



ORIGINAL PAPER

Social networks and civic participation: analysis of 23 institutional Facebook pages from Romania's North–East region

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Abstract: In this article we analyze the digital interaction between 23 local public authorities from Romania's North–East region and citizens through the Facebook social network, focusing on two clusters grouped more by the administrative and economic importance of the cities rather than strictly by population size. The study measures the engagement level using specific indicators (*Posts, Reactions, Comments, Shares*) for the May–June 2024 period, strategically coinciding with an interval estimated to have intense civic activity. The results indicate substantial variability in digital communication strategies, with clear patterns of inactivity on certain days and significant differences in performance regarding social media use in institutional communication. The data analysis provides empirical bases for optimizing communication strategies and more territorially balanced digitalization policies.

Keywords: *social networks, Facebook, civic participation, interaction, patterns.*

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Fundamental premises

As genuine communication channels, social networks provide sets of predictors regarding citizens' participation in civic actions (discussions and debates, voting participation, etc.). Social network users are constantly exposed to various information and debates that have the potential to influence their civic behavior. Through analyzing data from social pages, certain behavioral patterns can be observed, such as posting frequency, interaction level with civic action-related content, and the nature of friend networks that can predict the likelihood of a user actively participating based on their involvement in debates. The existence of citizens who participate in various discussions on social media platforms can have a "contagious" social effect, increasing the probability of higher user involvement around events of interest. For example, electoral-stakes events are the context in which news about political candidates or those already in office who participate in discussion groups promoting their public policies are frequently commented on and shared, predisposing towards active involvement both before and during the electoral campaign.

In this article, we examine the Facebook network not just as a social interaction tool but also as an essential mobilizing factor for civic engagement, having the capacity to convert passive users into active and dedicated members of society.

We list some of the fundamental premises that determined our decision regarding the data collection period:

Electoral behavior cyclicity: the pre-electoral period naturally generates an increase in public interest, users become more active and involved in discussions on social media platforms, and the need for information about candidates and programs increases.

Intensification of political communication: parties and candidates intensify their online presence, the frequency of posts and diversity of content on social media platforms increases, and implicitly more resources are invested in promoting online content.

Increase in organic engagement: more interactions (posts, likes, comments, shares), more heated discussions in comments, formation of active pro or contra groups.

Central arguments

The analysis of Facebook data from Socialinsider reports around local elections is not arbitrary; it is based on the following considerations:

Maximum representativeness: Data collection was conducted during a period when we estimated an intense information flow and when there was a probability of capturing both the diversity of opinions and positions (including political ones), as well as the main topics of local interest.

Statistical relevance: Real data provides us with a concrete basis for analyzing *engagement* that will allow the identification of relevant patterns, and through the diversity of interactions, we estimate a representative sample.

Predictive value: The analysis of online behavior for a time interval around local elections that theoretically interests both local public authorities and citizens can indicate electoral trends and support in identifying priority themes for citizens, which allows measuring the effectiveness of local public authorities' messages to them.

Time interval implications: We relied on collecting a set of real data for statistical analysis through which we could observe the dynamics of communication between local public authority and citizens.

Starting from the consideration that citizens' use of electronic means to interact through traditional channels with public authorities is likely an extension of civic and political involvement, we analyze the level of engagement through the Facebook social network in 23 county cities and county seat municipalities from Romania's North-East region. We propose a series of hypotheses regarding the interaction of local public authorities with citizens through the Facebook social network, and to test them, we analyze Socialinsider data, evaluating the parties' involvement through analysis of *Posts, Reactions, Comments, Engagement, and Shares*. Through these measurements, we intend to bring a better understanding and management of online communication on social networks and social networks themselves, with an added benefit being the possibility of adaptation according to our research interests.

Practical implications – Practical measurement of online interaction of certain local public authorities.

Originality/Value – This paper is the first to propose measurements to evaluate parties' involvement on the institutional Facebook page of public authorities in the N-E region and which aims to provide methodological foundation to correlate in future research with a tool for measuring web pages, engagement patterns that can guide communication strategies in the local public authority-citizens relationship. This can be used both in academic circles and public administration, for a better understanding of institutional online *engagement* through the Facebook platform.

