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ARTICLE

# THE METHOD OF ASSESSMENT THE EFFECTIVENESS OF WEB-SITES FOR BANNER ADVERTISEMENT ON FUZZY SETS THEORY

**Ilyas I. Ismagilov*, Svetlana F. Khasanova**

*Institute of Management, Economics and Finance, Kazan Federal University, Kazan, RUSSIAN FEDERATION*

## ABSTRACT

*This article deals with method of estimation the effectiveness of web-sites for banner ads by measuring communicative effects of sites for users. We propose to solve the optimization task for maximizing communicative effect of advertising campaign and find period of time for ad placement on web-sites under the budget limits. Communicative effect of site is calculated by the negation operator of the Hamming distance between two fuzzy numbers: "Target audience" and "Average user of the site." Fuzzy number "Target audience" is formed as a result of the determination by experts (marketers) the demographic and territorial characteristics of the target audience, and the fuzzy number "Average user of the site" is calculated according to the demographic and territorial metrics of the site. The sites and times for banners on them is the solution of linear programming task. This technique can help in marketing and management decisions, and can also be used for market research of preferences of different groups of the population.*

**KEY WORDS**
*fuzzy sets, site effectiveness, site metrics, communicative effect, banner ads, advertising effectiveness*

## INTRODUCTION

The best sites for hosting the company's banners are the secret of success of advertising campaign. There are a lot of qualitative and quantitative factors that influence on defining the most effective web-sites.

The first Internet banner advertising appeared in 1994 that was the beginning of the rapid development of online advertising. The first methodology for assessment the effectiveness of banner advertising based on indicators such as:

1) Evaluation of indicators of growth the awareness, feedback, intentions to purchase;
2) The test of significance of components of a banner, for example, tests the impact of the animation, color, banner's size on the amount of feedback;
3) Evaluation of the impact of different factors on results, such as the test for assessment of the effect of the exposure, content, complexity, background on the awareness and feedbacks.

The first studies of the effectiveness of banner advertising, such as in [1], [2], [3] showed that the banner advertising increases consumer awareness of the brand, the company, it changes the attitude to the process of buying and number of visits of the sites. The research of efficiency through the number of clicks was performed by [3]. However, the feasibility of assessing of the online advertising effectiveness through a number of clicks has been questioned in studies by [4], [5], [6], because not all visiting of sites lead to the purchase, and the frequency of clicks on the banner advertising is on average, 0.5% of visits.

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In the works by [7], [8], [9] there conducted the evaluation of the effectiveness and simulation of Internet advertising based on statistical data. However, all these techniques are useful for assessing only the banner advertising and not comparable to other types of advertising.

[10] suggests using the data of the envelopment analysis (DEA - Data Envelopment Analysis) to assess the relative efficiency of the process which has complex characteristics, which are converted into a single comparable figure. The feature of this method is that the specific weights of each factor are determined individually and, in contrast to the regression analysis, they are recounted from the position of maximizing the final effect. As independent characteristics there were considered the indicators that influence the effectiveness of banner advertising as emotional coloring, color, interactivity, animation, message length. As effectiveness indicators at the output there are used such as CTR (click speed), attitude to advertising and the number of responses.

The empirical studies by [11] on 111 companies showed that campaigns using a combination of online advertising and traditional off-line advertising lead to positive consumer reaction and synergies that also proved by [12].

Proposed a methodology to assess the effectiveness of online advertising based on Poisson-gamma model. Further, [13] develop a model for predicting the level of sales of keywords in online advertising, using the analysis of the hierarchy by Bayesian. There is the comparison of Internet advertising to other types of advertising. This approach allows us to estimate more accurately the effect of the campaign.

***Corresponding Author**
Email:
Ilyas.Ismagilov@kpfu.ru

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Studies by [14] using the logit and probit of models show that the effectiveness of Internet advertising depends not only on the characteristics of the advertising and the site, but also on the type of the advertised product. The distance to the physical point of sales is the most important factor for the goods of search type.

[15] suggested the use of multicriteria linear programming (MCLP) to predict the potential users of online advertising using information from users' browsers about clicks and requests for Internet users, and displaying the most appropriate advertising for them. This model has shown its prospect when compared with models like Support Vector Machines (SVM), Logistic Regression (LR), Radial Basis Function Network (RBF Network), k-Nearest Neighbour algorithm (KNN) and NapveBayes.

