DATA ENVELOPMENT ANALYSIS – A KEY TO THE MUSEUMS' 'SECRET CHAMBER' OF MARKETING?

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ABSTRACT:
Intensive financial investments in marketing communication of museums are connected, in parallel, to their visual presentation as well as to strengthening the communication efficiency toward public. However, the unresolved question remains whether these finances are spent effectively or rather whether the communication strategy plan attracts the adequate target audience. How many visitors did react to a given campaign? Unfortunately, there is no single and definite answer on how to measure the efficiency of marketing communication in museums. The aim of the study is to use the Data Envelopment Analysis method to introduce a model for helpful assessment of the marketing communication efficiency within museums. While searching for the solution, we were inspired by the production economics, from which we chose the statistical method of Data Envelopment Analysis. This allowed us to evaluate the efficiency of production units and also to identify inefficiencies. In the public and non-profit sector, this methodological approach appears very rarely, and according to our findings, it has not been applied yet in the museum sphere in Slovakia.

KEY WORDS:
data envelopment analysis, effectiveness, marketing communication, museum

Introduction

Efficiency is very often spelled out in the sectoral spheres of human activity as it relates to *"the most effective use of economic resources to meet the needs of the population"*.[1] As this expression is given in terms of resources, inputs and outputs,[2] it has been often predominant in sectors that are provided and financed from the public sources.[3] According to Webster, *"effective marketing requires managers to have adequate information and appropriately sourced resources in the product planning markets"*.[4] Kotler, one of the first

1   VYBÍHAL, V., CEDIDLOVÁ, M.: *Fiscal Effectiveness of Investment Incentives and Competition.* Vilnius : Versus Aureus Publishers, 2014, p. 11-12.
2   IMROVIČ, M., ŠVIKRUHA, M.: Source Aspects in the Reform of Local Self-Government in the Slovak Republic. In *Scientific Papers of the University of Pardubice, Series D*, 2015, Vol. 12, No. 3, p. 34-45.
3   NWOKAH, G., AHIAUZU, A. I.: Emotional Intelligence and Marketing Effectiveness. In *Marketing Intelligence & Planning*, 2009, Vol. 27, No. 7, p. 864-881.
4   WEBSTER, C.: Marketing Culture and Marketing Effectiveness in Service Firms. In *Journal of Service Marketing*, 1995, Vol. 9, No. 2, p. 8.

authors to discuss marketing efficiency, claims the first requirement of effective marketing is to recognise key leaders in the knowledge of the market, choosing the best market segments that can serve and prepare to offer consumers better quality in terms of their needs and requirements.[5]

Likert emphasises that leadership and all processes within an organisation must be aimed to ensure a maximum probability that in all interactions and all relationships with the organisation each member will view the experience as supportive.[6] And one of them is also the area of cultural heritage where we find museums and monuments.

The main product of these cultural industry cathedrals is the preservation of the assigned cultural heritage, while *"most of the services provided are therefore public services"*.[7]According to Webster, the added value of marketing efficiency is also significant for museums – it allows them to manage the draft budget for the potential sale of cultural products, monitor the satisfaction of a cultural viewer through questionnaires and evaluate the cost-effectiveness of various expenditures.[8]

It can be said, therefore, that museums as public facilities are financed through society and under the 'umbrella of the public'. From this reason, they report a number of results on the effectiveness of their management each year. However, even in a single statistic report, there is no measure of effectiveness within the analysed items of marketing communication.[9] Why? The answer to this question can be summarised in the following points, which we can define as the reasons for 'the neglect' of measuring the effectiveness of marketing communication tools:

1. Ignorance of the concept of efficiency expressed by museum staff. This issue is based on the level of socio-human or natural education of employees, which results in the absence of marketing knowledge and skills in the personnel composition of the organisation.
2. Employee initiative. This point is directly related to funding of museums which is reflected in the lack of staff ratings. Given this factor, people working in the museum sector do not find their own engagement in favour of their 'breadwinner'. To put it simply, the amount on the payroll does not motivate them to look for other ways to get the museum they work for closer to the visitor.
3. Aging of the management staff. Due to the skewed principles respected by many museum leaders, modern marketing practices are difficult to apply to these organisations. None of the competent managers require information on the effectiveness of media in practice from marketing staff, because, at least in the Slovak museum environment, any activity of a monumental object is evaluated through the 'guaranteed success recipe' of the statistics associated with the visitors.
4. One of the most important arguments for not monitoring the effectiveness of communication is the fact that no one has yet developed a 100% guaranteed system, model or methodology to measure the effectiveness of marketing communication tools, whether in the public sector, commercial or non-profit sphere. This factor can be described as the most serious reason for 'blocking' the assessment of marketing communication tools in the third-sector regulation of society life. The issue of communication indicators remains still unresolved for museums, and there are many questions that need to be answered correctly.

