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# Analysis of the effectiveness of city halls' social networking sites in Poland as a factor in building an efficient communication based on information technology

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**Abstract:** Current digital transformation processes dynamically influence the development of new business models. Progressive digitization is also changing the current view of public services. Trust in public institutions, effective communication and public e-services are important criteria of modern business research in the context of building new business models. The digitalization of public service processes means the need to redefine the traditional concepts of communication and e-service models [1, 2]. The article is an attempt to answer the research question: is the use of communication channels, such as Facebook, by main city halls in Poland effective? Which models of communication with the residents guarantee the effective construction of communication and build the image of the city?

The research is based on quantitative and qualitative methods. The effectiveness of communication of public institutions' activity on social networking sites were examined by statistical methods such as the DEA (Data Envelopment Analysis) methods, while the triangulation method was used to analyse the published content. A characteristic feature of each city is a high level of use of information and communication technology in order to increase interactivity as well as to increase the knowledge and awareness of residents. We treat a city as successful when it undertakes investments in human and social capital and communication infrastructure in order to actively promote sustainable economic development. The Facebook pages of 18 voivodeship cities in Poland in 2021 were analysed in order to examine the effectiveness of the information carrier, which are posts about public services.

The results of the analysis show which voivodeship town halls in Poland use social media tools to build effective communication with the citizens. During the research, the content of posts was analyzed and grouped in the context of services and tasks of public institutions. As a result, those content groups were identified that generate the greatest effectiveness, and thus are the most attractive to the citizens. The results of the analysis can be used to build more effective communication channels for the interactive exchange of knowledge, information and e-services between public institutions and citizens, as well as to effectively create knowledge and build a new model of customer relationships management.

**Keywords:** digital communication; public e-service; social media.

## 1. Introduction

The public sector is an integral part of the national economy of any country. Regardless of the concept of the state adopted, the fulfilment of public tasks by the state requires special organizational structures. The main and fundamental elements of the public sector are the state, local governments and entities of mixed ownership, which in their activities provide services related to ensuring universal access to educational, social, health and other services for citizens to meet public needs. This fact compels us to

Tools need to be developed, by which the effectiveness and efficiency of communication of public institutions in carrying out their tasks can be assessed.

New public management (NPM) models and models based on participatory management concepts, such as good governance [3], new public governance or new public services (NPS), consider the role of citizens as clients and partners of public institutions. Viewed in this light, public institutions contribute to the effective and successful delivery of their missions and ultimate goals jointly developed with their stakeholders when they act in an innovative, participatory, compliant and ethical manner and accountable for their mandates. Citizens provide added value [4].

To date, no generally accepted method for assessing the profitability of operating utilities has been developed. It is widely recognized in the literature [5] that there is a need to measure the success of public institutions using the categories of efficiency and effectiveness in order to achieve their statutory objectives and meet the needs of their stakeholders at the lowest possible cost [6]. However, the performance evaluation of public institutions and the research findings to date have sparked numerous controversies and controversies.

Due to the specificity of public entities and the potential to use innovative technological solutions, the performance evaluation of these entities in the field of digital models of public services is mainly considered in the context of information management. Social media communications models refer to the intended use of information technology for such activities as searching for customers, building relations, communication, informing and providing, and exchanging offers. The feature used by social media as electronic communication technology is to provide interactive opportunities to post comments or other content and rate the content [7]. Boyd and Ellison [8] describe social networking sites as "Web-based services that allow individuals to create public profiles in a comprehensive system, create lists of other users with whom they share connections, and list their views and search connections."

The statistical data show more than 4.26 billion people worldwide use social media in 2021, and this number is expected to increase to nearly 6 billion by 2027. Social networking is one of the most popular digital activities in the world, and it's no surprise that social networking adoption is growing steadily across all regions. In January 2020, the global social media usage rate was 49%. This number is expected to increase as less developed digital markets catch up with other regions in terms of infrastructure development and the availability of cheap mobile devices. Social media has become an integral part of everyday internet use. On average, Internet users spend 144 minutes per day on social media and messaging apps, an increase of more than half an hour since 2015. Market leader Facebook was the first social network to cross the 1 billion registered accounts mark and currently has around 2.7 billion monthly active users, making it the most popular social network in the world. [9].