Also review of literature provides methodology for assessing the effectiveness of online advertising from the perspective of firms, exposing ads on their sites. In the work, [9] proved the existence of Nash equilibrium situation for the market of advertisers of oligopolistic type. Through the calculation of sensitivity to the cost of advertising per thousand clicks (CPM) competitors are provided by the method of calculating of the best price per CPM for the firm.

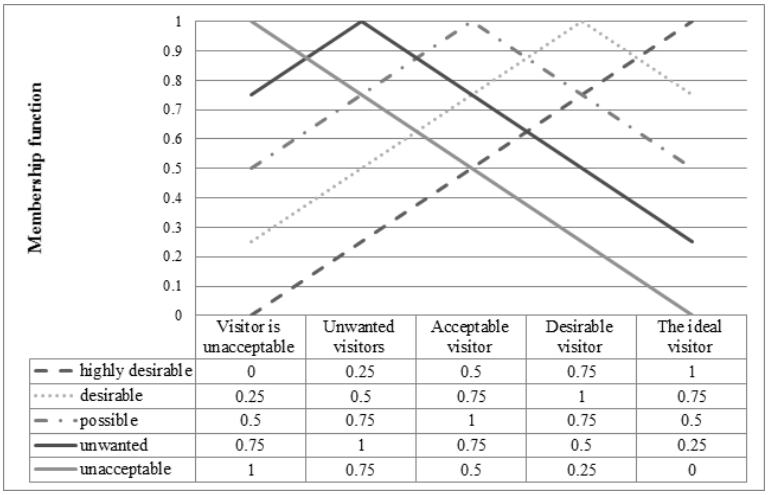
Advances in technology and the Internet leads to the increase of the amount of online advertising. Foreign studies show that the efficiency is influenced by many factors. Depending on factors stood out as the most important are the different methodologies for assessing the effectiveness of online advertising. As a general result it is possible to classify the procedure as following. First, the methodology for assessing the effectiveness of online advertising, based on factors related to the quality of the advertising campaign - color, animation and banner placement and information. Second, methods that calculate the effect of advertising depending on the placement of online advertising and the ways to select the target audience. The third method of calculating the effectiveness of online advertising depends on the charSacteristics of the offered goods and services. It should be noted the development and complexity of techniques and tools for assessing the effectiveness of online advertising, the research and incorporation of new factors of competitiveness of e-commerce.

## METHOD

The banner advertising has two main effects: the communicative and economic effect. With this in mind, we propose the following model for evaluating the effectiveness of sites, their selection and calculation period of advertising on sites:

1) Formation of an image of the target audience by defining its characteristics. The characteristics of the target audience are determined based on the information that can be accessed using web page counters of the attendance: gender (male / female), age (under 18, 18-24, 25-34, 35-44, 45 and older), the country residence, region of Russia. The image of the target audience is formed by making expert assessments of each characteristic. We propose the following scale of linguistic assessments "highly desirable, desirable, possible, unwanted, unacceptable."

To evaluate the target audience there is introduced a fuzzy number "Target Audience by characterization i" and its five linguistic terms (values of fuzzy number): "The ideal visitor $\mu_i$ ($A_1$)", "Desirable visitor $\mu_i$ ($A_2$)", "Acceptable visitor $\mu_i$ ($A_3$)", "Unwanted visitors $\mu_i$ ($A_4$)", "Visitor is unacceptable $\mu_i$ ($A_5$)". Membership functions of the characteristics of the target audience to the linguistic terms are determined by the ratio shown in [Fig. 1] [18].




| | Visitor is unacceptable | Unwanted visitors | Acceptable visitor | Desirable visitor | The ideal visitor |
|---|---|---|---|---|---|
| highly desirable | 0 | 0.25 | 0.5 | 0.75 | 1 |
| desirable | 0.25 | 0.5 | 0.75 | 1 | 0.75 |
| possible | 0.5 | 0.75 | 1 | 0.75 | 0.5 |
| unwanted | 0.75 | 1 | 0.75 | 0.5 | 0.25 |
| unacceptable | 1 | 0.75 | 0.5 | 0.25 | 0 |

