

On Content Distribution Model and Analyzing Distribution Effectiveness

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Almost all traditional methods of advertisement distribution have been concerned only with primary information distribution via certain kinds of media. However, the rapid growth of the Internet and interactive media have demonstrated the power and efficiency of secondary information distribution of information by consumers such as words of mouth and free-mail. However, an advertisement distribution model which can be used to analyze and measure the effectiveness of such secondary distribution has never been discussed. Therefore, in this paper, we propose an advertisement distribution model and show how to use the model to analyze both primary and secondary information distributions. Our experiment and analytical results are also discussed. The experimental result shows that the proposed model can be used to measure and analyze the effectiveness of advertisement distribution.

1. Introduction

In general, there are two kinds of information flows in an information distribution environment such as advertisement distribution; one is the primary information distribution, and the other is the secondary information distribution. The primary information distribution is the distribution done by providers or broadcasters to consumers through certain kinds of media such as television, newspaper, etc. The secondary information distribution is the distribution done by consumers to consumers. Traditionally, the secondary distribution of advertisements has been done by “power of mouth”. However, the rapid growth of the Internet and interactive media devices have resulted in the secondary information distribution performing effectively in various ways such as email, etc. Therefore, we certainly cannot ignore this kind of distribution power.

In recent years, much research has been conducted to address marketing and advertising on specific media particularly on mobile phones. For example, Dimitris and George¹⁾ attempt to develop a model identifying the factors influencing the effectiveness of a mobile messaging advertisement. Chittenden and Rettie²⁾ discuss an evaluation of e-mail marketing, and the research suggests that e-mail marketing is growing rapidly and should be integrated into the overall communication in order to increase the effectiveness of the whole marketing. Rettie,

et al.³⁾ investigate the effectiveness of text messaging advertisement or SMS to user responses and branding effects. Haghirian, et al.⁴⁾ study how to increase the advertising value of mobile marketing or mobile advertising by investigating various factors such as the characteristics of mobile advertising, the characteristics of advertising contents and mobile consumers’ characteristics. Those researches^{1)~4)} also analyze the factors which increase the response rate from users, but they do not discuss the secondary information distribution. There are some researches^{5),6)} which have discussed secondary information distribution. For instances, Ratsimor, et al.⁵⁾ propose a framework for intelligent marketing in the mobile environment called eNcentive. Garyfalos and Almeroth⁶⁾ develop applications and services using the idea of coupons for wireless ad hoc networks. The basic ideas of those researches are to provide an incentive and a framework for distributing information among users. But there are no proposals for analyzing the effect caused by the incentive or the framework.

With regard to the above mentioned works, the research does not concern the measurement and analysis methods for the effectiveness of advertisement distribution in both primary and secondary information distribution. The measurement methods of the effectiveness of advertisement distribution, at present, have only been done by consumer rating surveys, questionnaires and a few other researches^{7),8)}. Nevertheless, these methods and researches^{7),8)} can measure only the effectiveness of primary information distribution. Moreover, those methods have not taken into account that contents may

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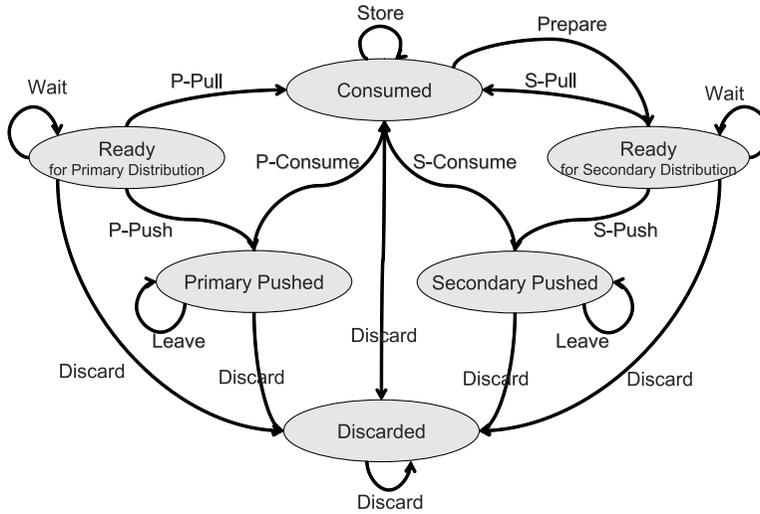


Fig. 1 The proposed advertisement distribution model.

be freely copied by anyone in certain circumstance, which is a basic concept of the Superdistribution⁹⁾.

In order to find what will be the next generation of advertisement distribution and analyze it, we should measure and analyze both primary distribution and also secondary distribution. However, an advertisement distribution model which can be used to analyze and measure the effectiveness of secondary information distribution has never been investigated. Therefore, we are proposing an advertisement distribution model which can be used to analyze and measure the entire circulation including both primary and secondary information distributions.

In the next section, we explain in detail the proposed model and the definition. Sections 3 and 4 describe the analysis method of the proposed model, and some examples are illustrated in applying the model. Section 5 describes our experiment and analytical results, and our consideration of the proposed model and the analysis is discussed in Section 6. Finally, Section 7 shows our conclusion and future works.

