s} & \cdots & b_{1,n-1} & b_{1,n} \\
b_{2,1} & b_{2,2} & b_{2,3} & \cdots & b_{2,i} & \cdots & b_{2,j} & \cdots & b_{2,s} & \cdots & b_{2,n-1} & b_{2,n} \\
b_{3,1} & b_{3,2} & b_{3,3} & \cdots & b_{3,i} & \cdots & b_{3,j} & \cdots & b_{3,s} & \cdots & b_{3,n-1} & b_{3,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
b_{i,1} & b_{i,2} & b_{i,3} & \cdots & b_{i,i} & \cdots & b_{i,j} & \cdots & b_{i,s} & \cdots & b_{i,n-1} & b_{i,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
b_{j,1} & b_{j,2} & b_{j,3} & \cdots & b_{j,i} & \cdots & b_{j,j} & \cdots & b_{j,s} & \cdots & b_{j,n-1} & b_{j,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
b_{s,1} & b_{s,2} & b_{s,3} & \cdots & b_{s,i} & \cdots & b_{s,j} & \cdots & b_{s,s} & \cdots & b_{s,n-1} & b_{s,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
b_{n-1,1} & b_{n-1,1} & b_{n-1,3} & \cdots & b_{n-1,i} & \cdots & b_{n-1,j} & \cdots & b_{n-1,s} & \cdots & b_{n,n-1} & b_{n,n} \\
b_{n,1} & b_{n,1} & b_{n,3} & \cdots & b_{n,i} & \cdots & b_{n,j} & \cdots & b_{n,s} & \cdots & b_{n,n-1} & b_{n,n}
\end{pmatrix}$$

b_{ij} denotes the quantity of audiences who start to watch at time i and remain watching when it comes to time j. So Matrix $B_{n\times n}$ has the following characters:

(1) b_{ij}=0 (i<j), which means this matrix is a triangular array. Although b_i may be

more than 0 when i<j, meaning audiences watching the television yesterday may still be watching today, we assume all the audiences watching at time i are new using TV considering feasibility of calculation.

(2) $\sum_{r=1}^{i} b_{r,i} = a_i$, which means the sum of elements in row i equals the quantity of audiences who are now watching the television.

(3) In row *i*, $b_{i,p}=0$, *for* $p<i$. $b_{i,i+j}=b_{i,i}\cdot(1-F(j))$, for $F(j)=\Phi(\frac{j-\mu}{\sigma})$ is the standard normal distribution function(j=1,…,n-i).

Matrix $B_{n\times n}$ could be simplified as:

$$
\begin{array}{cccccccccccc}
 & & & & k_1 & & k_2 & & k_3 & & & \\
\end{array}
$$

$$
\begin{pmatrix}
b_{1,1} & b_{1,2} & b_{1,3} & \cdots & b_{1,i} & \cdots & b_{1,j} & \cdots & b_{1,s} & \cdots & b_{1,n-1} & b_{1,n} \\
0 & b_{2,2} & b_{2,3} & \cdots & b_{2,i} & \cdots & b_{2,j} & \cdots & b_{2,s} & \cdots & b_{2,n-1} & b_{2,n} \\
0 & 0 & b_{3,3} & \cdots & b_{3,i} & \cdots & b_{3,j} & \cdots & b_{3,s} & \cdots & b_{3,n-1} & b_{3,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
0 & 0 & 0 & \cdots & b_{i,i} & \cdots & b_{i,j} & \cdots & b_{i,s} & \cdots & b_{i,n-1} & b_{i,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
0 & 0 & 0 & \cdots & 0 & \cdots & b_{j,j} & \cdots & b_{j,s} & \cdots & b_{j,n-1} & b_{j,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
0 & 0 & 0 & \cdots & 0 & \cdots & 0 & \cdots & b_{s,s} & \cdots & b_{s,n-1} & b_{s,n} \\
\vdots & \vdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \cdots & \vdots & \vdots \\
0 & 0 & 0 & \cdots & 0 & \cdots & 0 & \cdots & 0 & \cdots & b_{n,n-1} & b_{n,n} \\
0 & 0 & 0 & \cdots & 0 & \cdots & 0 & \cdots & 0 & \cdots & 0 & b_{n,n}
\end{pmatrix}
$$

Assume the crisis information is broadcasted 3 times a day at time k_1,k_2,k_3. The corresponding broadcast moment is *i,j* and *s*. The accumulated quantity of audiences who see the information could be shown in the shadow part in Matrix $B_{n\times n}$.

