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THE ISSUE ON SOME ECONOMETRIC ASPECTS OF MARKETING COMMUNICATIONS RESEARCH METHODOLOGY

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ПИТАННЯ ПРО ДЕЯКІ ЕКОНОМЕТРИЧНІ АСПЕКТИ МЕТОДОЛОГІЇ ДОСЛІДЖЕННЯ МАРКЕТИНГОВИХ КОМУНІКАЦІЙ

The article using the mathematical apparatus discusses the methodology for studying marketing communications in modern conditions. The study of current methods and relevant literature (both foreign and domestic) on this problem indicates the lack of a stable position among scientists-economists regarding an understanding of the essence of this process. The author justifies the need to rationalize marketing communications, presents the prevailing trends in this area and the advantages of integrative forms of these communications. Features of interactive marketing communications are disclosed, including such elements as segmentation and scoring. The tasks that can be implemented using the "decision tree" are classified, algorithms for its creation are developed, the most popular of them are identified, the problems of their use in the process of planning marketing communications are highlighted. The article in the study of marketing communications uses the methods of the neural network, deduces the mathematical formula of the potential of the neuron and the flow-chart of its econometric model in the system of integrated marketing communications. The place of logistic regression in the methods of research of marketing communications has been determined. It was concluded that it is of high importance in the diagnosis of consumer feedback on marketing offers. Logistic regression is considered in the paper as a single-layer neural network in which the activation function has a sigmoidal appearance. ROC analysis is used to analyze the quality of binary classification. The article attempted to formalize this system in the integrated marketing communications by trade, catering, paid services and tourism. The study is supported by informative tables and diagrams that complement the empirical material contained in the article. In the conclusion of the publication, certain conclusions were made indicating the reliability and objectivity of the formalized results obtained on the basis of the use of the corresponding mathematical apparatus.

У статті з використанням математичного апарату розглядаються методика дослідження маркетингових комунікацій у сучасних умовах. Вивчення чинних методик та відповідної літератури (як зарубіжної, так і вітчизняної) щодо названої проблеми свідчить про відсутність у вчених-економістів стійкої позиції щодо розуміння суті цього процесу. Автор обгрунтовує необхідність

раціоналізації маркетингових комунікацій, наводить переважаючі тенденції у цій галузі та переваги інтегративних форм цих комунікацій. Розкриваються особливості інтерактивних маркетингових комунікацій, у тому числі таких елементів як сегментування та скоринг. Класифіковано завдання, які можна реалізувати за допомогою "дерева рішень", вироблено алгоритми його створення, позначено найбільш популярні з них, виділено проблеми їх використання в процесі планування маркетингових комунікацій. У статті для дослідження маркетингових комунікацій використовуються методи нейронної мережі, виведено математичне формулювання потенціалу нейрона і блок-схема його математичної моделі у системі інтегрованих маркетингових комунікацій. Визначено місце логістичної регресії у методах дослідження маркетингових комунікацій. Зроблено висновок про її більшу значущість у діагностиці відкликання споживачів на маркетингові пропозиції. Логістична регресія розглядається у статті як одношарова нейронна мережа, в якій функція активації має сигмоїдальний вигляд. Для аналізу якості бінарної класифікації застосовується ROC-аналіз. У статті зроблено спробу формалізовано відобразити цю систему в інтегрованих маркетингових комунікаціях з галузей торгівлі, громадського харчування, платних послуг та туризму. Дослідження підтримується інформативними таблицями і схемами, що доповнюють емпіричний матеріал, що міститься в статті. У тому числі такі схеми як "Варіант прийняття рішення з урахуванням "дерева рішень"", "Блок-схема математичної моделі нейрона у системі інтегрованих маркетингових комунікацій", "Логістична регресія як нейронної мережі" та інші. У висновку публікації зроблено певні висновки, що свідчать про надійність та об'єктивність формалізованих результатів, отриманих на основі використання відповідного математичного апарату.