2. The Proposed Advertisement Distribution Model

In general, the advertisement distribution life cycle is composed of “Distributed”, “Consumed” and “Discarded” states. Our study shows that contemplating and analyzing such states are not sufficient to produce an efficient and accurate analysis. For example, an advertisement can be consciously and unconsciously

redistributed by consumers and such distribution can occur repeatedly by push and/or pull methods. Note that, in the push distribution method, the contents are transmitted to consumers in a sequence and at a rate which are both determined by senders. For the pull distribution method, the contents are delivered in response to some particular consumer’s requests. In order to determine and analyze the factors for realizing such redistribution, we must analyze the secondary information distribution as well. Hence, we propose an advertisement distribution model which includes the different states for primary and secondary information distributions as shown in Fig. 1. In this figure, the left and right hand sides represent the life cycle of primary and secondary information distributions, respectively. This model is composed of 6 states and 11 operations. The definition of each state is clarified as follows:

- Ready for Primary Distribution
It represents the state in which advertisers or sponsors are ready to distribute their advertisements by push and/or pull methods of distribution. For examples, handbills are printed and prepared. Web advertisements are stored in Web servers and are ready for distribution
- Primary Pushed
In this state, the distributed advertisement is being distributed to consumers from advertisers. For instance, newspapers and magazines are being displayed in a store, a television commercial is being broadcast by a broadcaster, posters are put up in

public places, and email is being transmitted. Note that another reason to define this state is to distinguish pull and push methods of advertisement distribution.

- Consumed
In this state, advertisements are consumed consciously or unconsciously by consumers. All consumption methods such as watching, listening and reading are considered to be the same method (action) which leads to this state.
Unlike the primary distribution and secondary distribution, the consumed state can be defined as a single state, because consumers are not interested in where the advertisement comes from but are interested in the content of the advertisement. It means that the Consumed state does not relate to who sends the advertisement. In other words, the probabilities of redistributing, discarding and storing the received advertisement are the same for the both.
- Ready for Secondary Distribution
This represents the state in which consumers are ready to redistribute consumed advertisements to third persons by push and/or pull methods. For example, they try to forward advertisements by email, or put the advertisements in their own servers for anyone to access.
- Secondary Pushed
In this state, the consumed advertisement is being distributed to other consumers by the consumers. In other words, this state is similar to the “Primary Pushed” state but it is done by the consumers not by advertisers or sponsors. The reason for defining this state is the same as the “Primary Pushed” state discussed above.
- Discarded
The distribution of the advertisement in this state is terminated, and no one consumes it anymore.

The definition of each operation is clarified as follows:

- Primary Push (P-Push)
Advertisers or sponsors distribute advertisements to consumers by push methods.
- Primary Pull (P-Pull)
Consumers access advertisements such as web advertisements to acquire advertisement information.
- Secondary Push (S-Push)

Consumers redistribute the consumed advertisement to other consumers by push methods such as forwarding email.

- Secondary Pull (S-Pull)
Consumers access other consumers’ sources of information to acquire advertisements prepared by other consumers.
- Primary Consume (P-Consume)
Consumers consume advertisements distributed by advertisers or sponsors.
- Secondary Consume (S-Consume)
Consumers consume advertisements redistributed by other consumers.
- Discard
Consumers or advertisers discard advertisements physically or forget them. In addition, unsuccessful delivery of advertisements in the “Primary Pushed” and “Secondary Pushed” state is also considered as “discard”. As a result of this action, the distribution is ended.
- Wait
Advertisements are waiting to be distributed by both push and/or pull methods.
- Leave
Advertisements are still in the process of being distributed. For instance, newspapers are being kept in a book store.
- Store
After having consumed them, consumers record or store the advertisements.
- Prepare
Consumers make the secondary distribution of advertisements possible.

3. The Analysis Method of the Proposed Model

3.1 Advertisement Analysis

As illustrated in **Fig. 2**, “Ready for Primary Distribution”, “Primary Pushed”, “Consumed”, “Secondary Distribution”, “Secondary Pushed” and “Discarded” are defined as S_1 , S_2 , S_3 , S_4 , S_5 and S_6 , respectively. In addition, an action from S_i ($1 \leq i \leq 6$) to S_j ($1 \leq j \leq 6$) is defined as a_{ij} . In this case, S_i is to be considered as a state of an advertisement, and a_{ij} is to be considered as a transition probability of an advertisement from the state S_i to the state S_j where $\sum_{j=1}^6 a_{ij}$ is to be 1. Therefore, the Markov Chain Model and its theory^{(10),(11)} can be used to analyze the advertisement transition among the 6 states. In other words, we define

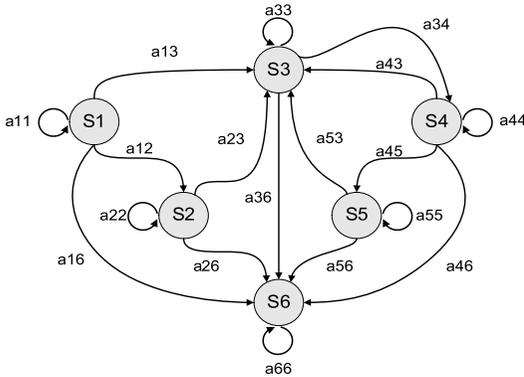


Fig. 2 The proposed advertisement distribution model.

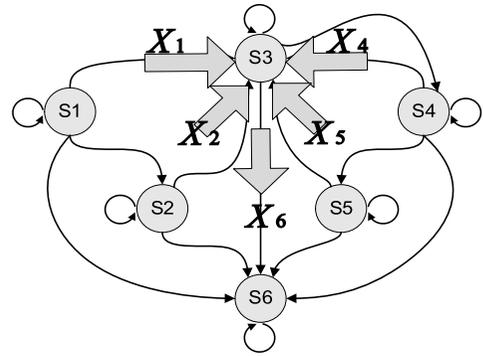


Fig. 4 The quantity of advertisement being consumed.

		To					
		S1	S2	S3	S4	S5	S6
From	S1	a11	a12	a13	0	0	a16
	S2	0	a22	a23	0	0	a26
	S3	0	0	a33	a34	0	a36
	S4	0	0	a43	a44	a45	a46
	S5	0	0	a53	0	a55	a56
	S6	0	0	0	0	0	a66

Fig. 3 The state transition probability matrix.

a vector of probabilities of each state at time t as P_t shown in Formula (1), and when we define the state transition probability matrix as A shown in Fig. 3, the next vector of probabilities of each state at time $t + 1$ can be obtained by Formula (2).

$$P_t = [S_1 \ S_2 \ S_3 \ S_4 \ S_5 \ S_6] \quad (1)$$

$$P_{t+1} = P_t \times A \quad (2)$$

The detailed reason is explained in Section 4, but in our model, we call the value of S_i “quantity” rather than “probability” because the value may be more than 1.