This paper presents the findings of a study on the effectiveness of information and promotional campaigns for 18 Voivodeship Town Halls in Polish social media. The use of social media tools to promote public services and build a successful communication is consistent with the premise of participatory management concepts. The accountability of the task performed is based on a model of the effectiveness of the social media sites used by the municipality, using the data envelopment analysis (DEA) method to measure the ratios of the results obtained and their impact to the inputs received [10]. For public institutions, success is measured by delivering value to the widest possible range of citizens, as measured by the number of respondents.

## 2. Materials and Methods

The professional literature justifies the implementation of electronic public administration services using the NPM concept. Advertising and information campaigns should reach as many recipients as possible. Reasons for using IT tools and social media: saving time, diversifying choices and diversifying service offerings, convenience, overcoming geographical and time barriers, saving money [11]. There is no doubt that society's needs and ways of life determine the nature, form and extent of communication online public services. Due to globalization and consumerism, young societies are looking for new social

models and attitudes. Mobility, active leisure behavior and the use of information and communication technologies are the main features of the lifestyle of modern society, which make social activities carried out more consciously and responsibly. Therefore, meeting the needs of today's citizens requires a similar style of communication. Today's communication is based on media convergence, which can reach target groups through multiple channels, so that various contents can complement and promote each other, and broadcasters can engage in dialogue with decision makers.

The methodology used in the study is related to the analysis of website management on social media platforms operated by municipal offices in the province of Poland. The aim is to study the phenomenon of information campaign effectiveness, as well as its dynamics and relevance the Facebook community of the units studied. For research design, the question to be answered is how to "translate" the research question of analysis into the language of actionable concepts and research questions, and which methods and tools should be used to achieve the goal.

The most commonly used method belongs to non-parametric methods and is data envelopment analysis (DEA). It allows analysis of the efficiency of a limited number of decision-making units (DMUs). For example, decision makers are companies, public institutions, schools, libraries, hospitals and bank branches. The DEA method is suitable for companies pursuing the same goals and operating under the same market conditions. Furthermore, the factors characterizing their activities are the same except for the range and intensity of consumption [12]. In the case study, the decision makers were the 18 selected town halls. In general, the DEA method is used most of the time for efficiency analysis, but works that use the DEA method to measure the effectiveness of a specific group of decision-making units can also be found [13].

In the DEA model, the efficiency (in our case – effectiveness) of a given object is defined as follows [14]:

$$U_q = \frac{\text{Weighted } \sum \text{ of outputs}}{\text{Weighted } \sum \text{ of inputs}} = \frac{\sum_{i=1}^r \mu_i y_{iq}}{\sum_{j=1}^m v_j x_{jq}} = \frac{\mu_1 y_{1q} + \mu_2 y_{2q} + \dots + \mu_r y_{rq}}{v_1 x_{1q} + v_2 x_{2q} + \dots + v_m x_{mq}} \quad (1)$$

where:

r – the number of outputs,

m – the number of inputs

y<sub>r</sub> – output values,

x<sub>m</sub> – input values,

μ<sub>r</sub> – the weights of outputs,

v<sub>m</sub> – the weights of inputs

During the analyse it was possible to identify a source of determining inefficiency while determining how a production unit can become effective by reducing/increasing inputs or outputs. It also states that the number of decision units should be three times greater than the sum of their inputs and outputs [15].

#### CCR DEA model (the Constant Return to Scale – CRS)

The authors propose an input-oriented CCR-DEA model to determine how promoting town halls through Facebook social networks affects consumers and their perceptions of town halls. The CCR DEA model assumes a decision-making unit where the optimal combination of input and output variables is independent of the size of the operation, which means that we use this approach to measure the effectiveness of each selected municipality in Poland. The objective function is to maximize the efficiency value of the city hall under constraints, namely i.e., no town hall will be more than 100% efficient because the input and output weights will be non-zero and positive.

