Targeting Model of HEI Video Marketing based on Classification Tree

Hrystyna Lipyanina [0000-0002-2441-6292], Svitlana Sachenko [0000-0001-8225-1820], Taras Lendyuk [0000-0001-9484-8333], Anatoliy Sachenko [0000-0002-0907-3682]

Ternopil National Economic University, Lvivska Str., 11, Ternopil, 46000, Ukraine
xrustya.com@gmail.com, s_sachenko@yahoo.com, tl@tneu.edu.ua, as@tneu.edu.ua

Abstract: Modernization of higher education and increased competition in the educational services market require new ways of improving the efficiency of higher education institutions (HEI) management. The generalized structure of forming the HEI video marketing strategy is developed and a series of actions for achieving goals is presented. An algorithm for the targeted advertising forming based on classification tree using R language is proposed. The research methodology is described and HEI targeting model is developed employing the classification tree and contextual advertising campaign data on Facebook. The results of the pilot case study are presented, which confirm the practical usefulness of the proposed targeting model, which allows forming target groups.

Keywords: targeting model, targeted advertising, video marketing, classification tree, dendrogram, Higher Education Institution.

1 Introduction

Today, marketing is a necessary attribute of every higher education institution (HEI). The new Law on Higher Education [28] in Ukraine causes changes in the field of education: the competition between HEIs increases, the requirements and values of consumers (target audiences) have changed significantly. All these factors stimulate the need to organize effective HEI marketing advertising activities. Obviously, a similar problem is relevant for the world education system.

In order to promote education services advertising, HEIs must use modern information and communication technologies, integrated into a well-designed and strategically thought-out system.

One such tool is video marketing, which might be an important part of the overall HEI marketing strategy. For example, recent Ericsson data [13, 14] indicate that world mobile Internet users consume more than half of million gigabytes of mobile data in 2020, and about two-thirds of this amount is used to transmit and download video content. Almost 95% of teenagers have access to smart phones, and 45% of them say they are “almost constantly” on the Internet [12]. A Nielson study [1] shows that performance increases by 74% after 15 seconds of video viewing, and the intention to

make a purchase increases by 72% after 10 seconds of viewing. The number of daily video views on Facebook exceeds 4 billion [15].

Let us give you some statistics on how popular video marketing has become in recent years [36]: video is projected to claim more than 80% of all web traffic; adding a video to marketing emails can boost click-through rates by 200-300%; embedding videos in landing pages can increase conversion rates by 80%; 90% of customers report that product videos help them make purchasing decisions; 87% of online marketers are currently using video content in their digital marketing strategies; a single minute of video content is the equivalent of 1.8 million words.

In this regard, we can assume that the development of HEI marketing strategy should be focused on optimizing the work with the brand, effective use of advertising tools and communication elements, including social networks [34], synthesis of innovative marketing concepts in the field of education [27]. Thus, exploring ways to improve video marketing performance is one of the most promising areas in HEI marketing strategy.

2 Related Work

Paper [33] focuses on the growing importance of online marketing, including research of the state of the art through analysis of the data provided by numerous surveys. It also contains brief description of the online marketing itself, basic strategies on the internet nowadays. The study [22] evaluated the main content of YouTube videos of Spanish brands that were included in the 2015 Interbrand rating. There were estimated 900 videos published by 30 Spanish brands belonging to different business sectors.

The authors [2] have patented that video clips are shown to persons who have a high likelihood of video viewing. When one or more viewers of database saw new videoclip, those viewers who have seen the new clip with positive results are compared to others in the database that have not seen it yet.

The authors [3] have proposed a system and method for providing advertisements targeted at media playlists. The method may include obtaining a user's request for a media item, identification of one or more media playlists. Work [4] proposed a system and method for determining promoter and viewer rewards for video promotion and viewing, including a promoter definition based on matching the profile associated with the video. Article [5] investigates combination of anthropogenic annotated features and general video processing techniques to predict the effectiveness of estimates from Youtube ads.