Key words: marketing communications, mathematical apparatus, "decision tree", neural network, logistic regression, integrated marketing communications.

Ключові слова: маркетингові комунікації, математичний апарат, "дерево рішень", нейронна мережа, логістична регресія, інтегровані маркетингові комунікації.

PROBLEM STATEMENT

Fundamental changes in marketing activities contributed to a significant restructuring of the entire communication strategy. This is primarily due to the fact that the strengthening of the competitive environment of many companies imposes new requirements on them in the field of creating new technologies for the promotion of goods in the conditions of the information society. At the same time, the basic basis for the formation of effective marketing communications (MC) is deep knowledge of the client or consumer based on the introduction of modern information and communication technologies.

ANALYSIS OF RECENT RESEARCH AND PUBLICATIONS

In the economic literature there are a number of scientific works devoted to one or another aspect of the study of marketing communications. A significant contribution to the development of the theory and practice of the studied problem in modern conditions was made by I. Ansoff, B. Berman, R. Blackwell, S. Dibb, E. Dichtel, P. Doyle, P. Drucker, F. Kotler, A. Koshik, M.X. Meskon, X. Meffert, J. Nielsen, A. Thompson, D. Trout, R. Wilson, B. Halligan, X. Herschgen, etc.

Some issues related to the development of the marketing concept were covered in the fundamental publications of the scientists of the countries of the post-Soviet space — G. Bagiev, V. Barinova, A. Voichak, V. Voilenko, S. Garkavenko, V. Gerasimchuk, B. Golik, G. Zagoria, S. Ilyashenko, I. Korneeva, N. Kudenko, T. Lukyanets, P. Orlova, A. Pavlenko, V. Pelishenko, V. Pilipchuk, T. Primak, I. Reshetnikova, S. Romat, M. Saenko, A. Starostina, A. Fedorchenko, A. Shafalyuk, D.A. Shevchenko, etc.

Among domestic scientists, we note the works of Sh. Akhundov, A. Ashurov, R. Akhundov, I. Abbasov, L. Hajiyeva, T. Imanov, A. Mamedov, D. Mamedov, S. Mirzoev, E. Guliyev, I. Heirhabarov, R. Shyukyurov, etc.

Thanks to the research of these and other scientists, theoretical and methodological issues of organizing a marketing complex are sufficiently studied. However, the increasing role of integrated MC (IMC), their coordination and balance have necessitated an increase in the scale and depth of scientific developments that justify ways to optimize the solution of marketing problems facing economic structures. This, of course, determines the relevance of the study of improving the use of the mathematical apparatus for the study of MC.

PURPOSE OF THE ARTICLE

The purpose of this article is to study the existing methods of research of marketing communications using a mathematical apparatus and to develop directions for their improvement taking into account the change in the consumer environment.

STATEMENT OF THE MAIN BODY OF RESEARCH

Foreign practice shows that in leading companies of various industries of MC channels it contributes to sales growth, and the use of consumer base management systems not only increases consumer loyalty, but also provides a significant increase in revenues from direct sales [1, p. 16—20; 2, p. 25—32].

The need to carry out and rationalize MC is shown in Table 1.

The presented trends determine the objective need to use systems for managing the consumer environment, optimizing IMC and investing in the prospect of consumer behavior.

Management systems for the consumer environment and forecasting models of IMC are actively used in medium and large companies [3, p. 35—41]. Their implementation contributes to an increase in responses to offers, the profitability of marketing companies, an increase in consumer loyalty and the cost of the consumer base, as well as the effectiveness of IMC channels.

As an innovative type of IMC, interactive marketing is used, carried out through interaction through a website on the Internet. It makes it possible to remotely accept an application, make an operational report, and gain access to a large amount of information resources. In general, interactive marketing helps to increase customer loyalty and reduce the cost of servicing the incoming call flow.