3.2 Analyzing Advertisements being Consumed

In order to analyze the effectiveness of advertisement distribution, the quantity of advertisements being consumed at a particular time shall be observed. Using the defined state transition, this value is computed based on the following Formula (3).

$$Y_t = \sum_{i=1}^t Y'_i \quad (3)$$

$$Y'_t = (X_1)_t + (X_2)_t + (X_4)_t + (X_5)_t - (X_6)_t$$

$$(X_1)_t = (S_1)_{t-1} \times a_{13}$$

$$(X_2)_t = (S_2)_{t-1} \times a_{23}$$

$$(X_4)_t = (S_4)_{t-1} \times a_{43}$$

$$(X_5)_t = (S_5)_{t-1} \times a_{53}$$

$$(X_6)_t = (S_3)_{t-1} \times a_{36}$$

$(X_1)_t, (X_2)_t, (X_3)_t, (X_4)_t$ and $(X_5)_t$ are the quantities of advertisements being consumed at time t , that come from S_1, S_2, S_4 and S_5 to S_3 , respectively, as shown in Fig. 4. $(X_6)_t$ is the quantity of advertisements being discarded at time t which goes from S_3 to S_6 , as also shown in Fig. 4. And the Y'_t is the differential quantity of advertisements being consumed at time t . Y_t is the summation of Y'_t from the beginning of the advertisement distribution until time t . In other words, Y_t shows the total quantities of consumed advertisements and represents the effectiveness of its distribution in the model.

4. Verification of the Model

In order to verify the use of this model, four simple cases of advertisement distributions using handbills, emails and Web servers are shown in this section; they are (1) “primary distribution only”, (2) “primary and secondary distributions”, (3) “primary and secondary distributions with copy” and (4) “primary distribution by pull method”.

4.1 Primary Distribution Only (Example 1)

In this example, we assume that 100 advertisement handbills are distributed. 100 consumers receive all the distributed handbills. After that, 3/4 of consumers do nothing with the handbills, but 1/4 of consumers throw them away and/or forget them. In this case, the transition probability matrix A is to be defined as shown in Fig. 5. And the initial quantity of each state is to be defined as P_0 in Fig. 5 be-

Table 1 Quantity transition in Example 1.

Time	S_1	S_2	S_3	S_4	S_5	S_6	Y'_t	Y_t
1	0	1	0	0	0	0	0	0
2	0	0	1	0	0	0	1	1
3	0	0	0.75	0	0	0.25	-0.25	0.75
4	0	0	0.5625	0	0	0.4375	-0.1875	0.5625
5	0	0	0.421875	0	0	0.578125	-0.14063	0.421875
6	0	0	0.316406	0	0	0.683594	-0.10547	0.316406

$$P_0 = [1 \ 0 \ 0 \ 0 \ 0 \ 0]$$

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0.75 & 0 & 0 & 0.25 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Fig. 5 The initial state quantity and transition probability matrix of Example 1.

cause all the handbills are in S_1 at the beginning that is to be represented as the quantity 1 as a normalized value. The actual number of advertisements of each state is able to be calculated from the normalized state value in P_t by multiplying the initial absolute value (in short, *I*AV) at anytime of t , afterwards. In this example, the *I*AV is 100. In the same manner, Y'_t and Y_t are represented in the normalized values, and the actual number of advertisements of Y'_t and Y_t are able to be calculated from *I*AV.

Then, according to the Formula (2), the next quantity of each state is to be calculated. **Table 1** shows the quantities of S_i from time 1 to 6, as well as Y'_t and Y_t .

This example shows that the handbills being consumed decreases to 0 as shown in **Fig. 6** if the secondary information distribution is not performed. Note that, in this example, a_{44} , a_{55} and a_{66} in A of Fig.5 have no impact on the analysis because there has been no secondary distribution. They are defined as 1 to keep A as a Markov Chain transition matrix.

4.2 Primary and Secondary Distributions (Example 2)

100 handbills are distributed. 100 consumers received all the distributed handbills. After that, 7/20 consumers do nothing with the handbills. 5/20 consumers throw the handbills away and/or forget them. And 8/20 consumers redistribute the handbills to their friends. In this case, the initial state quantity (P_0) and transition probability matrix (A) are shown in **Fig. 7**. **Table 2** shows the quantities of S_i from time 1

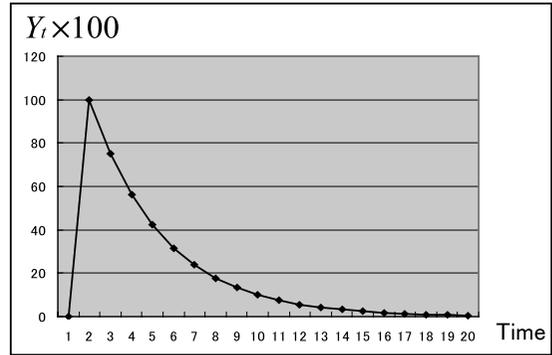


Fig. 6 Handbills being consumed in Example 1.

$$P_0 = [1 \ 0 \ 0 \ 0 \ 0 \ 0]$$

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0.35 & 0.4 & 0 & 0.25 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Fig. 7 The initial state quantity and transition probability matrix of Example 2.

to 6, as well as Y'_t and Y_t .

This example shows that the handbills being consumed increases gradually as shown in **Table 2** and **Fig. 8** if the secondary information distribution is performed. The total number of handbills being consumed is exceeding 100. This is because the consumers who received handbills still remember the advertisement for some time. And this is also the reason why we call the state quantity rather than the state probability.