Paper [6] addresses the problem of video ad performance optimizing with smart technologies that improve the advertising relevance to the target audience. A study [7] describes how to compare at first viewers' reactions to skippable video formats and then to non-skippable formats in terms of recall on brand and economic performance.

The results of the study [8] show that in 2019 digital marketing tools were most actively used: artificial intelligence, augmented reality, machine learning, video marketing, chats, virtual assistants. Article [9] shows which groups of Latin American Facebook users were involved in targeted videos of Hillary Clinton's auto-play during

the 2015/2016 primary election season, which elements in those videos best encouraged these people to like the video.

The purpose of [10] is researching video as potential trigger for consumer behavior. Therefore, the authors applied trigger theory and media to learn about enhancing the effectiveness of mobile marketing videos regarding participants' behavioral intentions. The results show that the consumer's position in the information search was the most important factor. The results obtained in [11] indicate that peripheral ways to persuade have a stronger influence on individual information acceptance than central ways. Paper [16] reviews video crowdfunding activities from the leading crowdfunding website and shows that the proposed measures have an explanatory effect on project financing results.

The attention in [17] is focused on empirical targeting models. The paper argues that the general practice of developing such models does not sufficiently take into account the business goals. The results of a comprehensive empirical study confirm that it is recommended significantly more profitable target groups. Article [25] addresses these issues and provides fresh empirical data on video marketing and its role in nowadays business environment. It also provides insights into video marketing trends and opportunities that are considered crucial in the near future.

The work [18] is the first to investigate the long-term effects of entrepreneurial marketing on social media. Using structural equation modeling, the long-term effect of Facebook-based celebrity endorsement among 234 long-wave Facebook fan community members was also explored. The authors of [19] use content analysis to examine topics and formats of 5932 Facebook posts from leading US colleges and universities. Article [20] combines the substantive characteristics of a short video marketing model with the relevant theories of intention to purchase and propose a research model.

Article [21] examines a technology adoption model to assist the inventor of an online video marketing platform in assessing the behavioral intention to use special online video marketing platforms for small and medium-sized businesses. Article [23] examines the problem of social media marketing of user-created instant music videos. A hybrid variable scale clustering algorithm (HVSC) is proposed to analyze user features using text and video content. A study [24] offers critical managerial perceptions of social media marketing on how to use both FGC and UGC in managing the marketing funnel and brand reputation.

Work [26] analyzed the general evolution of this modern advertising type, which conveys sociocultural values and creates school identity, examines different ways of use, norms, and diversity of the images offered by some educational institutions. The study [30] investigates how to enhance geographical targeting by a suite of other targeting strategies, including behavioral targeting, temporal targeting, and use of discount in an online-to-offline commerce context, to form a more comprehensive contextual targeting strategy. However, there is no specification of this study results.

Work [31] proposes a two-step method based on the Gaussian filter and decision tree (M-GFDT). The Gaussian filter corrects the business data distribution in the first stage, and classifies the decision tree. The decision tree is a widespread approach to identifying and visualizing of logical patterns in data. The decision tree construction

algorithm, first proposed by Quinlan [37], operates on the principle of recursive partitioning of the dataset and incremental tree construction [29].

Multifaceted marketing ads include a look-alike model that reads data on user behavior in networks. For example, in [2] it is patented that video clips are shown to people who have a high likelihood of video viewing, but now Facebook is already doing so during an advertising campaign that simplifies the work [32].

It should be noted the above-mentioned work mostly analyzes user actions in response to video marketing. Besides a number of similar works require relatively sophisticated tools for their implementations, that is, the question of simplifying the formation process and, accordingly, making targeted management decisions in the formation of video marketing strategy is still relevant.

In this regard, a goal of this paper is to develop targeting models for HEI video marketing based on the classification tree (dendrogram). Unlike analogues [30, 31], a model of video marketing targeting based on dendrogram allows making changes by dendrogram branches in the advertising campaign strategy by attributes, which the objective function depends on. Moreover, the use of the *rpart library* in the R programming language makes it possible to clean quickly and filter data, which makes it easier to target groups forming compared to [31]. The novelty of the work is the formation of the most favorable (in economic terms) target group for HEI video marketing, which will reduce the advertising campaign cost.