Table 1. Developing and Exploring IMC in US Firms*

Economic	
Systematic losses of firms as a result of poor quality of IMC, million dollars	50
Profit of American firms from email marketing in 2018, million dollars	200
Systematically Increasing Firms' Email Marketing Costs	1,0
Email Marketing ROI	60,0
Proportion of respondents planning to increase email marketing costs	0,95
Loyalty research	
The share of consumers recommending business competitors among those left satisfied with the interaction with the firm	0,85
The proportion of customers who will not use the services of firms, among those who remain dissatisfied	0,74
Increase in spending of the average consumer over the price of its initial purchase	12
Investigation of IMC channels	
The proportion of email recipients who open letters from companies	0,9
Percentage of email recipients who make one purchase per year as a result of receiving a message	0,6
Increased spending by email subscribers	0,91
Increase in the exchange of orders of consumers who subscribe to email mailings	0,5
Increase in the frequency of purchases of consumers who subscribe to email messages	0,3
Increase the frequency of clicks in personalized mailings	0,2
Increase conversion from personalized mailings	0,2
Share of the recipients of coupons and discounts that apply them during the subsequent period	0,8
Proportion of customers frequently mentioned in e-mail communications	0,4
Proportion of marketers with no mobile email strategy	0,5
The proportion of MC discussed through telephone calls	0,8
Increase in consumer outflow due to lack of feedback to MC through social networks	0,2

* Compiled by the author.

Having a huge consumer base, you should not give marketing announcements for everyone at once — this is expensive and irrational [4, p. 125—132]. You should look for consumers who are more likely to respond to a marketing offer. The main methods of such a IMC are segmentation and scoring.

In Western circles, the earliest definitions of market segmentation and scoring are given. Market segmentation is expressed as the process of identifying groups of customers with individual content of demand to diversify marketing efforts and clearly customize the product according to market requirements, and scoring is the determination of the likelihood of a positive outcome of interaction with the consumer based on the scoring model. Segmentation elements include the "decision tree", neural networks, and scoring — logistic regression and ROC analysis [1, p. 21—50; 6, p. 251—274].

The "decision tree" is used to characterize the purchasing consumer and is a reflection of the decision rules based on the tree, where each intermediate link corresponds to a reliable condition and solution option.

The intermediate link is an approach, the answer to which gives a transition to the next node (see Fig. 1).

In modern conditions, the use of the "decision tree" is significant and the problems solved with this option can be classified in two ways — description of information and grouping.

As for the creation of the "decision tree", it can be reflected by the following algorithm. In particular, there is a training sample T including a plurality of firms each having m attributes. One of these attributes shows the relationship of firms to one of the subsystems. In a number of works, the meaning of creating a "decision tree" is formally reflected as follows:

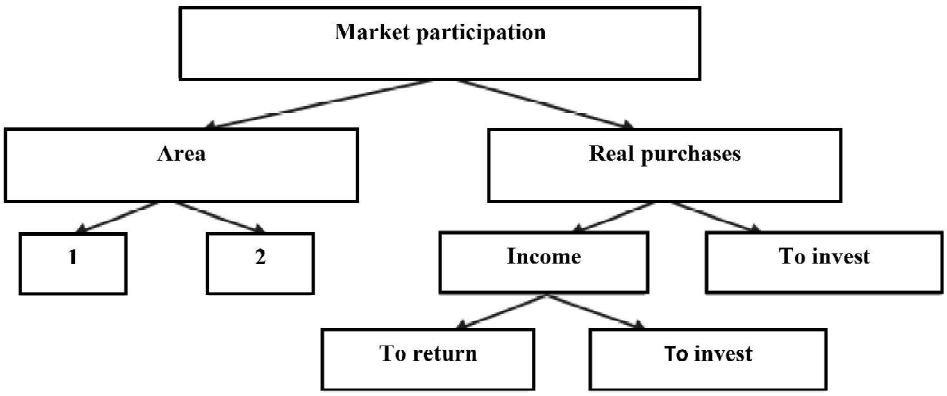


Fig. 1. Decision Tree Decision Option

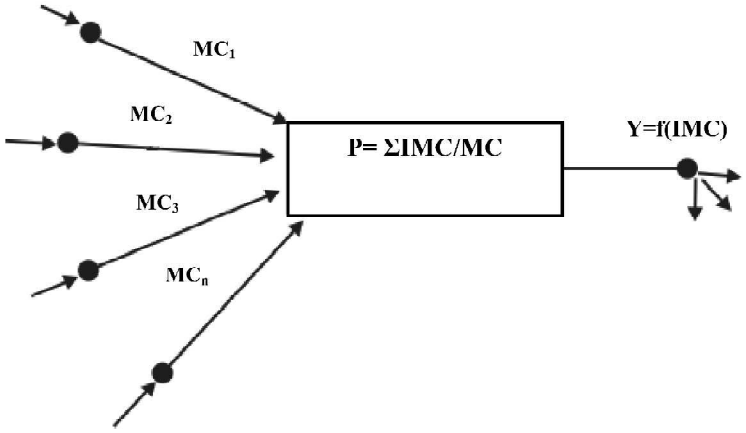


Fig. 2. Flow-chart of a mathematical model of a neuron in the IMC system

Subsystems are designated by a set according to the formula:

$$C = \{C_1, \ldots, C_k\}$$

then:

1. T includes parameters related to one subsystem C_i.
2. T does not include variants, i.e. is an insignificant set.
3. T contains examples of different systems.

The most popular algorithms for creating a "decision tree" are narrow: when one attribute to which the distribution is carried out is mapped, the algorithm does not return to the previous attribute in order to improve the breakdown. Therefore, narrow algorithms do not provide a favorable distribution.

The use of the "decision tree" for planning IMC is problematic in the following cases:

1. Creating an optimal "tree of solutions" involves an NP-complete problem. With many characteristics of consumers, it is impossible to create an optimal tree.
2. Techniques for the formation of the "decision tree" are aimed at retraining, which does not allow the formation of a stable model of conversion of IMC.
3. In reality, you have to work with categorical variables, which limits their use.

The IMC study uses so-called neural network techniques. Their model is a transformation of information and is reflected in Fig. 2 [5, p. 154—175].

The data from the neuron is grouped with the wi criteria for an individual signal x_i, i = 1,..., n, where n is the heterogeneity of the input signal space.

The potential of a neuron is determined by the following formula:

$$P = \sum_{i=1}^{n} w_i x_i$$

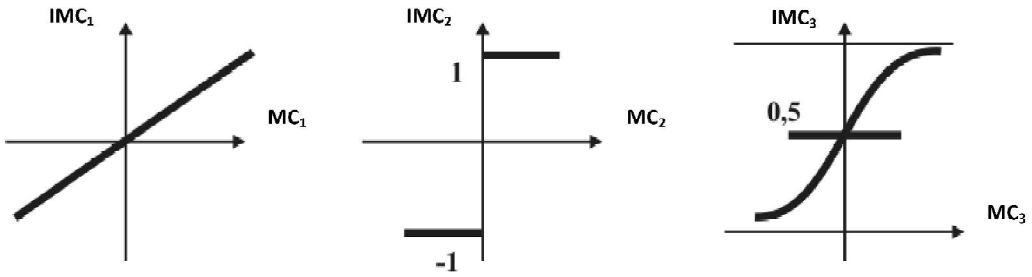
The feeding signal of the neuron is converted using the transfer function f (P). In this case, the type of function f (P) is given in stages, by linear or nonlinear function (see Fig. 3). The limit function gives a signal when it exceeds the limit value. This type of function is difficult to apply in the IMC system, but has a certain application perspective.