4.3 Primary and Secondary Distribution with Copy (Example 3)

In this example, 100 emails are distributed. After that, 7/20 consumers do nothing with the emails. 5/20 consumers delete and/or forget the received emails. And 8/20 consumers forward two emails to their friends. In other words, the number of advertisements being redistributed in the secondary distribution is dou-

Table 2 Quantities transition in Example 2.

Time	S_1	S_2	S_3	S_4	S_5	S_6	Y'_t	Y_t
1	0	1	0	0	0	0	0	0
2	0	0	1	0	0	0	1	1
3	0	0	0.35	0.4	0	0.25	-0.25	0.75
4	0	0	0.1225	0.14	0.4	0.3375	-0.0875	0.6625
5	0	0	0.442875	0.049	0.14	0.368125	0.369375	1.031875
6	0	0	0.295006	0.17715	0.049	0.478844	0.029281	1.061156

Table 3 Quantity transition in Example 3.

Time	S_1	S_2	S_3	S_4	S_5	S_6	Y'_t	Y_t
1	0	1	0	0	0	0	0	0
2	0	0	1	0	0	0	1	1
3	0	0	0.35	0.4	0	0.25	-0.25	0.75
4	0	0	0.1225	0.14	0.8	0.3375	-0.0875	0.6625
5	0	0	0.84288	0.049	0.28	0.36813	0.769375	1.431875
6	0	0	0.57501	0.33715	0.098	0.57884	0.06928	1.501155

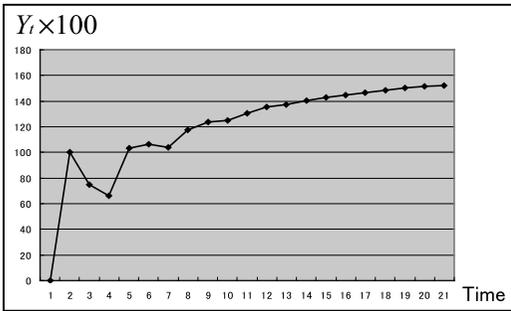


Fig. 8 Handbills being consumed in Example 2.

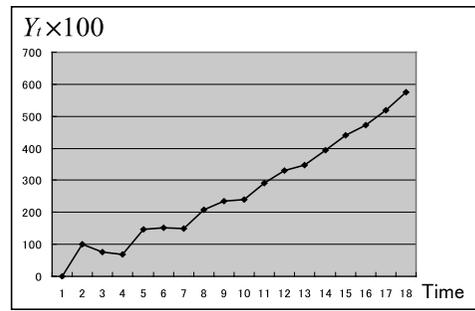


Fig. 9 Email being consumed in Example 3.

bled, i.e. the quantity transferred from S_4 to S_5 shall be doubled and added to the quantity of S_5 . Therefore, P_t is to be calculated by the following Formula (4) where the P_0 and A are same as in Fig. 7.

$$P_{t+1} = P_t A + P_c \tag{4}$$

where $P_c = [0 \ 0 \ 0 \ 0 \ c_5 \ 0]$

In this example, c_5 is defined as $(S_4)_t \times a_{45}$ which is the additional value to S_4 as mentioned above.

This example shows the Y_t rapidly increases with the occurrence of the copies as shown in **Table 3** and **Fig. 9**.

4.4 Primary Distribution by Pull Method (Example 4)

In this example, an advertisement website is accessed. And there is no redistribution of advertisements done by consumers. In other words, the secondary distribution is not performed in this example. In pull distribution methods such as Web, the probability of a_{13} and the IAV are not obviously obtained unlike the previous examples. Therefore, we propose the following method to estimate a_{13} and IAV

so that our proposed model is also able to apply for any pull access methods.

First we define t as a certain period of observation, which can be 1 day, 6 hours or 1 hour, and observe the number who have accessed to the Web site. Suppose from $t = 1$ to n , we obtain W_t which is a number who have accessed the website from $t - 1$ to t . In this case, a_{13} is to be estimated according to the following Formula (5) where MAX is a function to get the maximum value from arguments.

$$a_{13} = \frac{\sum_{t=1}^n W_t}{(MAX(W_1, \dots, W_n)) \times n} \tag{5}$$

The denominator defines the possible maximum number accessing the Web site within the observation period, that can be regarded as a maximum capacity or power of the advertisement to attract consumers. While the numerator defines the total number accessing the Web site, that can be regarded as an averaged capacity or power of the advertisement. Therefore, a_{13} is defined as an average accessing rate of the Web site within the observation period against the maximum capacity.

Table 5 Quantity transition in Example 4.

Time	S_1	S_2	S_3	S_4	S_5	S_6	Y'_t	Y_t
0	1	0	0	0	0	0	0	0
1	1	0	0.5291	0	0	0	0.5291	0.5291
2	1	0	0.661375	0	0	0.396825	0.132275	0.661375
3	1	0	0.694444	0	0	0.892856	0.033069	0.694444
4	1	0	0.702711	0	0	1.413689	0.008267	0.702711
5	1	0	0.704778	0	0	1.940722	0.002067	0.704778
6	1	0	0.705294	0	0	2.469306	0.000517	0.705294

Table 4 Number of hitting website in Example 4.

	Number of Accessing the Web site
First day	150
Second day	210
Third day	80
Fourth day	270
Fifth day	100
Sixth day	90
Seventh day	100

$$P_0 = [1 \ 0 \ 0 \ 0 \ 0 \ 0]$$

$$A = \begin{bmatrix} 0.4709 & 0 & 0.5291 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0.25 & 0 & 0 & 0.75 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Fig. 10 The initial state quantity and transition probability of Example 4.