Based on the above-mentioned points, the aim of the research study is to introduce a model for helpful assessment of the marketing communication efficiency within museums using the Data Envelopment Analysis. Our main goal is to create a simple tool for analysing communication campaigns that would allow museum employees to monitor the effectiveness of individual marketing communication tools. One of the best inspirations for its operation is the method of analysis of relatively robust data – DEA (Data Envelopment Analysis).

5   KOTLER, P.: From Sales Obsession to Marketing Effectiveness. In *Harvard Business Review,* 1977, Vol. 55, No. 6, p. 67-75.
6   See: LIKERT, R.: *New Patterns of Management*. Michigan : McGraw-Hill, 1961.
7   BUTORACOVÁ ŠINDLERYOVÁ, I., BENKOVÁ, E.: The Theory of City Marketing Conception and Its Dominance in the Tourism Regional Development. In *HOTELlink: Časopis za hotelijerstvo, restoraterstvo i gastronomiju*, 2009, Vol. 10, No. 13-14, p. 390.
8   WEBSTER, C.: Marketing Culture and Marketing Effectiveness in Service Firms. In *Journal of Service Marketing*, 1995, Vol. 9, No. 2, p. 6-21.
9   LUKÁČ, M.: *Koniec neefektívnej marketingovej komunikácie v múzeách*. Trnava : OZ FSV UCM, 2015, p. 113-115.

Measuring Marketing Efficiency: Overview of Relevant Works

The issue of measuring the effectiveness of marketing communication tools in the museum sphere is currently widely discussed, but only in terms of theoretical considerations. From a practical point of view, however, this process is not solved at all; the main problem is the lack of procedures and methods that would allow systematic measurement of the effectiveness of communication activities related to monumental objects. In the Slovak museum environment, this topic is still only passionately discussed; nevertheless, without any specific practical outputs.

The analysis of the issue of measuring the efficiency of marketing communication is generally related to the international paradigm focused on by many authors whose publications can be included in the marketing theory and marketing communication.[10] In their works, the authors present in particular an evaluation of the effectiveness of advertising.[11] Measuring the efficiency of advertising is also discussed by Vybíral or Vysekalová, particularly from a psychological point of view.[12] The measurement of the effectiveness of Public Relations within the public relations theory is reflected, for example, in the works of Bajčan, Caywood, MacNamara, Evans or Weber.[13]

In the foreign museum environment, the question of the method for measuring the effectiveness of communication is in the stage of development and processing. This topic is being discussed not only on the academic grounds, but also in advertising agencies. 'The first swallow to make a summer' of systemic measurement of the effectiveness of marketing communication for museums is the model proposed by Kotler and Scheff. It is precisely this model that can become a reflection bridge or gentle inspiration even for Slovak monumental objects and at least partially improve the present unfavourable state within Slovak academic and non-academic discussions on related topics. Kotler and Scheff propose to measure the effectiveness of marketing communication according to the procedures used in the profit sector, taking into account the artistic specifics of museums. Measurement should be done at three levels, as follows:

*   Regular evaluation, i.e. performance evaluation on a daily, weekly, monthly or quarterly basis;
*   Interim evaluation, usually annual;
*   Long-term evaluation, which would be carried out every three to five years.[14]

The authors also proposed to use the "management by objectives" concept which consists of determining the communication goals that the museum wants to achieve in the given period. It can be, for example, attracting a new professional audience, increasing attendance or enhancing the degree of recognition of the museum brand. In particular, the management of this institution should be involved in this process; not only to set these goals, but also to control their fulfilment. Ratings cannot be implemented with a plain statement that the set goals have been achieved. In particular, it is necessary to determine how the results will be measured.