The advantage of using a linear function is the ability to differentiate it, which helps to reduce the specific gravity of the output signals of the IMC network. At the same time, a sigmoidal transfer function is often used, which is the relationship between the linear and stepped versions:

$$Y = \frac{1}{1 + e^{-kP}}$$

This function stably simulates the operation of the neuron model. The coefficient k contributes to a sharp transition: the larger it is, the sigmoidal function is closer to the limit, and the smaller it is, the closer it is to the linear. The sigmoidal function is differentiable and, unlike linear and threshold, has no breaks. It seems that this approach is very interesting in the study of IMC.

In solving a specific problem in the IMC system, to create a neural network, you should choose the type of transfer function, its parameters, the number of neurons and the number of stages. In this study on the IMC system, we chose a step function.



a) linear b) stepped c) sigmoidal

Fig. 3. Neuronal transition functions

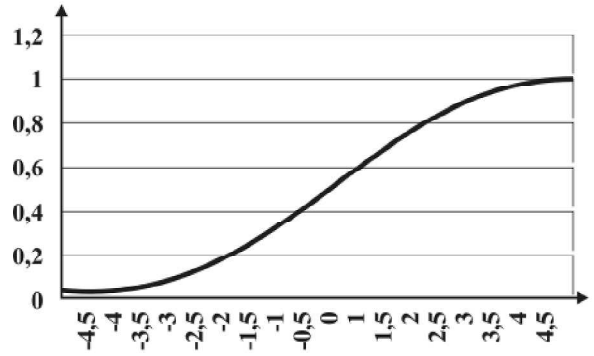


Fig. 4. Logistics curve of IMC

Logistic regressions take a significant place in the IMC research methods, the use of which in the diagnosis of consumer feedback on a marketing offer is more significant, since they contribute to the implementation of binary recall in the form of a continuous function.

Note that any regression model is framed by the following formula:

$$y = F(x_1, x_2, \ldots, x_n)$$

Theoretically, multiple linear regression can be applied to model binary recall. In particular, if the consumer responded to the IMC, then the value of this variable in the learning phase is 1 or 0 (zero). At the same time, the generated regression model will reflect the recall probability value, < 0 and > 1.

The logistic function flowchart reflects the IMC sigmoid shown in Figure 4.

Logistic regression is also represented as a single-layer neural network in which the activation function has a sigmoidal appearance (Fig. 5).

ROC analysis is used to analyze the quality of binary classification. In our studies, an attempt was made to formally reflect this system in the IMC by trade, nutrition, paid services and tourism.

When diagnosing IMC, relative indicators are used:

TPR — specific gravity of positive classifications:

$$TPR = \frac{TP}{TP + FN} \cdot 100\%$$

FPR is the specific gravity of falsely positive classifications:

$$FPR = \frac{FP}{TN + FP} \cdot 100\%$$

Probability of positive outcome in positive classification:

$$PPV = \frac{TP}{TP + FP}$$

Sensitivity — specific gravity of positively classified cases:

$$S_e = TPR = \frac{TP}{TP + FN} \cdot 100\%$$

Specificity is the proportion of negative classifications and negative examples:

$$S_p = \frac{TN}{TN + FP} \cdot 100\%$$

The graph of the ROC curve of the IMC system for trade and nutrition is shown in Fig. 6.