In the "conclusions" section, we present the potential benefit of the results for interested public authorities and for future research.

Citizens' participation in civic and political actions: the foundation of civic engagement

Citizens' participation in civic actions and political activities represents the core of civic engagement (Steven & Levy, 1999). At an individual level, civic engagement is represented by social contact (personal and social interactions: conversations, discussions, collaboration or common actions, participation in social events or gatherings, etc.), which citizens have among themselves in their community or in the social groups with which they interact and through which they contribute to the diffusion process (Bandiera & Rasul, 2004), (Lin, 2003), (Lynch, Kent & Srinivasan, 2001), (Venkatesh & Davis, 2000). The diffusion and extended dissemination of local authorities' posts on the Facebook social network page through shares combined with other predictors can indicate the level of interaction.

Largely depending on the proportion of internet users, the use of social networks in public and governmental organizations is considered a powerful and useful tool in opening and increasing the degree of citizen participation (Nica, Popescu, Nicolăescu & Constantin, 2014). Although the electoral campaign itself is not our major interest, in terms of online activity intensity, we expect a more pronounced participation from both public authorities and citizens equally.

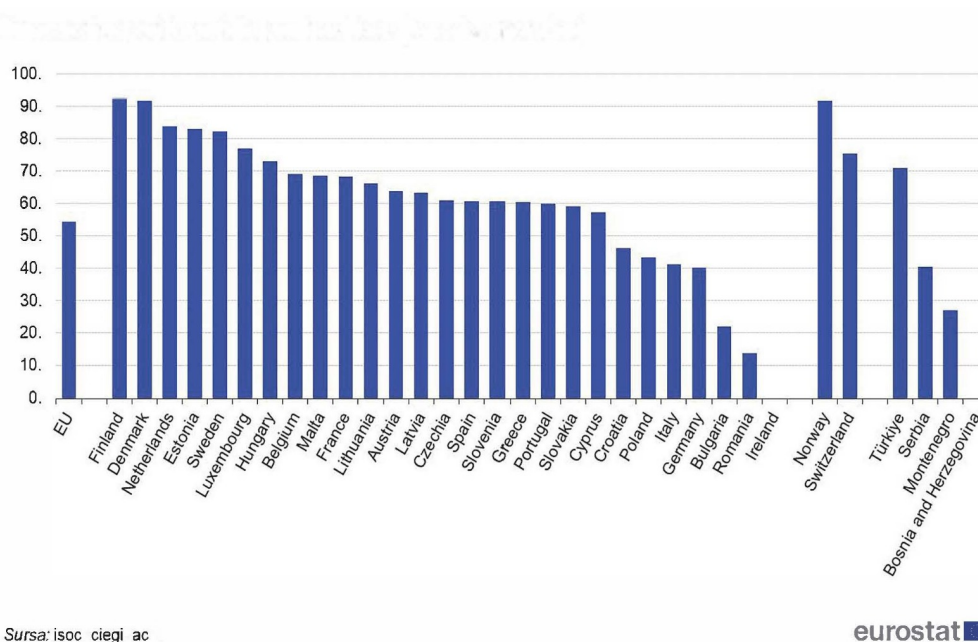
What role do social networks play in citizen mobilization and involvement (in electoral campaigns)? Any content posted on social networks can capture citizens' attention influencing their involvement if the topics addressed are significant and of interest to them (Bonsón, Royo & Ratkai, 2016). Social networks are the tool through which politicians can reach voters as internet users increasingly depend on digital

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platforms to obtain news and information of interest. However, this fact does not guarantee that all social network users are politically active online. Yet citizen involvement is considered important not only for the visibility and election of the candidate as a political action but also for the debate of public policies with citizens (Missingham, 2011).

The role of social networks in contemporary communication and forms of online participation on Facebook, together or separately, are frequently researched themes in the field of electronic governance, but quite few investigate the role of options that Facebook social network page buttons and their characteristics (*Posts, Comments, Shares and Interactions*) offer. Each of these options can be a "voice" and a potential amplifier. The better the information operations are executed, the more potential they have to gain influence.