10   For example: ALSBURY, A., ROS, J.: *Marketing: To nejlepší z praxe*. Praha : Computer Press, 2002; HANKOVÁ, J.: *Jak měřit efektivitu*. [online]. [2017-12-20]. Available at: <http://www.strategie.cz/ scripts/detail.php?id=13581>; OLSON, J., CURRIE, R.: *Evaluating a Post-Buy Analysis*. New York : American Marketing Association, 2004; PAVLŮ, D. et al.: *Marketingové komunikace a výzkum*. Zlín : Professional Publishing, 2006; KOTLER, P., ARMSTRONG, K. L.: *Marketing Management*. Praha : Grada, 2007.
11   See: PELSMACKER, P.: *Marketingová komunikace*. Praha : Grada, 2007; CLOW, K. E., BAACK, D.: *Reklama, propagace a marketingová komunikace*. Brno : Computer Press, 2008; VRABKOVÁ, I., VAŇKOVÁ, I.: *Evaluation Models of Efficiency and Quality of Bed Care in Hospitals*. Ostrava : VŠB – Technická univerzita Ostrava, 2015.
12   For more information, see: VYBÍRAL, Z.: *Psychologie lidské komunikace*. Praha : Portál, 2000; VYSEKALOVÁ, J.: *Psychologie reklamy*. Praha : Grada, 2007.
13   See: BAJČAN, R.: *Techniky Public Relations aneb jak pracovat s médií*. Praha : Management Press, 2003; CAYWOOD, C. L.: *Public Relations*. Brno : Computer Press, 2003; EVANS, D.: *Social Media Marketing an Hour a Day*. Indianapolis : Wiley Publishing, 2008; MACNAMARA, J. R.: *Research in Public Relations – A Review of the Use Evaluation and Formative Research*. [online]. [2017-10-16]. Available at: <http://www.skoola.com/Files_books/research-in-public-relations.pdf>; WEBER, L.: *Marketing to the Social Web*. Hoboken : Wiley Publishing, 2009.
14   KOTLER, P., SCHEFF, J.: *Standing Room Only – Strategies for Marketing the Performing Arts*. Boston : Harvard Business School Press, 2007, p. 456.

The evaluation should be more comprehensive and should include a retrospective assessment of the methods, tactics and strategies applying the impact and the means used to meet the defined objectives.

Obviously, there is no academic research in Slovakia dealing with the topic of measuring the efficiency of marketing communication tools applied in the cultural sphere. However, this problem is mentioned in Tajtáková's publication *Culture Marketing*,[15] albeit just within three sentences associated with defining the effectiveness of communication in relation to marketing mix and the product. It should also be taken into account that the book by Tajtáková is the only Slovak scholarly information resource that provides a theoretical concept of marketing of cultural institutions. A slightly better situation is in the commercial sphere where multiple authors are putting forward the issue of measuring the effectiveness of marketing communication.[16] Their works can be included in the theory of marketing and marketing communication. These publications mostly focus on evaluating the effectiveness of a single marketing communication tool (ads), providing basic definitions of advertising effectiveness and presenting the methods and ways of detecting the effectiveness of an advertising campaign. A similar approach is also adopted in the work of Hradiská[17] who treats this issue from the viewpoint of advertising psychology. We note that no Slovak author has introduced a comprehensively elaborated methodology for evaluating the effectiveness of each marketing communication tool. In the area of consulting services, only some marketing and PR agencies offer solutions to measure the efficiency of advertising and Public Relations. These services are especially useful to the commercial sector.

Data Envelopment Analysis: Major Approaches

Data Envelopment Analysis is a statistical method for measuring efficiency using linear programming tools. The early DEA models are associated with the authors Debreu[18] and Koopmans.[19] While the latter one formulated the earliest definition of effectiveness, it was Farrell's suggestion that had proposed models for evaluating the effectiveness rate in 1957. Debreu and Farrell argued that lack of marketing power on managers may cause severe inefficiencies among the companies and provided services.[20] The Farrell's models consisted of the calculation of the linear convex wrapping curve and the use of spacing functions to measure the distance of the organisation from the projected point to the effective curve. To put it simply, the whole process was based on measuring the ability of an organisation to transform its inputs into outputs. Furthermore, Charnes, Cooper and Rhodes,[21] followed by Banker, Charnes and Cooper,[22] expanded Farrell's ideas for measuring the efficiency of single-entry and one-time outputs. That is why we currently recognise two major types of DEA analysis: CCR approach and BCC approach.