3 Materials and Methods

3.1 Generalized Algorithmic Structure

Based on the authors' experience in targeting the advertising of the admission campaign and recommendations [33-35], a generalized algorithmic structure for forming HEI video marketing strategy was developed (Fig. 1).

In (Block 1), the HEI determines video marketing strategy for computer science (CS) specialty. Block 2 involves evaluation of the state and potential of the existing HEI CS video marketing, and then strategy objectives are specified (Block 3). In Block 4 planning actions take place. It is necessary to take into account the specificity of HEI advertising, when client's behavior is especially important. Strategy quasi-experiment takes place in Block 5 verifying a proposed strategy in some practical case. Next, we need to evaluate the expected efficiency (Block 6) because it is important for budget redistribution. If this evaluation doesn't satisfy then it is necessary to simulate video marketing targeting for the advertising campaign to make changes during the formation of the target group at the planning stage (Block 4).

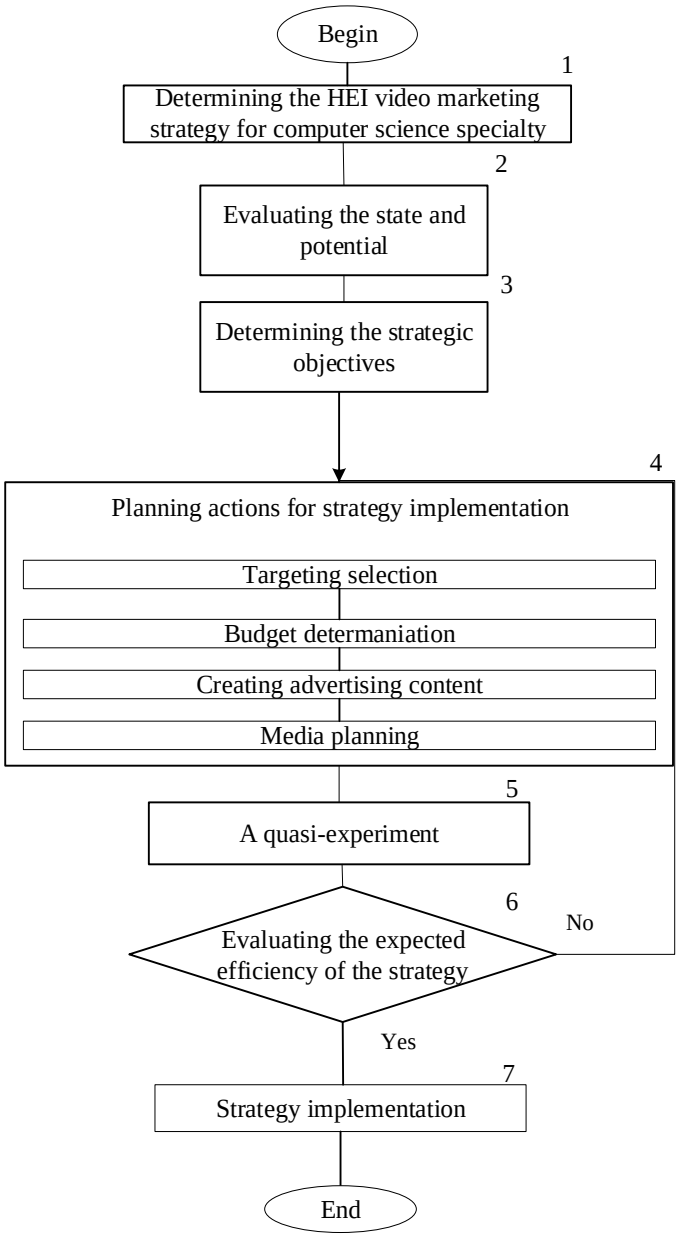

Fig. 1. Generalized algorithmic structure for forming HEI video marketing strategy of computer science specialty

Next, we need to evaluate the efficiency (Block 6) of the expected new video marketing strategy for the computer science specialty, to perform automation at this stage, because it takes a long time to process and is important for budget redistribution.