Assuming that we define t as one day and the observed accessing the Web site is as shown in **Table 4**, $a_{13} \approx 0.5291$ is obtained. So, a_{11} is to be defined as 0.4709 in this case. We also assume that 3/4 of the consumers forget the advertisement after accessing it while the rest can remember. Hence, a_{33} and a_{36} are 0.25 and 0.75, respectively. Consequently, the initial system state quantity (P_0) and the transition probability matrix (A) are to be defined as shown in **Fig. 10**.

As in Example 3 in the previous subsection, we also need a value to compensate S_1 in this case; i.e. the quantity of S_1 shall be always kept as 1 because a kind of copy-and-delivery of advertisements happened while accessing the Web site and it does not take any resources away from it. Therefore, P_t is to be calculated by the Formula (6).

$$P_{t+1} = P_t A + P_c \tag{6}$$

where $P_c = [c_1 \ 0 \ 0 \ 0 \ 0 \ 0]$

In this example, $c_1 = a_{13}$ to make S_1 always 1.

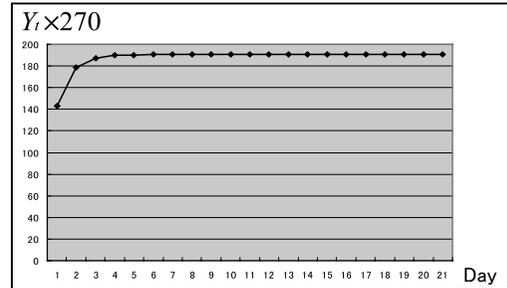


Fig. 11 Web advertisement being consumed in Example 4.

The next step is to obtain the IAV . In order to do so, we propose the following Formula (7) to be used to define it.

$$IAV = \frac{\sum_{t=1}^n W_t}{\sum_{t=1}^n \{(S_1)_t a_{13}\}} \tag{7}$$

The denominator defines the total quantity of advertisements flowing from S_1 to S_3 , while the numerator defines the total number of consumers accessing the Web site during observation period. Thus, IAV is to be defined as an absolute number of website accesses corresponding to the quantity “one”. However, according to Formula (5) where a_{13} is defined as a constant and S_1 is compensated as always 1, in this particular case, Formula (7) can be simplified into Formula (8) as below.

$$IAV = MAX(W_1, \dots, W_n) \tag{8}$$

It means that IAV in Formula (8) is defined as the maximum number accessing the Web site within the observation period in order to prevent S_1 from becoming a negative value. Thus, each quantity of state can be calculated by multiplying IAV to P_t as same as in Example 1, 2 and 3. In this example, according to the Formula (8), $IAV \equiv 270$ is obtained.

Finally, using the parameters we obtain, we are able to calculate the quantity transition of each S_i . **Table 5** shows the quantities of S_i from time 1 to 6, as well as Y'_t and Y_t . **Figure 11** shows the number of Web advertisement being consumed day by day, and it shows that

Table 6 Conditions of the experiment.

Experiment Place	Waseda Univeristy, Honjo Campus
Primary Advertisement Distribution Media	Handbill, Web
Experiment Period	21 days
Tools for Supporting Secondary Distribution	E-mail service provided in the website
Tool for Gathering Distribution Result	Questionnaires, Count function

we are able to estimate the possible future value if each parameter is constant and the same in the future.

Generally, this proposed method may apply to calculate a_{43} and $I\!A\!V$ for the secondary distribution by pull method. However, we will investigate how to determine a_{43} and $I\!A\!V$ for secondary distribution of the pull method as our further study.

4.5 Generalization of Calculating Formula

After considering the calculation of all examples, Formula (2), (4) and (6) are to be generalized as shown in Formula (9).

$$P_{t+1} = P_t A + P_c \tag{9}$$

where $P_c = [c_1 \ 0 \ 0 \ c_4 \ c_5 \ 0]$

c_1 , c_4 and c_5 represent the copy of primary pull distribution conducted at S_1 , the copy of secondary pull distribution conducted at S_4 , and the copy of secondary push distribution conducted at S_5 , respectively.

Using this generalized formula, in the Example 1 and 2, all of c_1 , c_4 and c_5 are to be defined as 0. In the Example 3, c_1 and c_4 is defined as 0, and c_5 is defined as $(S_4)_t \times a_{45}$. In the Example 4, c_1 is defined as a_{13} , and c_4 and c_5 are defined as 0.

5. The Experiment and Its Analysis

To verify whether the proposed model can be used in real-life advertisement distribution, we conducted a practical experiment of advertisement distribution at Global Information and Telecommunication Studies (GITS), Waseda-Honjo Campus.

In our experiment, we set out handbills and the Web as the primary advertisement distribution media. In our handbills, there is some useful information for living in Saitama Honjo and information inviting consumers to access our Web site called EZHONJO. On our Web site, there is also a lot of useful information for living in Saitama Honjo.

Questionnaires are designed to collect information related to consumers receiving information via handbills, emails, our Web site or word-

of-mouth. Then what consumers react to the received information. Such feedback from consumers is used to define the transition probability matrix (A) of the handbills and word-of-mouth distribution.

We also provide an email service as a tool for distributing the information in the Web site. In other words, consumers can use this service to send emails to their friends easily. In the Web site, we also create functions for counting and recording the number of consumers accessing our Web site by consumers; and number of transmitting emails from our email service. This counting of consumers' responses is used to determine transition probability matrix (A) of Web and email distribution. Nevertheless, the count function can count only some parts of Web and emails distribution. For instance, forgetting and discarding advertisement which are defined as a_{36} cannot be counted by this count function.

The period of our experiment is 21 days. To clarify conditions of our experiment, **Table 6** is shown.