To what extent is the potential of social networks exploited in the North-East region? Although statistically social networks are among the most powerful instruments with implications for social order, in Romania (Graph 1) we observe that the level of citizen interaction with public authorities has the lowest share. According to statistics, only 14% of internet users interacted with public authorities over 12 calendar months. Such a percentage can support the statement that the potential of social networks is not sufficiently exploited in the public authority-citizens relationship.



Figures 1: Interaction with Public Authorities 2023 (last 12 months);

Preliminary data analysis

We explore social network participation to see the extent to which local public authorities interact with citizens. We measure the interaction level of local public authorities from the North-East region through the Facebook social network by analyzing the frequency of posts for information/communication or other specific actions. To test the hypotheses, we measure the posting frequency and number of interactions on the institutional Facebook pages of 23 county cities and county seat municipalities from the North-East region, during the period of May 26–June 24, 2024. The comparative analysis of this data is relevant for determining whether there are significant differences in terms of increasing or decreasing interaction during the electoral campaign, confirming or invalidating our expectations.

Statements

The level of interaction (*engagement*) is influenced by a set of factors (number of *posts*, *reactions*, *comments*, *shares*, day) that act simultaneously. On a secondary level, we state that:

1. The number of daily posts positively influences the level of *engagement*, controlling for other variables.
2. The number of reactions has a positive impact on the level of *engagement*, independent of the effects of other variables.
3. The number of comments contributes positively to the level of *engagement*, taking into account the effects of other variables.
4. The number of shares has a positive influence on the level of engagement, controlling for other variables.
5. The day of the week moderates the relationship between other independent variables and the level of *engagement*.

In the pre-testing phase of the Socialinsider instrument, we created a database comprising *Posts*, *Reactions*, *Comments*, *Shares*, *Engagement*, for the institutional Facebook social pages of 23 local public authorities from the N–E region, for the interval May 23–June 24, 2024.

To obtain the overall picture of large-scale trends and patterns before focusing on specific aspects, the same data was analyzed to validate/invalidate data that verifies the initial statements and supports the intention of identifying possible anomalies. Through this analysis, we intended not only to test the instrument but also to obtain benchmarks for an in-depth analysis which, depending on its complexity, we could carry out partially or entirely in future more extensive and thorough research.

Posting frequency: With an average of 0.81 and a median of 0.74 posts per day, a moderate posting activity is observed, below one post per day. The relatively small standard deviation (0.44) indicates reasonable consistency in posting frequency.

Engagement: Reactions are the dominant form of engagement, with an average of 56.34 per day, significantly higher than comments (7.24) and shares (8.70). The notable difference between the mean (72.90) and median (42.57) of total engagement suggests the presence of days with exceptionally high engagement, which influences the average.

Variability: High standard deviations, especially for reactions (47.98) and total engagement (61.97), indicate considerable fluctuation from day to day. This variability suggests that certain posts or days generate significantly more interest than others.

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Asymmetric distribution: For all measured variables, except posts, the mean is significantly higher than the median, indicating a positive asymmetric distribution. This suggests the presence of occasional engagement "peaks" that pull the average upward.

Posting efficiency: The high ratio between engagement (mean 72.90) and number of posts (mean 0.81) shows that on average, each post generates a significant level of interaction.

Engagement patterns: Reactions appear to be the audience's preferred form of engagement, being significantly more numerous than comments or shares. Shares (mean 8.70) are slightly more frequent than comments (mean 7.24), highlighting content as being considered valuable enough to be shared. We can say that viewed as a whole, the data points toward a moderate but effective posting strategy, with fluctuating but generally good engagement. The presence of days with exceptionally high engagement suggests opportunities to identify and replicate factors that contribute to the expected success of these posts. Thus, the data distribution explains social media activity characterized by occasional "peaks" of interest and involvement, rather than a uniform distribution of interactions.