When evaluating the efficiency of the expected strategy (Block 6), it is necessary to simulate video marketing targeting for the advertising campaign of higher education institutions, which will allow changes to be made during the formation of the target group at the planning stage (Block 4).

3.2 Technique of Experimental Research

Data from Facebook advertising campaign results are used as a basis for the experimental research methodology. As mentioned above, HEI targeted advertising should be focused on customer behavior. Therefore, in the first step of the technique, it is advisable to select the following four targeting options for *Age*, *Sex*, *r*, *Vaverage* (Table 1).

Table 1. Video marketing targeting options for Facebook advertising campaigns

Parameter	Indicator	Description
Age	Age	Age groups: 13-18, 18-25, 25-30, 30-35, 35-40, 40-45, 45-50, 50-55
Sex	Sex	female, male
r	Results	The number of times, when ad has reached a goal-specific result and setting.
Vaverage	Average video watching time	The average video playback time, including the retry time of a single show.

The next step in the technique is to target Facebook video advertising. For this purpose, it is expedient to employ an algorithm for recursive partitioning of a data set and incremental construction of a tree [29, 37]. To assess the quality of the constructed tree T during its optimization, the following set of criteria is used:

- penalty for model cost complexity, which includes a penalty factor for each uncut branch $\mathrm{CC}(T = \sum tDt + \lambda t)$;
- deviation $D0$ for the zero tree (i.e. variability estimation in the original data);
- relative parameter of value complexity $Cp = \lambda / D0$;
- relative learning error for a tree with *t* nodes $RELer = \sum tDt / D0$;
- cross-check error ($CVerCVer$) with a breakdown of 10 blocks, also attributed to the zero-tree deviance D_0; $CVer$, is usually larger than $RELer$;
- standard deviation (S_i) of the cross-check error.

Preferred is a tree consisting of such a number of branches *t* for which the sum ($CVer + SE$) is minimal.

Hence, an algorithm (Fig. 2) was developed based on dichotomous trees [29], implemented in the programming language R.