We distributed 50 handbills to students attending the entrance ceremony at GITS, Waseda Univeristy Honjo-Campus. Then three weeks after distributing the handbills, we distributed 50 questionnaires to anyone in the campus randomly. There are 38 responses to the questionnaires; 7 out of 38 questionnaires returned state that they received the handbills at the Entrance ceremony. 2 out of the 7 redistributed the advertisement information (in the handbills received) to 9 persons. 4 out of 7 stated that they stored the handbills. The remaining one stated that he/she discarded his/her handbill.

5.1 The Analytical Result of Handbill and Word-of-Mouth Distribution

The result from the questionnaire shows the distribution of handbills and word-of-mouth because some consumers use word-of-mouth to distribute the advertisement as a secondary distribution. The detail of a_{ij} acquired from the questionnaires gathered after 21 days is clarified in **Table 7**, and the initial state quantity

Table 7 Transition probability detail acquired using questionnaires.

Transition Probability	Definition	Value
a_{12}	$\frac{\text{Number of Transmitted Handbills}}{\text{Number of Printed Handbills}}$	1 ($\frac{50}{50}$)
a_{23}	$\frac{\text{Number of Consumed Handbills}}{\text{Number of Successfully Transmitted Handbills}}$	1 ($\frac{50}{50}$)
a_{33}	$\frac{\text{Number of Stored Handbills}}{\text{Number of Consumed Handbills}}$	0.5714 ($\frac{4}{7}$)
a_{34}	$\frac{\text{Number of Consumers who Redistributed Advertisement}}{\text{Number of Consumed Handbills}}$	0.2857 ($\frac{2}{7}$)
a_{36}	$\frac{\text{Number of Discarded Handbills}}{\text{Number of Consumed Handbills}}$	0.1429 ($\frac{1}{7}$)
a_{45}	$\frac{\text{Number of Redistributed Advertisement}}{\text{Number of Secondary Distribution Advertisement}}$	1 ($\frac{9}{9}$)
a_{53}	$\frac{\text{Number of Consumed Redistributed Advertisement}}{\text{Number of Redistributed Advertisement}}$	1 ($\frac{9}{9}$)
a_{66}	This transition probability is always be 1	1

$$P_0 = [1 \ 0 \ 0 \ 0 \ 0 \ 0]$$

$$A = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0.5714 & 0.2857 & 0 & 0.1429 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Fig. 12 The initial state quantity and transition probability matrix of handbills and word-of-mouth distribution of 21 days.

(P_0) and transition probability matrix (A) are shown in **Fig. 12**. Note that, the calculation of a_{33} , a_{34} , a_{36} , a_{45} and a_{53} is based on information from collected questionnaires.

In order to calculate Y_t , we use the same method discussed in Section 4.3. In this analysis, we define an instance time t as one day. According to the questionnaire, some consumers copied and redistributed the handbills, and some consumers used word-of-mouth to redistribute advertisement information. Using word-of-mouth is also considered to be copying. We can find the average quantities of advertisement which are copied (c_5) and distributed in everyday (t) by using the Formula (10).

$$c_5 = \begin{cases} 0 & (t = 0, 1, 2, 3) \\ \frac{1}{TNAC} \times ANCRDA \times \frac{1}{PO} & (Otherwise) \end{cases} \quad (10)$$

In this analysis, when $t = 0, 1, 2, 3$ the quantity of S_5 is 0 because the advertisements are not firstly reached at this state. Therefore, c_5

is defined as 0 when $t = 0, 1, 2, 3$. “*TNAC*”, “*ANCRDA*” and “*PO*” are defined as “Total Number of Advertisements Corresponding to the normalized value”, “Average Number of Copied and Re-Distributed Advertisement” and “Period of Observation”, respectively.

With regard to our questionnaires, “*TNAC*”, “*ANCRDA*” and “*PO*” are 50, 64.285 and 21, respectively. Since we cannot know the exact *ANCRDA* in this experiment, the *ANCRDA* is estimated by using Formula (11) where as “*NCRDA*” is the Number of Copied and Re-Distributed Advertisements which gained from the questionnaires, “*NPRH*” is the Number of People who Received Handbills at the GITS entrance ceremony which acquired from the questionnaires, and “*ANPRH*” is the Actual Number of People who Received Handbills at GITS entrance ceremony. According to the experiment and its questionnaires, “*NCRDA*”, “*NPRH*” and “*ANPRH*” are 9, 7 and 50, respectively.

$$ANCRDA = \frac{NCRDA}{NPRH} \times ANPRH \quad (11)$$

The calculated “ c_5 ” shows the result of 0.0612.

As discussed in Section 4, *IAV* can be considered as “Numbers of Primary Distribution Advertisement” in push distribution methods, which is 50 in this experiment; because we firstly distributed 50 handbills. Moreover, c_1 and c_4 in Formula (9) are defined as 0 because there is no primary and secondary pull distri-

Table 8 Transition probability detail of three weeks acquired using count function.

Transition Probability	Definition	Value
a_{11}	From $\sum_{j=1}^6 a_{ij}$ with $a_{12}, a_{16} = 0$	0.6892
a_{23}	By Formula (5)	0.3108
a_{33}	From $\sum_{j=1}^6 a_{ij}$ with $a_{36} = 0$	0.387
a_{34}	$\frac{\text{Number of Accessing to the Email Service Web Page}}{\text{Number of Access to the Advertisement Website}}$	0.6129 ($\frac{76}{124}$)
a_{45}	$\frac{\text{Number of Transmitted Email}}{\text{Number of Accessing to Email Service Web Page}}$	0.25 ($\frac{19}{76}$)
a_{46}	From $\sum_{j=1}^6 a_{ij}$ with $a_{44} = 0$	0.75
a_{53}	$\frac{\text{Number of Consumed Transmitted Email}}{\text{Number of Successfully Transmitted Emails}}$	1 ($\frac{19}{19}$)
a_{66}	This transition probability is always be 1	1

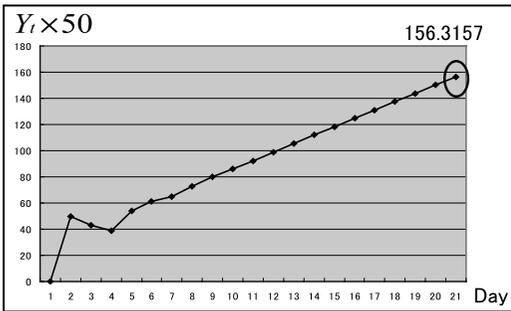


Fig. 13 Handbills and word-of-mouth advertisements being consumed of 21 days.

bution in this experiment.