$$N(i,j,s) = b_{1,i} + b_{2,i} + ... + b_{i,i} + b_{i+1,j} + b_{i+2,j} + ... + b_{j,j} + b_{j+1,s} + b_{j+2,s} + ... + b_{s,s}$$

Then the crisis information coverage model shown in Formula (6) could also be written as:

$$N(k_1,k_2,...,k_i) = b_{1,k_1} + b_{2,k_1} + ... + b_{k_1,k_1} + b_{k_1+1,k_2} + b_{k_1+2,k_2} + ... + b_{k_2,k_2} + ... + b_{k_{i-1}+1,k_i} + b_{k_{i-1}+2,k_i} + ... + b_{k_i,k_i}$$

$$= \sum_{s=1}^{i} \sum_{j=1}^{k_s-k_{s-1}} b_{k_{s-1}+j,k_s} \qquad (7)$$

So the problem is now turning into an integer programming problem.

$$\text{Max } z = N(k_1, k_2, ..., k_i) = \sum_{s=1}^{i} \sum_{j=1}^{k_s - k_{s-1}} b_{k_{s-1}+j, k_s}$$

$$\text{st} \begin{cases} i = c \\ b_{k_{s-1}+j, k_s} \in B_{n \times n} \\ 0 < k_1 < k_2 < ... k_i \le R \\ k_1, k_2, k_3, ... k_i \text{ } are \text{ } integers \\ c \text{ } is \text{ a given integral, while } R \text{ } is \text{ } the \text{ ceiling value.} \end{cases} \quad (8)$$

Considering the small amount of R and *I* (less than 100), we could use the listing method to solve the problem. There are C_n^c plans from which we should decide on the best solution. We establish the programming procedures and use implicit enumeration algorithms for the best broadcast strategy.

4. Data analysis and discussion

4.1 Model of time length when TV is on and model of HNUT

CCTV-Sofres Media Research (CSM)[1]conducted a TV ratings survey in 102 cities around China.

It showed that the watching hours (per capita) experienced the first bounce up after a four-year continuous decline. The average watching time improved form 173 minutes in 2004 to 174 minutes in 2005. According to the CSM survey in Hefei, the average watching time was 170 minutes and the average frequency was 1.42 times a day. And 8%of them had continuous watching time more than 180 minutes. We estimate the model of time length when TV is on is $N(119.3, 43.2^2)$ basing on the above data. Cause 15 minutes is the length of one period, the model of time length when TV is on is $N(5.4, 2.88^2)$.

$$F(x) = \Phi(\frac{x - \mu}{\sigma}) \quad (9)$$

1 CSM Media Research is a joint venture between CTR Market Research (the leading market research company in China) and the TNS Group. As an industry pioneer and the innovative leader of Media Research in China, CSM always endeavors to provide premium quality market data and services based on its professional media audience research.

We can get the values of x=1, 2… 96 using Formula(9).

Table 2 shows the average HUT of Hefei City in 2007. The highest point is 36%, while the lowest point is 0.5%.

Using model (1)we could calculate the rate of QNUT at different period, as is shown in Table 2. The sum of percentage of QNUT is 121.092% (>100%). If we assume one set of television could be turned on for no more than 2 times a day, at least 21.092% televisions are turned on twice a day. In this model we neglect the action of repeatedly turning on and assume different family members are watching TV each time the TV is turned on.

[Here insert Table 2]

[Here insert Figure 2]

4.2 Optimal choice of broadcasting frequencies

We use model 8 and implicit enumeration method to do computer programming, and get the optimal choices of broadcasting frequency between 1 and 8(as is shown in Table 3).

[Here insert Table 3]

We revise the accumulated rate of HNUT based on the former data 121.092%. The revised rate denotes the full coverage rate of television audiences. In this article we only consider broadcasting time choices of crisis information in 24 hours. If the broadcasting is only for noon or night or at certain channel, this model could also be suitable for the situation mentioned above.

5. Conclusion

Optimal releasing time is crucial for the accurate transmission of crisis information. We get the following conclusions based on data analysis and empirical study.

(1) Appropriate releasing time could realize the effective transmission of crisis information.

Most crisis information is not urgent enough to interrupt the broadcasting of TV programs. So we could select the appropriate time basing on the importance of crisis and communication requirements.

(2) The optimal combination of releasing information is difference according to the frequencies of broadcasting. For example, to issue 1 time, we can select the period of 20:45-21:00; to issue 2 times, we should select the periods of 19:15-19:30 and 21:15-21:30. The two optimal combinations have no overlap period because the amount of audiences does not include the frequent watching audiences.