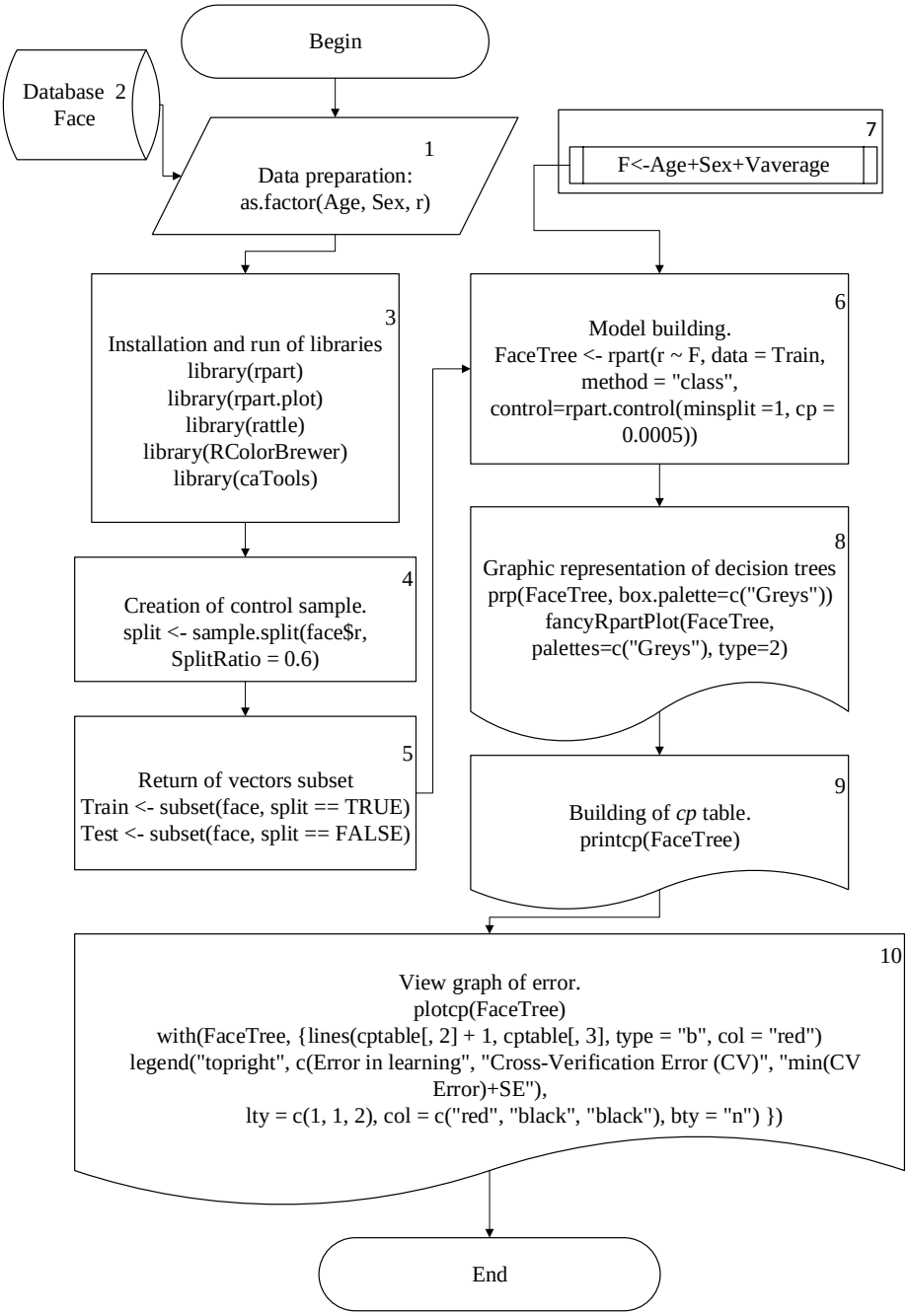

Fig. 2. Algorithm for targeting video marketing based on dendrogram using R language

In block 1, the data must be prepared and cleared for analysis (file with the extension "*.xlsx") (block 2), where the model parameters values are located in columns. Parameters are converted into data with factors value of (*Age*, *Sex* and *r*).

Next, the libraries (Block 3) are run to build the model, control samples (Block 4) are created and the vector *r* data is split into two groups in a predetermined ratio, keeping the relative ratios of different labels in *r*. In addition, a subset (Block 5) of vectors, matrices, or data frames that meet certain conditions are returned. In block 6, a targeting model is constructed based on the recursive partition and regression tree, taking into account the settings (Block 7) and the graphical representation of the dendrogram (Block 8). Block 9 builds a *cp* table based on the tree Complexity Parameter, and block 10 maps the model errors, details of which are described below in Section 3.3.

3.3 Experimental Results and Discussion

For implementation of the algorithm and the program (see Fig. 2) on the example of the admission campaign for "Computer Science specialty" of Ternopil National Economic University (Fig. 3) more than a thousand of indicators of advertising campaign on Facebook according to the parameters (see a Table 1) were used.

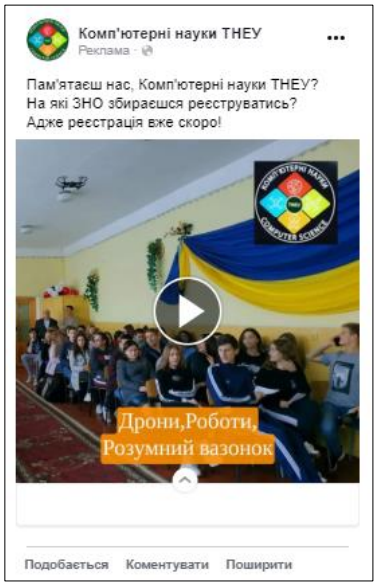

Fig. 3. Targeted Computer Science advertising at Ternopil National Economic University on Facebook

The resulting model of targeting based on dendrogram is presented in Fig. 4 and a graphical representation of the model error is in Fig. 5. As it can be seen in Fig. 4 most videos were viewed by male clients in the age of 18-25, 35-55.