**Fig.1:** Type of membership functions describing the value of linguistic variable "Target audience".

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2) The second step there is the selection of the potential sites for banner advertising. For each of the analyzed sites, the attendance statistics of pages is collected which has the same demographic and territorial characteristics that have been used to form an image of the target audience. The data may be collected using tools of Yandex metrics or other site effectiveness counters. Experts determine the value of the proportion of Internet users that can be attracted by the most popular of the studied sites [0, 1], for example, m=0.5. In order to describe the typical / average website visitor, there entered fuzzy numbers for each of the demographic and territorial characteristics of the "Average visitor to the site by i-th characterization." For a qualitative description of a fuzzy number in terms of human understanding there are identified five linguistic terms (values of linguistic variable) with the corresponding node points that are uniformly removed from the maximum share: "Major share of Internet users (0.5)", "Significant proportion of Internet users (0,375)" "Average number of Internet users (0.25)", "Small proportion of Internet users (0,125)", "No Internet users (0). [16]" The calculation of the membership functions of the site characteristics to each linguistic term are presented by the formula [17]:

$$\mu_i(C_i) = \{ \qquad . \qquad if\ v_i \le d \le m:$$

where $\mu_i(C_j)$ – is the value of the membership function of a characteristic for the i -th linguistic meaning;
$d_i$ - the proportion of all users in the region by characterization;
m - maximum share determined by experts;
$y_j$ - the values of the nodal points of the i -th linguistic meaning.

Type of membership functions has the form shown in [Fig. 2].

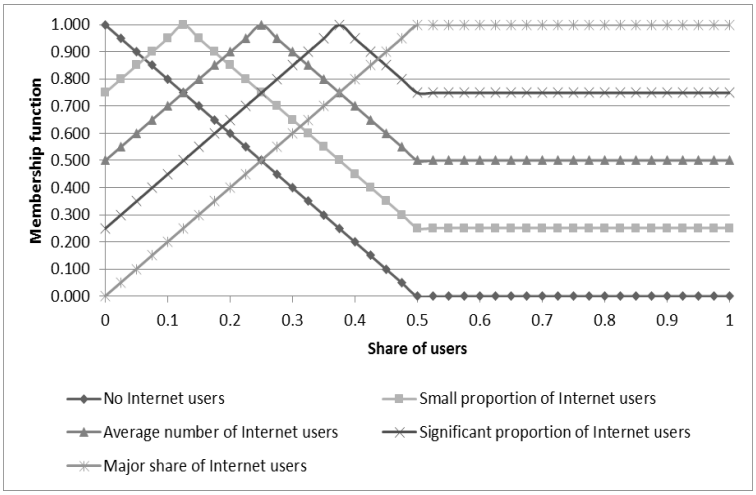


**Fig. 2:** Type of membership functions of fuzzy terms of "Average visitor to the site by characterization i "

3) The assessment of communicative efficiency of the site is calculated. For each analyzed site there is determined the Hamming distance [18, 19] between the fuzzy number "Target audience by characterization" and the corresponding fuzzy number the "Average visitor to the site by characterization." The greater the distance between fuzzy numbers means the less communicative effect of this website is. Consequently, the "Communicative effect" for each characteristic is calculated as the negation operation of the found distance, the overall communication effect of site is calculated as average of demographic and territorial characteristics:

$$K = 1 - \sum_{i=1}^{} |\mu_i(A_i) - \mu_i(C_i)|$$

where K – is the communicative effect of a site for this advertising campaign;

$\mu_i(A_j)$ - the value of the membership function of i-th characteristic for the j -th linguistic value of number of " Target Audience by characterization i ";
$\mu_i(C_j)$ - the value of the membership function of i- characteristic for the j -th linguistic value of number of "Average visitor to the site by characterization i".

4) The selection of sites for banner advertising comes down to the optimization task of linear programming with the following characteristics. Unknown variables are time of placing banners on the site. The objective function is to maximize the communicative effect of ad campaign. The cost of banner advertising per one day and the budget form the restrictions of the problem.