The advantage of DEA measurements is the fact that a whole set of units (according to the selected model type) designates a unit as effective or inefficient. In the latter case, it identifies the source of inefficiency while determining how the unit can achieve the efficiency threshold by increasing or decreasing inputs or outputs. What is more, this method can identify for its ineffective unit its 'exemplary example', which can be an efficient unit with a similar combination of inputs and outputs. Another advantage of DEA can be considered to be the use of software task solutions through software systems, such as Frontier Analyst, DEA Solver Pro or OnFront. They are focused specifically on data envelopment analysis and are user-friendly. The major theoretical approach of DEA models is the fact that each problem can be set out within a matrix of permissible solutions. They represent all possible combinations of inputs and outputs. This set of permissible solutions is defined by the effective frontier. If feasible combinations of inputs and outputs of the unit in question lie at the effective frontier, then it is an efficient unit. Under the efficient unit, we can understand the one "*for which there is no other reality that would achieve the same output by using a smaller number of inputs, or would achieve greater outputs using the same amount of inputs*".[23] If the unit is not efficient (i.e. it is not at the frontier of production options), it is necessary to adjust the size of its inputs or outputs. To solve the problem of how to reduce inputs or how to increase outputs, we can find a response in the data envelopment analysis method.

In specific situations, it is often necessary to consider multiple inputs and outputs. For this reason, a weights system is used for such a grouping. We designate a set of homogeneous units as U1, U2, ..., Un. Each unit produces r outputs and consumes m inputs. Then we denote X = {xij, i = 1, 2, ..., m; j = 1, 2, ..., n} as the input matrix and Y = {yij, i = 1, 2, ..., r; J = 1, 2, ..., n} as the output matrix. Inputs and outputs of the Uq unit contain the q-th line of matrices Xq and Yq. We can generally express the measure of effectiveness of this unit as:

$$\text{Efficiency} = \frac{\text{outputs}}{\text{inputs}} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}} = \frac{\sum_i u_i y_{iq}}{\sum_j v_j x_{jq}}, \qquad (1.1)$$

where vj = 1, 2, ..., m are the weights assigned to the j-th of the input and ui, i = 1, 2, ..., r are the weights assigned to the i-th output.

The DEA analysis therefore consists in maximising the effectiveness of the Uq unit (1.1). However, only with the condition that the efficiency of all other units in a given set cannot be bigger than 1 (or 100%). The input and output weights must also be bigger than zero. This is so that all the considered characteristics are included in the model.

DEA Models in the Museum Sphere

The beginnings of DEA models in the non-profit sphere can be found in the 1950s, because this linear programming method was originally developed to assess the effectiveness of management and planning of public non-profit institutions (such as schools). As one of the founding 'fathers' of DEA models argued in his work, the need for better methods development as well as better methods of productivity evaluation had been desirable.[24] In his words, the problem solution tended to produce careful measurements and outputs while being restrictive because they failed to combine the weights of multiple inputs into single satisfactory overall measure of efficiency.[25]

The theory of DEA analysis has gradually become well-known and has been used in various modifications to the present day.[26] For example, its application has expanded to the health sector, when the first use of DEA analysis in this sphere occurred in the early eighties thanks to Sherman.[27] He used it to analyse the effectiveness of medical staff. Based on the results obtained from DEA applications in healthcare facilities, it has emerged that data envelopment analysis as a tool for quantifying effectiveness can be applied to other areas. This method can be used not only in assessing the effectiveness of business entities but can also be beneficial either for the analysis of efficiency in the public sector or in conjunction with increasing the efficiency of the