The ordinate axis (see Fig. 5) shows the X-val Relative Error and the abscissa axis parameter of the complexity of the tree *cp*, which starts from the lower boundary point (inf). Size of tree is determined by the number of branches 1… 9. As it can be seen in Fig. 5, starting from branch 7 of the tree the result is stabilized and the subsequent addition of branches has little effect on the tree learning error.

The calculations showed that the parameter of the tree complexity, with a minimum of relative error (min (SV error) + SE) at cross-checking is determined by the value of *cp* = 0.0033 between branches 7 and 8 (see Fig. 5), where SV is Cross Validated and SE – Standard Error for cross validation error.

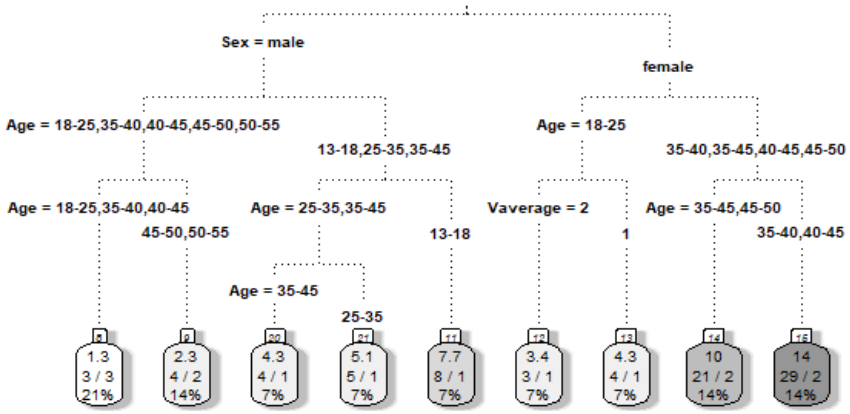

Fig. 4. Targeting tree-based model for HEI solutions

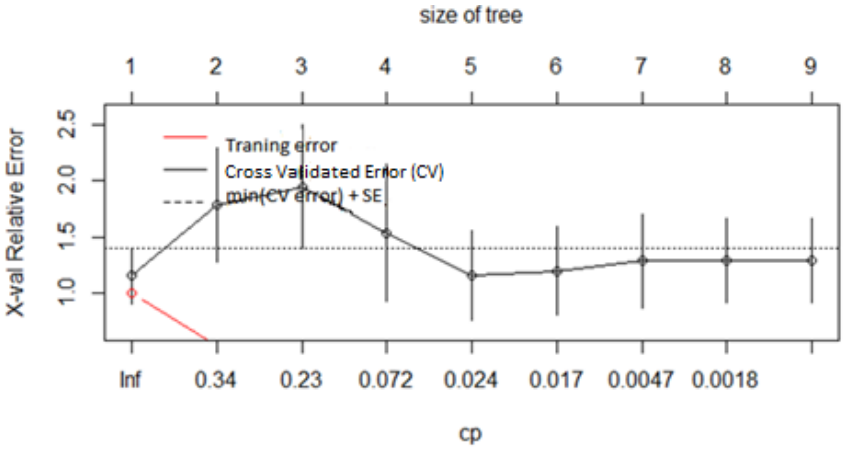

Fig. 5. Error graphical representation of the targeting model based on dendrogram

To check the modeling results based on dendrogram (see Figs. 4, 5), a repeated simulation of targeted advertising was conducted, where we select the following target group for the ad: male in the age group 18-25, 35-55. As can be seen from the results of the re-simulation (Fig. 6), the conversion cost for video ads decreased from $ 0.99 to $ 0.08 as of July 13, 2019 (with 113 conversions), which is about 24% better than the first ad variant campaigns.

Fig. 6. The results of the re-simulation on Facebook

Let's keep in mind that the average of an ad is click-through rate – *CTR* increased from 2.78 to 3.4.