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Target function: $\sum_{l=1}^{n} K_l * d_l * t_l \rightarrow max$,
Changing cells: $t_l$
Restrictions: $\sum_{l=1}^{n} C_l * t_l \leq B, t_l \geq 0, t_l = integer$,

where $K_l$– is the communicative effect for the site,
$d_l$- the share of visitors in the region,
$t_l$- the period of advertising on the site, day.
$C_l$- the cost of advertising on the site, rub. / day.
$B$ - Advertising budget.

The solution to this problem can be found by using the package "Solver" in MS Excel. As a result, there are defined the sites and period of time that are advisable to place advertising for achieving the maximum communicative effect of ad campaign with the audience. The presented method is a tool to support decision-making. The method is realized in MS Excel and it is suitable for firms of all spheres of activity.

## RESULTS

In our research were investigated the sites in city Kazan (Russia), which combined in groups of content of the sites: goods and services, businesses, cars, culture, news and media, entertainment, education. For each of the groups there were identified demographic and territorial characteristics of traffic through the site [20]. There were investigated several types of target audiences and identified the sites with the most communicative effect, shown in [Table 1].

**Table 1:** Communicative effect of the sites for different target audiences

| Type of the target audience | Most popular categories of sites |
|---|---|
| Women under 18 years old, mostly living in Russia, Moscow | News & Media, Culture, Entertainment |
| Young men 25-34 years old, mostly living in Russia Kazan | News and Media, Education, Culture |
| Women over 45 years old, primarily living in Russia, Volga region | News & Media, Auto, Enterprises |
| Men and women, 35-44 years old, mostly living in Russia, St. Petersburg | News and Media, Education, Culture |
| Students living in cities with the population over 1 ml. people | News and Media, Education, Goods and Services |
| Pensioners living in large cities and CIS countries | Culture, Entertainment, Education |

It should be noted the following feature of the method: the less specific characteristics of the target audience are (the large number of desirable characteristics which close to each other) increases communicative effect of sites with a large number audience and decreases communicative effect of sites which designed for a narrow audience. Thus, setting narrow characteristics of the target audience allows determining the sites with a large attendance precisely by the target audience, but possibly with low rates of attendance as a whole over the Internet, and therefore lowering prices for banner advertising.

This method also allows to explore consumer behavior of different segments of the population and to make market research for preferences and interests of buyers. This information can be very useful for strategy creation of company [21].

Modern web counters have been improved and in addition to the basic characteristics of users, such as gender, age and territory, they allow to recognize additional features as the interests and activities. Any new features can be used in the proposed method, and will improve the accuracy of the calculation of the communicative effect of the site.

## CONCLUSION

The Internet is an indispensable part of modern economic relations. The development of the Internet has led to the emergence of Internet advertising which is presented in the form of banners in certain parts of sites. According to the company Net craft on 01.01.2014, the Internet had 861.4 mln sites. Among such a large number and variety of places of banner advertising, the site selection is a challenge. Sites like Google, Yandex offer their advertising system, but the cost of such services may not be suitable for a small business or advertising budget. In this study, the method of choice and calculation of the optimal time of banner advertising on the sites has been proposed. The method is based on the calculation of the communicative effect of Internet sites and solving the optimization problem to achieve the maximum communicative effect of an advertising campaign with budget constraints. The communicative effect was calculated using the negation operation of the Hamming distance between two fuzzy numbers "Target audience" and "Average

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visitor of the site. Fuzzy number "Target audience" is formed as a result of determining the preferred characteristics of the target audience by an expert (marketer), and the fuzzy number “Average visitor of the site” is calculated according to the metrics of the site. [22]

The proposed method enables to make management decisions in conditions of a multi-criteria selection and a large number of alternatives. The solution of the optimization problem makes it possible to reach the maximum efficiency indicators of an advertising campaign in the given economic conditions. The development of tools of the Internet metrics allows to use not only demographic and territorial characteristics of the target audience, but also to determine their interests and specialization.
This method can also serve a tool of market researches of the population, since with the obtained values of communicative effects of sites they can make websites ratings of the most popular sites for different population groups.

The proposed method is implemented in MS Excel environment and is an effective tool to support decision-making.

## CONFLICT OF INTEREST

There is no conflict of interest.

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## FINANCIAL DISCLOSURE

None

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