15   TAJTÁKOVÁ, M.: *Marketing kultúry*. Bratislava : Ekonóm, 2006.
16   For example: LABSKÁ, H. et al.: *Marketingová komunikácia*. Bratislava : EKONÓM, 1994; KRETTER, A. et al.: *Marketing*. Nitra : SPU Nitra, 2004; KITA, J. et al.: *Marketing*. Bratislava : Iura Edition, 2005; ŠTUBŇA, P.: *Ekonomika pre tlmočníkov z/do taliančiny*. Bratislava : Z-F LINGUA, 2018.
17   HRADISKÁ, E.: *Psychológia a reklama*. Bratislava : ELITA, 1998.
18   DEBREU, G.: The Coefficient of Resource Utilization. In *Econometrica*, 1951, Vol. 19, No. 3, p. 273-292.
19   KOOPMANS, T.: *Activity Analysis of Production and Allocation*. New York : John Wiley & Sons, 1951.
20   FARRELL, M. J.: The Measurement of Production Efficiency. In *Journal of Royal Statistical Society*, 1957, Vol. 120, No. 3, p. 253-290.
21   CHARNES, A., COOPER, W. W., RHODES, E.: Measuring the Efficiency of DMUs. In *European Journal of Operational Research*, 1978, Vol. 2, No. 6, p. 429-444.
22   BANKER, R. D., CHARNES, A., COOPER, W. W.: Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. In *Management Science*, 1984, Vol. 30, No. 9, p. 1078-1092.
23   DLOUHÝ, M., JABLONSKÝ, J., NOVOSÁDOVÁ, I.: Využití analýzy obalu dat pro hodnocení efektivnosti českých nemocnic. In *Politická ekonomie*, 2007, Vol. 11, No. 1, p. 60-71.
24   FARRELL, M. J.: The Measurement of Production Efficiency. In *Journal of Royal Statistical Society*, 1957, Vol. 120, No. 3, p. 253-290.
25   COOPER, W. W., SEIFORD, L. M., ZHU, J.: Data Envelopment Analysis: History, Models, and Interpretations. In COOPER, W., SEIFORD, L. (eds.): *Handbook on Data Envelopment Analysis. International Series in Operations Research & Management Science*, Vol. 164. Boston : Springer, 2011, p. 1-39.
26   HORVÁTH, P., ŠEBÍK, K.: Voting Behavior and Municipal Elections 2014 in Slovakia. In *Slovak Journal of Political Science*, 2015, Vol. 15, No. 2, p. 93-113.
27   SHERMAN, H. D.: Hospital Efficiency Measurement and Evaluation. Empirical Test of a New Technique. In *Medical Care*, 1984, Vol. 22, No. 10, p. 922-938.

public services provided.[28] As the museum sphere belongs to the public sector, we have decided to apply this method to measure the effectiveness of the museums' marketing communication. In Slovakia, we have not been aware yet of the fact that DEA analysis was already applied to the investigation of the effectiveness of the communication of monumental objects. We are convinced that DEA analysis may become an added value in a methodological approach to measuring the effectiveness of individual marketing communication tools in the museum sphere.[29] So how does an algorithm look like which should result in a properly designed model and a reasonably constructed analysis? This long-awaited 'museum guide to use' could be divided into seven steps (marked with letters A-G) that follow and overlap each other.

A.   Problem Identification/Formulation

It is customary that any professional or scientific study begins with the formulation of a real-life problem, e.g. by defining questions. One of such questions in museums may be: *How to measure the effectiveness of marketing communication?* It is also important to realise that the effectiveness of marketing communication related to monumental objects is influenced by various factors. Therefore, in the first step of the proposed model, it is necessary to:

1. **Identify a set of factors –** this set can affect the ability of responsible employees to work with new technologies in marketing communication, the structure of the communication mix and the finances allocated to marketing communication.
2. **Perform factor selection** – this category includes:
   - external factors – we can characterise them as unpredictable – weather, competitive events in the region, legislative measures of the founder of the museum, etc.,
   - internal factors – e.g. the amount of money spent on museum marketing, the level of marketing communication, the quality of staff, the target audiences. Basics of this data can become the annual museum reports.
3. **Conduct an analysis of factors** – analysis of visitors' satisfaction, analysis of strengths and weaknesses of communication.

B.   Determination of Targets for Measuring the Effectiveness

At this point it is necessary to be fully aware of which forms of marketing communication we want to measure: whether all the techniques used or only those for which the largest volumes of funds are spent.