Unlike analogues [30, 31], the Targeted advertising model, based on dendrogram, allows the tree branches making changes in the advertising campaign strategy for the attributes, which the target function depends on. Moreover, the use of rpart library in the R programming language makes it possible to quickly clean and filter data, which simplifies the formation of target groups compared to [31].

4 Conclusions

A generalized algorithmic structure for HEI video marketing strategy forming is proposed, which is focused on Targeted Advertising, to improve the effectiveness of the admission campaign.

A targeting model based on dendrogram and target group allocation has been developed, which allows using tree branches to make changes in advertising campaign strategy based on the attributes dependent on the target function. Moreover, the proposed targeting model makes it possible to quickly clean and filter data, which simplifies targeting.

The results of the experimental research conducted on the example of HEI admission campaign for computing major confirmed the effectiveness of the developed targeting model, which is of practical importance in the formation of the Targeted Advertising budget, as part of the formation of video marketing strategy.

References

1. The Nielsen Company (US), LLC – https://www.nielsen.com/
2. Lopatecki, J., Rose, A., Hughes, J., & Wilson, B.: U.S. Patent No. 9,612,995. Washington, DC: U.S. Patent and Trademark Office. (2017).
3. Strobl, R., & Constantin, R.: U.S. Patent Application No. 13/463,673. (2018).
4. Nusbaum, M. J.: U.S. Patent No. 9,313,549. Washington, DC: U.S. Patent and Trademark Office. (2016).
5. Hahn, J., & Kovashka, A.: Measuring Effectiveness of Video Advertisements. arXiv preprint arXiv:1901.07366. (2019).
6. Stalidis, G.: A knowledge engineering framework for intelligent targeting of online video advertisements. International Journal of Technology Marketing. 13(2):1. (2019). DOI: 10.1504/IJTMKT.2019.10021177.
7. Belanche, D., Flavián, C., & Pérez-Rueda, A.: Brand recall of skippable vs non-skippable ads in YouTube. Online Information Review. (2020). DOI: 10.1108/OIR-01-2019-0035.
8. Kotane, I., Znotina, D., Hushko, D.: Assessment of trends in the application of digital marketing. Scientific Journal of Polonia University. 33(2): 28-35 (2019).
9. Elder, E., Phillips, J. B.: Appeals to the Hispanic demographic: Targeting through Facebook autoplay videos by the Clinton campaign during the 2015/2016 presidential primaries. Journal of Political Marketing. (2017). Doi:10.1080/15377857.2017.1377140
10. Alamäki, A., Pesonen, J., Dirin, A.: Triggering effects of mobile video marketing in nature tourism: Media richness perspective. Information Processing & Management. 56(3): 756–770 (2019). doi:10.1016/j.ipm.2019.01.003
11. John, S. P., & De'Villiers, R.: Elaboration of marketing communication through visual media: An empirical analysis. Journal of Retailing and Consumer Services. (54) 102052 (2020). DOI:10.1016/j.jretconser.2020.102052
12. Anderson, M., & Jiang, J.: Teens, social media & technology 2018. Pew Research Center. (31) 2018. https://www.pewresearch.org/internet/2018/05/31/teens-social-media-technology-2018/
13. DIGITAL 2020: Global Digital Overview. – https://datareportal.com/reports/digital-2020-global-digital-overview
14. Telefonaktiebolaget LM Ericsson – https://www.ericsson.com/en/mobility-report/mobility-visualizer?f=8&ft=2&r=1&t=11,12,13,14,15,16,17&s=4&u=3&y=2015,2025&c=1
15. Statista – https://www.statista.com/statistics/205352/digital-advertising-revenue-of-leading-online-companies/
16. Li, X., Shi, M., & Wang, X. S.: Video mining: Measuring visual information using automatic methods. International Journal of Research in Marketing. 36(2): 216-231 (2019).
17. Lessmann, S., Haupt, J., Coussement, K., & De Bock, K. W.: Targeting customers for profit: An ensemble learning framework to support marketing decision-making. Information Sciences. in press (2020). https://doi.org/10.1016/j.ins.2019.05.027.
18. Fink, M., Koller, M., Gartner, J., Floh, A., & Harms, R.: Effective entrepreneurial marketing on Facebook–A longitudinal study. Journal of business research. in press. (2018).
19. Peruta, A., & Shields, A. B.: Marketing your university on social media: a content analysis of Facebook post types and formats. Journal of Marketing for Higher Education. 28(2): 175-191 (2018).
20. Xiao, Y., Wang, L., & Wang, P.: Research on the influence of content features of short video marketing on consumer purchase intentions. In: Proceedings of the 4th International Conference on Modern Management, Education Technology and Social Science (MMETSS 2019). Atlantis Press. pp. 415-422 (2019).