Maximize:

$$z = \sum_{k=1}^r u_k y_{kq} \quad (2)$$

under condition

$$\sum_{k=1}^r u_k y_{kj} - \sum_{l=1}^m v_l x_{lj} \leq 0 \quad j = 1, 2, \dots, n \quad (3)$$

$$\sum_{l=1}^m v_l x_{lq} = 1 \quad (4)$$

$$\begin{aligned} u_k &\geq \varepsilon & j &= 1, 2, \dots, r, \\ v_k &\geq \varepsilon & j &= 1, 2, \dots, m. \end{aligned}$$

## 1 Data Collection, Inputs and Outputs

The study was based on multi-criteria data analysis to present quantitative relationships among interactions. Institutions included in the study were selected considering the e-service priorities of the public administration, within which a single market for digital information services is currently being created. Other factors that determine the choice of a public institution for research are the range of services offered and the field of activity of a particular institution. As part of the research, statistical data from the town hall's social network profiles were analysed, as well as a qualitative analysis of published posts. Based on observations and interviews, it has been suggested that public institutions that keep personal data share their activities in a similar way [11]. In addition, social network trends and technological possibilities are taken into account, which form the basis for determining the most posted topics. To achieve the research objectives, the authors identified six feature article groups for four main areas of published information:

1. Public e-services: posts informing about public projects and competition, participatory budget – messages directly aimed at citizens, e.g., informing of a participatory budgets, competition, inviting to an local event, weather alerts; posts informing about a municipal or citizens' initiative and ecology issues or changes in public transport – these posts inform citizens about social, municipal and environmental events;
2. Ex-ante Information: posts informing about upcoming cultural and entertainment events and anniversary celebrations;
3. Ex post Coverage: coverage of events attended by public authorities and politicians; coverage of events attended by local community members – the presence of residents is highlighted in the post;
4. Photo/Panorama: photos/city panorama/film promoting local attractions – promotion of the city or landmark;

A quantitative analysis was performed for the six identified thematic groups, and the effectiveness of the maintained profiles was evaluated. Quantitative data were analyzed as part of the research to describe the activity on the website: frequency of posts, activity, and intensity of interaction. The research findings depict office activity on social networking sites in September 2021. The month was chosen because September is the most active business month in Poland, with no international, national, or religious holidays interfering with the working rhythm. It is a time of active and intense business activity. Because of this, business and marketing activities in both the public and private sectors are the most goal-oriented.

The DEA study's inputs and outputs had to be carefully chosen because they could affect the distribution of effectiveness. Measuring the effectiveness of city halls' use of Facebook to promote

their brands may be difficult. City halls rarely collect data on the impact of social media outcomes on brand promotion. As a result, the output is measured using the intermediate results of a city hall's Facebook page. As a result, the inputs are the types of information published by city halls on their Facebook pages, and the output is the Likes, Comments, and Shares made by fans on the comments posted. The inputs and outputs model is following described:

- The input total number of post "E-services" deliver the output Likes=  $\sum(\text{number of Likes posted/ number of followers})$ , Comments=  $\sum(\text{number of comments posted/ number of followers})$  and Sharing  $\sum(\text{number of shares posted/ number of followers})$ ;
- The input total number of post "Ex-ante information" deliver the output Likes=  $\sum(\text{number of Likes posted/ number of followers})$ , Comments=  $\sum(\text{number of comments posted/ number of followers})$  and Sharing  $\sum(\text{number of shares posted/ number of followers})$ ;
- The input total number of post "Ex-post coverage" deliver the output Likes=  $\sum(\text{number of Likes posted/ number of followers})$ , Comments=  $\sum(\text{number of comments posted/ number of followers})$  and Sharing  $\sum(\text{number of shares posted/ number of followers})$ ;
- The input total number of post "Photo/panorama" deliver the output Likes=  $\sum(\text{number of Likes posted/ number of followers})$ , Comments=  $\sum(\text{number of comments posted/ number of followers})$  and Sharing  $\sum(\text{number of shares posted/ number of followers})$ ;

The variables output Likes, Comments, and Shares represent the number of Likes, Comments, and Shares considering the number of fans for each specific post. Because the number of fans on Facebook varies by city, these variables are used in the study rather than the number of Likes, Comments, and Shares. The research was divided into three stages:

1. First stage – examining of a general model (Model 1). Model 1 used three input variables (the total number of posts titled "E-services," the total number of posts titled "Ex-ante information" + "Ex-post coverage," and the total number of posts titled "Photo/panorama") and three output variables (Likes, Comments, and Shares);
2. Second stage - examining of an effectiveness of Models 2, 3, 4, and 5. The models show the effectiveness of each category of promotional activity in the cities studied. Except for Model 2, which used two input variables and three output variables, almost all of the models in this group examined one input variable and three output variables (Likes, Comments, and Shares);
3. Third stage - the effective/efficient analysis, which is performed for models with one summary input variable (the number of posts) and three output variables (Likes, Comments, and Shares) for Model 6.

Table below shows the input and output variable selection scheme for each model.

**Table 1.** Determinants of effectiveness in each model.

| Inputs                                            | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---------------------------------------------------|---------|---------|---------|---------|---------|---------|
| Total number of post "E-services"                 | √       |         |         |         |         |         |
| Total number of posts about the project           |         | √       |         |         |         |         |
| Total number of posts about municipal initiatives |         | √       |         |         |         |         |
| Total number of post "Ex-ante information"        | √       |         | √       |         |         |         |
| Total number of post "Ex-post coverage"           | √       |         |         | √       |         |         |
| Total number of post "Photo/panorama"             | √       |         |         |         | √       |         |
| Total number of posts in all categories           |         |         |         |         |         | √       |

| Inputs                                                         |   |   |   |   |   |   |
|----------------------------------------------------------------|---|---|---|---|---|---|
| Likes=Σ (number of Likes posted/<br>number of followers)       | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Comments=Σ (number of comments<br>posted/ number of followers) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sharing Σ (number of shares posted/<br>number of followers)    | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

### 3. Results

EMS Software [16] was applied to conduct the effectiveness analysis. For the first stage of analysis (Model 1) a general DEA model has been chosen. This model includes four inputs (total number of post "E-services," total number of post "Ex-ante information" + "Ex-post coverage," and total number of post "Photo/panorama") and three outputs was chosen (Likes, Comments, and Shares). This model provides an overall value of average effectiveness as well a clear way to differentiate between the units (city halls). Table 2 shows the results for the year 2021 in terms of the effectiveness of various city halls, with a descriptive analysis of the effectiveness coefficients, where 100% means effectiveness.

**Table 2.** DEA effectiveness scores.

|              | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|--------------|---------|---------|---------|---------|---------|---------|
| City         | 2021    | 2021    | 2021    | 2021    | 2021    | 2021    |
| Wrocław      | 50.69%  | 21.22%  | 51.84%  | 13.29%  | 81.36%  | 39.45%  |
| Bydgoszcz    | 56.71%  | 55.21%  | 22.69%  | 15.85%  | 47.16%  | 45.75%  |
| Lublin       | 74.48%  | 35.10%  | 34.69%  | 25.89%  | 50.75%  | 45.16%  |
| Zielona Góra | 100.00% | 100.00% | 69.38%  | 63.98%  | 96.21%  | 100.00% |
| Łódź         | 100.00% | 100.00% | 100.00% | 41.56%  | 100.00% | 100.00% |
| Kraków       | 24.96%  | 14.65%  | 35.51%  | 8.01%   | 19.09%  | 21.80%  |
| Warszawa     | 77.94%  | 58.81%  | 36.41%  | 14.04%  | 66.03%  | 65.87%  |
| Opole        | 100.00% | 100.00% | -       | 20.09%  | -       | 100.00% |
| Rzeszów      | 100.00% | 61.84%  | 100.00% | 100.00% | 75.91%  | 100.00% |
| Białystok    | 57.42%  | 39.63%  | 35.44%  | 17.93%  | 100.00% | 36.32%  |
| Gdańsk       | 100.00% | 53.50%  | 42.97%  | 15.62%  | 53.97%  | 82.36%  |
| Katowice     | 29.04%  | 11.95%  | 12.91%  | 16.55%  | 61.55%  | 25.48%  |
| Kielce       | 100.00% | 100.00% | 100.00% | 41.84%  | 86.63%  | 97.48%  |
| Olsztyn      | 89.80%  | 22.97%  | 50.56%  | 22.73%  | 69.19%  | 72.04%  |
| Poznań       | 100.00% | 75.09%  | 17.10%  | 9.00%   | 28.27%  | 78.60%  |
| Szczecin     | 18.71%  | 14.00%  | 28.36%  | 2.38%   | 78.45%  | 12.22%  |
| Toruń        | 100.00% | 57.83%  | 22.72%  | 15.59%  | 100.00% | 74.92%  |
| Gorzów       | 98.93%  | 83.80%  | 39.57%  | 57.19%  | 75.91%  | 31.05%  |