Having applied Markov Chain and Formula (9), the result is shown in **Fig. 13**. This analytical result principally represents the distribution of the handbills and word-of-mouth advertisement. It shows that after 21 days, the handbills and word-of-mouth advertisements being consumed ($Y_{21} \times 50$) is 156.3157.

Since the distribution are be spread to outside our campus, we cannot find out the real numbers of handbill and word-of-mouth advertisement being consumed. Nevertheless, this result can show that the numbers of advertisements being consumed have increased approximately 3 times of IAV after 21 days.

5.2 The Analytical Result of Web and Emails Distribution

The analytical result from our count function represents the distribution of Web and email advertisement. The detail of acquired informa-

$$P_0 = [1 \ 0 \ 0 \ 0 \ 0 \ 0]$$

$$A = \begin{bmatrix} 0.6892 & 0 & 0.3108 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0.387 & 0.6129 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.25 & 0.75 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Fig. 14 The initial state quantity and transition probability matrix of web and email distribution of 21 days.

tion from the count function is presented in **Table 8**, and the initial state quantity (P_0) and transition probability matrix (A) is shown in **Fig. 14**. Note that, this transition probability is defined by using the results from the count function obtained during 21 days of observation. Moreover, we define a_{36} as 0 because the count function in this experiment does not have the capability to count the numbers of advertisements which are forgotten or discarded. Hence, we assume that all consumers can remember the advertisement after having accessed the Web site. In addition, accessing the email service Web page is regarded as transiting to “Ready for Secondary Distribution” state.

Since, there are secondary information distributions done by emails in this experiment, Formula (10) is used to define this. According to our count function, $TNAC$ is 124 which is the numbers of consumers accessing our advertisement website. For $ANCRDA$, we use “Number

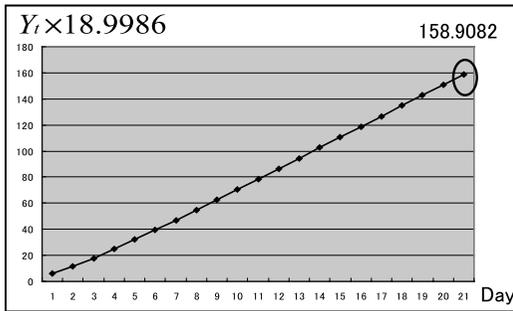


Fig. 15 Web and email advertisements being consumed.

of Transmitted E-mail” which is 19; and the result of c_5 is 0.0073 ($t \geq 3$).

As discussed in Section 4.4, c_1 in Formula (9) is obtained as 0.3108. For the I_{AV} , it is obtained by using Formula (8) and the result is 18.9986. And c_4 is defined as 0 because there is no secondary pull distribution in our experiment.

After getting those parameters, we use Markov Chain and Formula (9) to analyze the distribution. Consequently, we produce the result of “Web and Email Advertisement being Consumed” after 21 days ($Y_{21} \times 18.9986$) which is 158.9082 as shown in **Fig. 15**. The graph shows a constant-increasing line because we determine a_{13} and I_{AV} as averaged values from the observation and a_{36} as 0.

Note that the real number of advertisements being consumed after 21 day is 143. This number is obtained by totalling the number accessing the experimental Website during 3 weeks which is 124 and the total number who transmitted email during 3 weeks which is 19.

The analytical result of 158.9082 shows that it is not far from the real result which is 143. It shows that the proposed model can present and also predict the advertisement distribution rate of pull and push methods.

6. Consideration

6.1 On the Proposed Model

In the proposed model, the effectiveness of secondary information distribution can be measured and analyzed. We consider that one of the key factors for realizing future advertisement distribution is how to increase the effectiveness of secondary information distribution such as email and word-of-mouth, and make this distribution occur repeatedly. We believe that the proposed model can be used to find such factors. For instance, we can conduct simulations

and analyze by using the proposed model so that not only the factors which increase the effectiveness of distribution but also the factors which reduce the effectiveness are to be observed and analyzed as well. And according to the analytical result described in Section 5.2 on the pull distribution, we can also consider that the proposed calculation method for pull distribution is effective.

Generally, there are two approaches to analyze the effectiveness of the advertisement distribution; analyzing advertisements by focusing on contents²⁾, and analyzing distribution quantity statistically without regard to the contents⁷⁾. Since the proposed model has taken the latter approach, the model can analyze the effectiveness of advertisement distribution in the statistical way, but not the effectiveness of advertising contents. Furthermore, in the real world of advertisement distribution, the parameters may be varied from time to time. And in some advertisement distributions, the push and pull are done simultaneously by multiple advertisement media. The experiment we have conducted cannot examine those issues. However, in this case, we may define appropriate P and A to represent the combination of advertisement distribution effectiveness on different media. The combination of media in advertisement distribution may give more effectiveness than distributing them separately. We will conduct an experiment in our future work to prove this consideration.

6.2 Parameters Impact

Each parameter of Formula (9) has a different impact for the effectiveness of advertisement distribution. In order to clarify the impact, here we focus on c_5 and a_{34} because both parameters have impacts against the secondary distribution effectiveness and one of our goals is to analyze the factors to increase the effectiveness of the secondary distribution.