21. Olowolayemo A., Saleh N., Adewale N.T., Shatar F.: Exploring attitude toward online video marketing in Malaysia. In: Saian R., Abbas M. (eds) Proceedings of the Second International Conference on the Future of ASEAN (ICoFA) 2017, volume 2. Springer, Singapore. pp. 341-350 (2018).
22. Costa-Sánchez, C.: Online video marketing strategies. Typology according to business sectors. Communication & Society. 30(1): 17-38 (2017).
23. Wang, A., Gao, X.: Hybrid variable-scale clustering method for social media marketing on user generated instant music video Tehnički vjesnik. 26(3): 771-777 (2019). https://doi.org/10.17559/TV-20190314152108
24. Colicev, A., Kumar, A., & O'Connor, P.: Modeling the relationship between firm and user generated content and the stages of the marketing funnel. International Journal of Research in Marketing. 36(1): 100-116 (2019).
25. Sedej, T.: The role of video marketing in the modern business environment: a view of top management of SMEs. J. for International Business and Entrepreneurship Development. 12(1): 37-48 (2019). Doi:10.1504/jibed.2019.103388
26. Viñao, A., & Ruiz-Funes, M. J. M.: Advertising, marketing and image: Visual representations and school modernity through postcards. Sisyphus: Journal of Education IV, (1): 42-66 (2016).
27. Yeveitseva O. S., Novikov D. V.: Features of development of marketing strategy of higher education institution. Economy and the State. 3: 77-79 (2017). (in Ukrainian)
28. Law of Ukraine "About higher education". no. 1556-VII (2020). (in Ukrainian)
29. Breiman, L., Friedman, J. H., Olshen, R. A., Stone, C. J.: Classification and regression trees. Monterey, CA: Wadsworth & Brooks/Cole Advanced Books & Software. (1984). ISBN 978-0-412-04841-8.
30. Lian, S., Cha, T., & Xu, Y.: Enhancing geotargeting with temporal targeting, behavioral targeting and promotion for comprehensive contextual targeting. Decision Support Systems. (117): 28-37 (2019).
31. Wang, H., & Hong, M.: Online ad effectiveness evaluation with a two-stage method using a Gaussian filter and decision tree approach. Electronic Commerce Research and Applications. (35): 100852 (2019). DOI:10.1016/j.elerap.2019.100852.
32. Facebook for Business – https://business.facebook.com/business/help
33. Schwarzl, S., & Grabowska, M.: Online marketing strategies: the future is here. Journal of International Studies. 8(2): 187-196 (2015).
34. Bomba, A., Kunanets, N., Pasichnyk, V., & Turbal, Y.: Process modeling of message distribution in social networks based on socio-communicative solitons. International Journal of Computing. 17(4): 250-259 (2018).
35. 5 Steps to Develop a Video Marketing Strategy on a Startup Budget – https://digitalmarketinginstitute.com/blog/5-steps-to-developing-a-video-marketing-strategy-on-a-startup-budget
36. https://www.forbes.com/sites/forbesagencycouncil/2017/02/03/video-marketing-the-future-of-content-marketing/#505b54546b53
37. Quinlan, J. R. Decision trees as probabilistic classifiers. In: Proceedings of the Fourth International Workshop on Machine Learning. pp. 31-37 (1987).