(3) 3 times broadcast could guarantee that most people could get access to crisis information. That is to say, if we want half the audiences to get the information, we should broadcast 3 times.

(4) The utility of information publishing is decreasing. And the more repeating acceptance, the more redundancy there will be.

From the calculation results, if the broadcasting time is more than 6 times, the percentage that increases after each broadcasting time will experience a sharp decline.

(5) Promotion of model utility. We could promote the use of the model given some circumstances. (a) Constrained by broadcasting time period such as 18:00-22:00, we could get optimization solutions using the model. (b) TV channels. The broadcasting of crisis information could only select several channels from the huge amount of watching channels in cities. The selection of channels could be calculated by the model basing on the ratings of individual channel.

This time choice model of crisis information transmission could be extended to other fields of application. For example, the time choice of advertisements is now basing on advertising costs per thousand people which have not omitted the number of repeat watching audiences. This kind of problem can be solved using the model we mentioned above.

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Table 1: Comparison of information source choice between Chinese and American

Information Source	Chinese	American
Local Television	67.2%	68.4%
Local Radio	27.1%	62.7%
National TV	89.7%	49.0%
Internet News Sites	32.8%	26.4%
Internet forum	32.8%	22.3%
Internet Government Site	6.4%	16.0%
Local Newspaper	35.8%	15.9%
Friends/Family	49.8%	15.6%
Local Government	19.4%	4.2%
Doctors/Healthcare providers	4.4%	3.4%
Nonprofit Organization	1.3%	1.9%
Other	8.8%	5.1%

Table 2 HUT and rate of QNUT (Hefei City,China, 2007)

Time	HUT	Rate of QNUT	Time	HUT	Rate of QNUT	Time	HUT	Rate of QNUT
04:30-04:45	0.5	0.5	12:30-12:45	14.9	1.023	20:30-20:45	35.8	4.024
04:45-05:00	0.5	0.003	12:45-13:00	14.4	0.9	20:45-21:00	36	4.074
05:00-05:15	0.5	0.005	13:00-13:15	13.1	0.192	21:00-21:15	35.1	3.157
05:15-05:30	0.6	0.111	13:15-13:30	11.8	0.285	21:15-21:30	33.1	2.164
05:30-05:45	0.7	0.12	13:30-13:45	10.8	0.668	21:30-21:45	30.3	1.403
05:45-06:00	0.8	0.134	13:45-14:00	9.9	0.817	21:45-22:00	27.8	1.683
06:00-06:15	1.1	0.351	14:00-14:15	9.2	1.005	22:00-22:15	24.9	1.209
06:15-06:30	1.5	0.47	14:15-14:30	8.7	1.12	22:15-22:30	21.9	0.97
06:30-06:45	1.9	0.49	14:30-14:45	8.5	1.271	22:30-22:45	18.6	0.462
06:45-07:00	2.8	1.008	14:45-15:00	8.3	1.083	22:45-23:00	16	0.879
07:00-07:15	3.9	1.231	15:00-15:15	8	0.798	23:00-23:15	13.7	0.835
07:15-07:30	4.7	0.961	15:15-15:30	7.9	0.854	23:15-23:30	11.6	0.647
07:30-07:45	5.2	0.705	15:30-15:45	8	0.97	23:30-23:45	9.5	0.245
07:45-08:00	5.4	0.467	15:45-16:00	8	0.847	23:45-24:00	7.6	0.06
08:00-08:15	5.7	0.648	16:00-16:15	8	0.867	24:00-00:15	6.1	0.118
08:15-08:30	5.9	0.644	16:15-16:30	8.2	1.105	00:15– 00:30	5	0.229
08:30-08:45	6.2	0.844	16:30-16:45	8.4	1.142	00:30– 00:45	4.1	0.194
08:45-09:00	6.6	1.036	16:45-17:00	8.8	1.364	00:45 -01:00	3.3	0.102
09:00-09:15	6.9	1.007	17:00-17:15	9.3	1.472	01:00– 01:15	2.7	0.144
09:15-09:30	7.1	0.95	17:15-17:30	10.2	1.872	01:15– 01:30	2.2	0.111
09:30-09:45	7.5	1.168	17:30-17:45	11.6	2.378	01:30-01:45	1.7	0
09:45-10:00	7.9	1.174	17:45-18:00	13.4	2.802	01:45-02:00	1.4	0.091
10:00-10:15	8.3	1.179	18:00-18:15	15.6	3.252	02:00-02:15	1.200	0.108
10:15-10:30	8.8	1.296	18:15-18:30	18	3.539	02:15-02:30	1	0.043
10:30-10:45	9.3	1.33	18:30-18:45	21.2	4.466	02:30-02:45	0.9	0.095
10:45-11:00	9.8	1.379	18:45-19:00	24.5	4.743	02:45-03:00	0.8	0.061
11:00-11:15	10.2	1.337	19:00-19:15	27.1	4.27	03:00-03:15	0.7	0.036
11:15-11:30	10.8	1.599	19:15-19:30	29.6	4.442	03:15-03:30	0.7	0.116
11:30-11:45	11.3	1.562	19:30-19:45	31.4	4.06	03:30-03:45	0.6	0.002
11:45-12:00	12.4	2.222	19:45-20:00	33.1	4.308	03:45-04:00	0.6	0.09
12:00-12:15	14.1	2.884	20:00-20:15	34.5	4.368	04:00-04:15	0.5	0
12:15-12:30	15.2	2.351	20:15-20:30	35.4	4.215	04:15-04:30	0.5	0.076