C.   Model Selection

In the third step, it is necessary to decide what type of model we will choose to measure the effectiveness of marketing communication. We have two types of models to choose from in the DEA analysis: BCC and CCR approach to outputs or BCC and CCR approach to inputs. Since we regard the input costs as communication costs and output data, considering the number of visitors affected by communication activities as well as the measurement of the effectiveness of marketing communication, we clearly find it appropriate to use the BCC and CCR approach to inputs. Our main goal is to find out how the forms of marketing communication have affected the museum's traffic and not the other way around.

D.   Input Data

In the next phase, input data is added to the selected statistical program (in this case SAS statistical software). We obtain the input data from the following questions and items:

- How often was the analysed marketing communication technique used in the monitored period?
- What amount of funds was spent on the analysed marketing communication technique during the monitored period?
- How many people (person-hours) were needed during the period under review to analyse the marketing communication technique?

What, however, may be a problem at this step is the lack of skills and knowledge of marketing staffers to work with the statistical programme. In such a case, it is not possible to continue with the fifth step.

E.   Data Evaluation

In this step, the statistical programme processes the input data from which it calculates the original and target value of the inputs. Besides, we will get the value of the effectiveness of the different forms of marketing communication.

F.   Results Interpretation

The undisputed contribution of DEA models in the museum sphere is their connection to practice, and the results achieved should therefore not be left only in theoretical perspective.

G.   Suggestions to Optimize Communication

Based on the obtained results, museums should reassess their communication strategy and then use forms of communicating with the visitor based on those strategies of marketing communication that have proven to be effective. This is especially important in order not to waste any unnecessary funds.

DEA Results and Discussion

At time of a fierce competition driven by the ongoing economic crisis, not only business entities but also public or non-profit organisations are forced to look for internal mechanisms to increase the efficiency of their work.[30] The answer to this problem can be found in quantitative methods of inquiry. In this case, it is a symbiosis of mathematics and economic modelling. As mentioned above, we have chosen the Data Envelopment Analysis from a number of available methods. This method, in addition to weighting the efficiency, uncovers ineffective units, which can be considered *"a competitive advantage in the current turbulent environment"*.[31]

Through DEA analysis, we investigated the effectiveness of marketing communication of a selected object – one specialised museum that is firmly amongst the top ten most visited cultural monuments in Slovakia. For the purpose of this inquiry, we will mark it as the object under review 1 (abbreviated as O1). We have applied the DEA input-oriented model, since our intention is to minimise the cost of inputs needed to achieve outputs via marketing communication.

28   IMROVIČ, M.: Participation at the Municipal Level and Social Networks. In *Slovak Journal of Public Policy and Public Administration*, 2016, Vol. 3, No. 2, p. 111-121.
29   KOTLER, P., SCHEFF, J.: *Standing Room Only – Strategies for Marketing the Performing Arts*. Boston : Harvard Business School Press, 2007, p. 456.

30   OLSON, J., CURRIE, R.: *Evaluating a Post-Buy Analysis*. New York : American Marketing Association, 2004.
31   KUPEC, V.: *Marketingový výzkum ve vybraných procesech řízení banky*. Trnava : UCM, 2014, p. 114.

The following table lists the measured values of efficiency, the target value of efficiency and the identification of inefficient units. The declared efficiency target value is one of the possible options, but it does not affect the change in input/output ratio.

Table 1: Efficiency values, original and target values of efficiency of the marketing communication in the unit O1

Marketing communication item	CCR approach			BCC approach		
	Efficiency value	Value		Efficiency value	Value	
		Original	Target		Original	Target
Website	1.00	6.00	6.00	1.00	6.00	6.00
Press releases	0.64	4.00	2.56	0.71	4.00	2.84
Facebook	1.00	4.00	4.00	1.00	4.00	4.00
Posters	0.51	3.00	1.53	0.64	3.00	1.92
Direct mailing	0.41	4.00	1.64	0.47	4.00	1.88
Audio-visual materials (videos)	0.60	3.00	1.80	0.57	3.00	1.71
Online banners	0.54	5.00	2.70	0.38	5.00	1.90
Flyers	0.35	2.00	0.70	0.36	2.00	0.72
Tickets competition	0.25	2.00	0.50	0.31	2.00	0.62
Radio advertisement	0.38	2.00	0.76	0.42	2.00	0.84
Press advertisement	0.23	2.00	0.46	0.26	2.00	0.52
Outdoor posters	0.27	3.00	0.81	0.31	3.00	0.93
TV advertisement	0.19	2.00	0.38	0.22	2.00	0.44
Public transport advertisement	0.20	2.00	0.40	0.21	2.00	0.42

Source: own processing

Depending on the chosen DEA model approach and the relationship between the number of input units and the number of output units, a relatively high number of efficient units are present. The effective units are located in the top half of Table 1. For the unit efficiency, marketing communication can be identified through the museum's website and the social network *Facebook* which can still be seen as a hope for museum marketing. Social networks have become a virtual 'home' for people, and this is testified by the values of the efficiency found. They show that the museum's websites and social networks are 100% effective in its marketing communication.