Under the condition described in Section 5.1, the total quantities of advertisements being consumed after 21 days (Y_{21}) are calculated using the different values of c_5 and a_{34} , which is shown in **Fig. 16**. In Fig. 16, the y-axis represents the total quantity Y_{21} , and x-axis represents the different values of c_5 and a_{34} incremented by 0.1 against their original values. By increasing a_{34} , we have to adjust other a_{3x} parameters so that the $\sum_{i=1}^6 a_{3x}$ shall be always maintained as 1. In this consideration, we as-

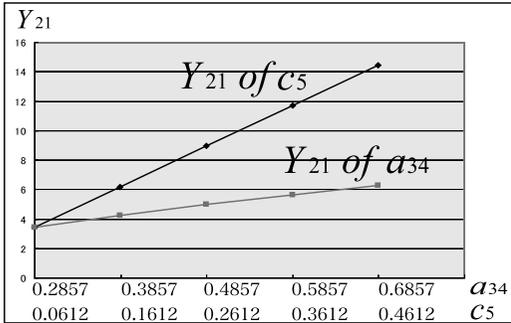


Fig. 16 The impact of *c*₅ and *a*₃₄ in Formula (8).

sume *a*₃₃ is to be decreased against the *a*₃₄ increasing. It should be noted that the value of *c*₅ and *a*₃₄ are not in the same scale, but we can estimate how large the increments give impacts against *Y*₂₁ in a qualitative way. Consequently, Fig. 16 shows *Y*₂₁ rapidly and constantly increases when *c*₅ increases; whereas in case of *a*₃₄, *Y*₂₁ gradually increases. Moreover, the result from our simulation also shows that 0.2857, 0.3857, 0.4857, 0.5857 and 0.6857 of *a*₃₄ requires 2, 2.7, 3.4, 4.1 and 4.8 out of 7 consumers to make secondary distribution because this simulation is based on the data in Section 5.1, i.e. 0.2857 of *a*₃₄ is obtained by the questionnaires that 2 out of 7 consumers who received the handbill advertisement redistributed the advertisement information.

In general, to increase *a*₃₄ is more difficult and more expensive than to increase *c*₅. That is, increasing *a*₃₄ means increasing the number of consumers who are willing to redistribute advertisements, and that involves a higher cost; e.g. by conducting marketing campaigns. On the other hand, to increase *c*₅ is done more easily, for example, by providing tools which can be easily used for copying and distributing advertisement such as sending multiple emails at the same time.

Figure 17 shows *NCRDA* done by 1 consumer with corresponding *c*₅ under the same condition as described in Section 5.1. The result in Fig. 17 shows that if we need 0.0612, 0.1612, 0.2612, 0.3612 and 0.4612 of the *c*₅, 1 consumer must copy and redistribute 4.4982, 11.8482, 19.1982, 26.5482 and 33.8982 advertisements, respectively. Note that, in order to find this number which is done by 1 consumer, *NCRDA* gained from Formula (11) must be divided by 2 because *NCRDA* in Section 5.1 are the total values done by 2 consumers. Using Formula (10) and (11) to find the number

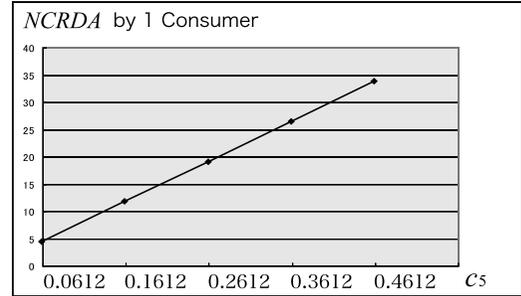


Fig. 17 Number of copied and redistributed advertisement by one consumer when *c*₅ is increased.

of copied and redistributed advertisement by 1 consumer, the Formula (12) is to be used.

$$c_5 \times TNAC \times PO \times \frac{NPRH}{ANPRH} \times \frac{1}{2} \quad (12)$$

Hence, using our proposed model, it is clearly shown that providing redistribution tools such as email which enable copying of advertisement information in the secondary distribution leads to the more effective proliferation of advertisements. In the actual situation there is almost no possibility that consumers will send more than 10 emails for 1 advertisement. In other words, it is quite difficult to make *c*₅ more than 0.1612. However, with regard to Fig. 16, even 0.1612 of *c*₅ gives higher *Y*₂₁ than 0.6857 of *a*₃₄. This result also represents that increasing number of consumer who will redistribute advertisement gives less distribution effect than increasing number of copied and redistributed advertisement in consumers even only a few numbers of consumer.

7. Conclusion and Future Works

Having conducted the experiment to verify the validity and usefulness of our model, we believe that our proposed advertisement distribution model can be used to analyze and measure the entire circulation of its distribution which includes primary and secondary information distributions. Our experiment shows that the model can present a part of the real world advertisement distribution, and analyze effectiveness of advertisements distribution. The proposed model can be also applied to analyze general information distribution such as an analysis of information awareness. By using the proposed model, we can analyze or estimate the factors which make the secondary distribution occur repeatedly in the entire distribution program. We believe that such factors are the

important keys for new kinds of advertisement distribution in the future.

However, there are some remaining issues in the proposed model because the experiment is done on simple cases of advertisement distribution. Complicated case of advertisement distribution will be investigated in our future works such as pull methods of secondary distribution and the combination of various advertisement distribution media. In addition, because of the rapid growth of mobile communication, new advertising models for making secondary information distribution such as incentive coupons have been being developed. Therefore, we will apply the proposed model to analyze the effectiveness of such incentives in mobile environments. Furthermore, some influencing factors for real-world advertisement distribution will be investigated to find the relation to and impacts on the parameters in the proposed model.

Another experiment will be conducted to confirm the validity of the proposed model, and dynamic change of transition probabilities will be investigated and applied to the proposed model in order to maximize its accuracy and effectiveness.

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