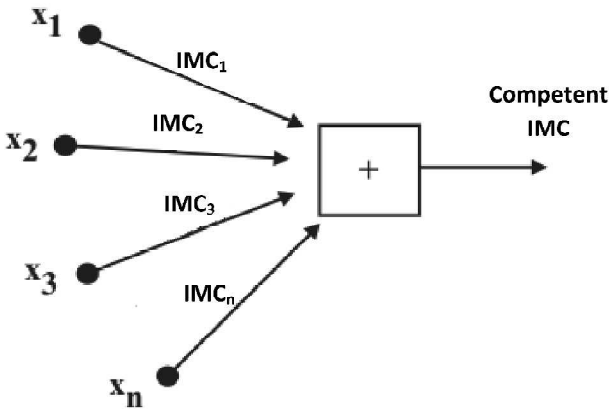


Fig. 5. Logistic regression as a neural network in the IMC system

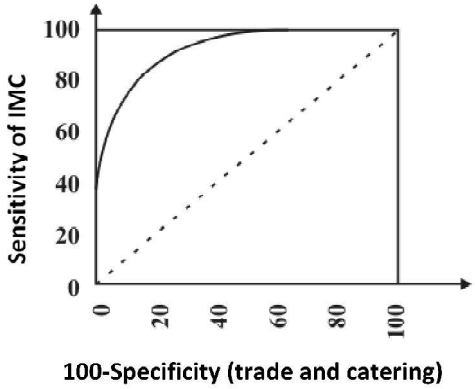


Fig. 6. ROC curve in the IMC system on trade and catering

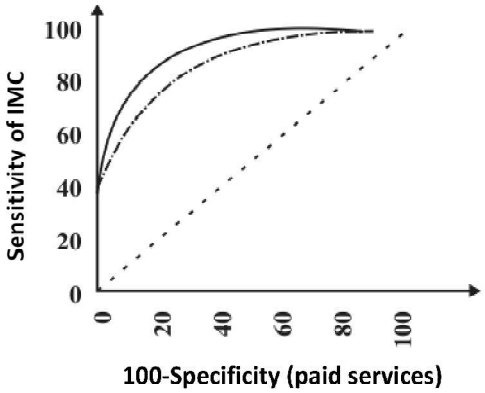


Fig. 7. Comparison of ROC curves of the IMC system for paid services

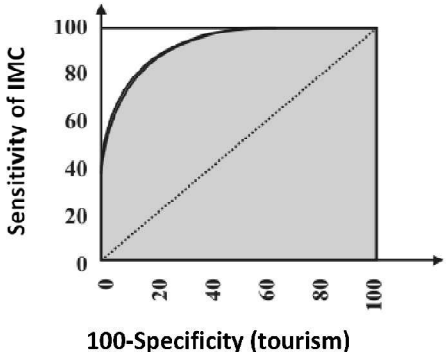


Fig. 8. Area under the ROC curve of the IMC system in tourism

AUC — the area under the graph of ROC curves of IMC systems for paid services and tourism are presented in Figures 7 and 8, respectively.

In practice, many formal criteria are used to select the cut-off limit. In the case of MC analysis, the minimum response probability and maximum sensitivity are set.

Logistic regression, being simpler compared to other types of models, does not always give an accurate result. At the same time, the results are positively interpreted and have a high level of reliability. The value predicted by logistic regression is non-cyclical, therefore, this mechanism seems to be the best for predicting the probability of a binary response in MC and IMC.

CONCLUSIONS

Thus, marketing communications using a mathematical apparatus are able to formalize them in a certain form. For this purpose, it is proposed to use methods such as "decision tree", neural network and ROC analysis. According to the "decision tree" method, in our opinion, you can choose the following options: an option related to a single MC system; a variant of several MC sets; variant from different classes of MC. According to the neural network method, sampling options are possible between linear, stepped and sigmoidal MC. According to the ROC analysis method, options for compiling IMC schedules are possible.

The MC study, based on a mathematical apparatus using decision tree methods, neural network and ROC analysis, yielded results, albeit relatively formalized, but which we believe may be quite useful for the study of IMC. In particular, using the "decision tree" method, a decision-making option was obtained based on the decision tree (the option belongs to one of the systems; a variant of unfamiliar sets; variant from different classes). The use of neural network methods made it possible to develop a flow-chart of a mathematical model of a neuron in the IMC system with the development of the transition of their functions to linear, stepped and sigmoidal. We have chosen a stepped neuron function for the IMC. Based on the ROC analysis method, IMC schedules were compiled in trade, public catering, tourism, and paid services.

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