Table 3 Optimal choice of broadcasting time

Broadcasting time	Broadcasting period	Corresponding time	Coverage rate	Coverage rate(revised)
1	66	[20:45]	35.999%	29.73%
2	60,68	[19:15],[21:15]	56.352%	46.54%
3	32,60,68	[12:15],[19:15],[21:15]	71.553%	59.09%
4	32,57,64,71	[12:15],[18:30],[19:30],[22:00]	80.338%	66.34%
5	24,33, 57,64,71	[10:15],[11:45], [18:30],[19:30],[22:00]	87.639%	72.37%
6	24,33,48,57,64,71	[10:15],[11:45],[16:30] [18:30],[19:30],[22:00]	94.946%	78.41%
7	13,25,34,48, 57,64,71	[7:30],[[10:30],[12:45],[16:30] [18:30],[19:30],[22:00]	99.933%	82.53%
8	13,25,34,48,57, 62,68,76	[7:30],[10:30],[12:45],[16:30] [18:30],[19:45],[21:15],[22:30]	103.992%	85.88%

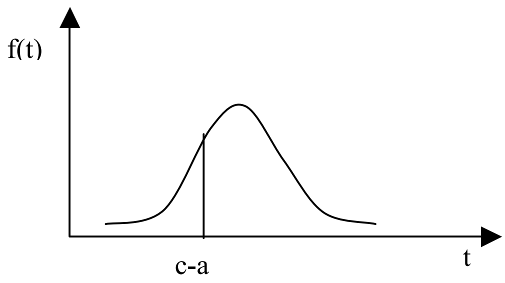

Figure 1 Distribution model of the time length of audiences watching TV

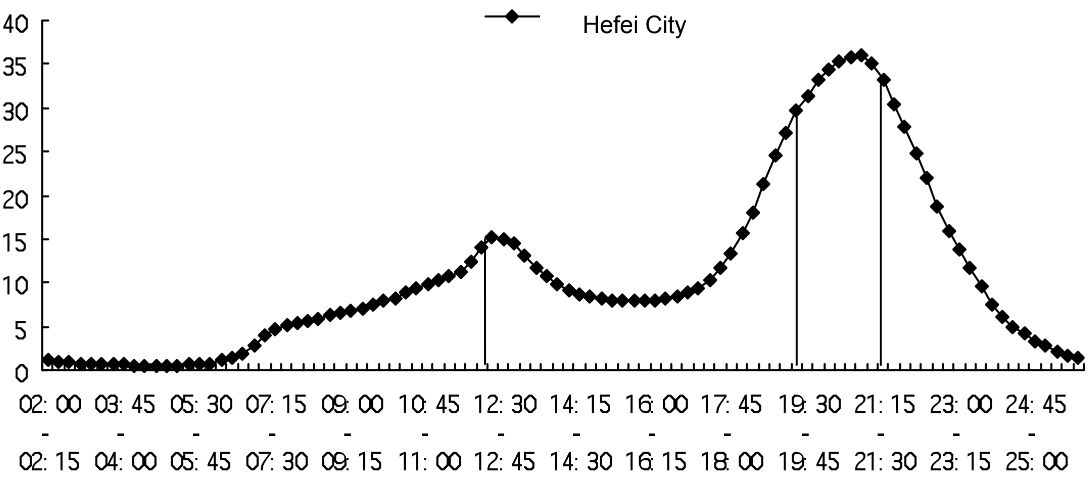

Figure 2 Statistics figure of television Open rate of Hefei City in 2007