As other significantly effective forms of marketing communication can still be considered press releases, posters and audio-visual materials (videos), because their effectiveness rates are above 50%. It can be said that museums try to communicate with the visitor not only via digital media, but also through 'traditional' communication techniques. It is also worth mentioning direct mailing in terms of effectiveness, because it only divides by three hundredths from the 50% threshold. The other types of marketing communication used are inefficient in terms of economy for the O1.
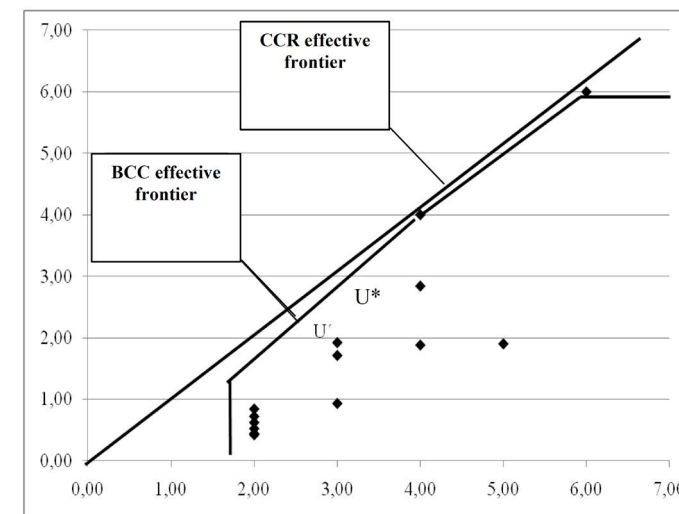

Chart 1: BCC and CCR approach of the DEA and their production efficiency
Source: SAS statistical software processing

In Chart 1, we can track specific units with their target values. They are actually a projection of the original values for the envelopment and thus represent the limit of efficiency. The point marked U* shows the projection of the DEA analysis by CCR approach, while point U* itself represents an effective frontier. The U' point is a projection for the BCC approach of the DEA analysis, while point U' itself represents an effective frontier. The chart also illustrates that in the case of the BCC approach model from point U' to the right, the function with respect to the CCR approach of the DEA model begins to acquire a concave shape and increases the number of effective units.

Conclusion

The effectiveness of marketing communication is very relevant to reflect on through scientific approaches. Some institutions continuously condemn marketing communication due to the form and complexity of the evaluations. On the other hand, marketing and PR agencies strive for any form of marketing communication mainly due to the amount of pre-invested funds. The first category clearly includes museums. Even though these public domain 'gems' spend more and more money on marketing communication each year, they do not oversee their relevance and accuracy. And the reason why? So far, there has been no adequate system to measure the effectiveness of individual marketing communication tools.

Since each investment has to be viable to the investor, we have also tried to design a model for Slovak museums to help them identify the shortcomings of existing communication practices and allow the necessary corrections to improve the effectiveness of their marketing activities. In searching for the solution, we were inspired by the production economics, from which we chose the statistical method of Data Envelopment Analysis. This allowed us to evaluate the efficiency of production units and also to identify inefficiencies. In the public and non-profit sector, this methodological approach appears very rarely and, according to our findings, it has not been applied yet in the museum sphere in Slovakia.

Our aim was to introduce a new and feasible methodological proposal to measure the effectiveness of marketing communication in the museum field. The DEA analysis allows evaluating the efficiency of production units. In addition to determining the degree of efficiency, this proposed method also enables to identify the sources of inefficiency. This, in the end, enables us to get into the root of the problem, and, perhaps, the DEA method may finally unlock 'the secret chamber' of museums and their marketing activities.

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