In the first stage of the research, Model 1 was examined, and the research results indicate a list of 8 out of 18 voivodship cities in Poland that managed to achieve full effectiveness of published posts. This means that all posts from each group received a relatively large number of responses. These are the cities that have reached the 100% indicator, i.e. Zielona Góra, Łódź, Opole, Gdańsk, Kielce, Poznań, Toruń, Rzeszów.

In the second stage of the analysis, the effectiveness of promotional activities was examined by dividing them into particular groups of inputs (Models 2-5). In the group of "e-services" posts (Model 2), where two categories of inputs defining the promotion of e-services were taken into account, the most effective were Opole, Łódź, Zielona Góra and Kielce. These two categories of posts inform about public services and e-services offered by municipal offices. From the point of view of the purpose of

government and government institutions, these are the most important categories of posts in the area of building effective communication between public institutions and citizens. In the group of posts from the "Ex-ante information" category (Model 3), the cities of Łódź, Rzeszów and Kielce are effective in their online activities. The results of the analysis indicate that these cities effectively implement marketing activities by promoting cultural and educational events. The greatest activity of residents on the social profile of these cities indicates a high level of interest. The city Opole didn't published some post in the analyzed period. In Model 4, where the effectiveness of "Ex-post coverage" posts was examined. This group of posts was included because of the fact, the social media can be an upcoming tool for political marketing effectiveness [17 / 17]. In this Model only Rzeszów achieved 100% effectiveness. In model 5 – the category of posts "Photo/panorama" –. In this model, the city of Łódź and Toruń proved to be the leader. Due to a lack of data, Opole were not analyzed.

In the third stage of the analysis, calculations were performed on the accumulated monthly data, thus creating a model with one input (total number of posts) and three results for Facebook (Model 6). In this Model the city of Opole and Rzeszów proved to be the leader. The results of Model 6 indicate a city that is able to effectively and to the greatest extent engage the local community in the information and communication activities of the city hall.

#### 4. Discussion

The scope of the research covers the effectiveness of public institutions' promotional and information activities that use modern and digital technologies as a tool for communication. The results of the analysis indicate which cities use social media tools to build effective communication with the citizens. In addition, during the research, attention was paid to the possibility of increasing the effectiveness of these activities when the names of social profiles of city offices will clearly indicate these institutions. An example may be the profile of the Szczecin City Hall, which is run under the name: Szczecin Floating Garden. For the purposes of the research, an additional analysis was carried out among respondents aged 19-25, asking the question: Why is the name of the profile of the city of Szczecin named Szczecin Floating Garden? Over 96% did not know the correct answer. Thus, the transparency and information efficiency of the institution may significantly decrease.

In order to obtain a full picture of the changes taking place in the level and effectiveness of the use of digital technology of public institutions in promotional and information activities, research should be continued over a longer period of time in order to examine the dependencies and dynamics of changes. The added value for the continuation of the research is the assessment of the effectiveness of the achievement of goals by applying a dynamic analysis of the effectiveness of time series in the form of the input-oriented Malmquist Productivity Index (MPI) [18]. Additionally it seems important to extend the research with the analysis of published content. Text Mining analysis using, for example, the R language seems to be helpful. Thanks to the extended research procedure, it will be possible to identify posts containing specific content, grouping, clustering, identifying links and visualization [19]. Research is an important contribution to science. The research results justify the use of digital technologies and modern communication platforms for the effective operation of public institutions.

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SIMILARITY INDEX

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