The collected data represent the 30 days from the period May 26-June 24, where we can visualize day-to-day trends, including periods of engagement increase and decrease. *Confirmed peaks:* days with exceptional engagement (May 30 and June 5) are evident, but we can also see other days with high performance. *Daily fluctuations:* the graph better highlights the daily volatility of engagement, especially for reactions and total engagement. *Period of inactivity:* June 9, which appears with zero values for all variables, is now more evident in the context of surrounding days. *Posting Trends:* we can more clearly observe the posting pattern, which seems to have a slight decrease toward the end of the analyzed period.

Preliminary results

For the descriptive interpretation of data from a theoretical perspective, we analyzed trends and relationships between different performance indicators for social media posts, focusing on key concepts from digital communication theory and social media marketing. Thus:

Posting frequency (Posts), with an average of 0.81 posts per day indicates a moderate posting strategy. Theory suggests that optimal posting frequency varies depending on platform and audience, but generally, content quality is more important than quantity (Batovski, 2013). The standard deviation of 0.44 shows moderate variability in posting frequency.

Interactions: Average engagement of 72.90 per post consists of reactions (mean 56.34), comments (mean 7.24), and shares (mean 8.70). This distribution aligns with the social media "engagement pyramid," where reactions (minimum effort actions) are most frequent, followed by shares and comments which require more effort (Charlene & Bernoff, 2008).

Content virality: The average number of shares (8.70) indicates a moderate level of virality. In the theory of innovation diffusion applied to social media, shares are essential for content spread beyond the immediate audience.

Content quality and audience resonance: Days with high Engagement (e.g., June 5 with 229.52) suggest content that strongly resonated with the audience. The "Uses and gratifications" theory would suggest that this content satisfied specific user

needs (information, entertainment, social connection, etc.). (Katz, Blumler & Gurevitch, 1973), (Chatman, 1991).

Consistency and fluctuations: The high standard deviation for Engagement (61.97) indicates significant fluctuations that can be interpreted through agenda-setting theory, suggesting that certain topics or content types have a greater impact on the audience. Agenda-setting theory is an important concept in communication and mass media. This theory maintains that mass media has a significant influence on topics that the public considers important. Proposed by Maxwell McCombs and Donald Shaw in 1972 in the article "The Agenda-Setting Function of Mass Media" in *Public Opinion Quarterly*, following a study of the 1968 US presidential campaign, the theory's basic principle is that mass media doesn't necessarily tell us what to think but influences what to think about. In other words, it determines which topics are considered relevant by the public. The operating mechanism is triggered by emphasizing certain themes and ignoring others through which mass media sets the public "agenda." The first level of agenda-setting theory is establishing topic importance, and the second level is influencing how the public thinks about these topics. The frequency of a topic's appearance, positioning, and space/time allocated in media being the influencing factors. This theory has significant implications for understanding public opinion formation and mass media's influence on society. (McCombs & Shaw, 1972).

Interactivity: An average of 7.24 comments per post indicates a moderate level of interactivity. The theory of two-way communication in social media emphasizes the importance of these interactions for building relationships with the audience.

Seasonality and content cycles: Significant fluctuations are observed from day to day, with engagement peaks (e.g., May 30, June 5). These patterns can be analyzed in the context of theories about rhythm and temporality in digital communication.

Relative posting efficiency: The ratio between engagement and number of posts varies considerably. Days with high engagement and a low number of posts (e.g., June 5: 1 post, 229.52 engagement) demonstrate the principle of quality over quantity in content strategy.

Absence of activity: June 9 with zero activity on all measurements may indicate an intentional pause or technical issue. In our data, June 9 is the election day subject to legislative restrictions. Theories about constant social media presence would suggest that such breaks can negatively affect long-term engagement.

At this point in the analysis, the data reflects a social media strategy with significant fluctuations in Engagement and a focus on content quality rather than posting frequency. For a more in-depth analysis, it would be useful to correlate these data with the type of content posted, time of day when the message is posted, and external events relevant to the audience. Referring to the relevance of statistical data, these focus on social media activity of public entities (local authorities from Romania's North-East region), over a 30-day period (May 26 – June 24). With an average Posts frequency of 0.81 posts per day, moderate social media activity is suggested. The average of 72.90 Engagement per Posts indicates a decent level of citizen interactions. There is also variability: high standard deviation for most measurements suggests inconsistency in post performance.

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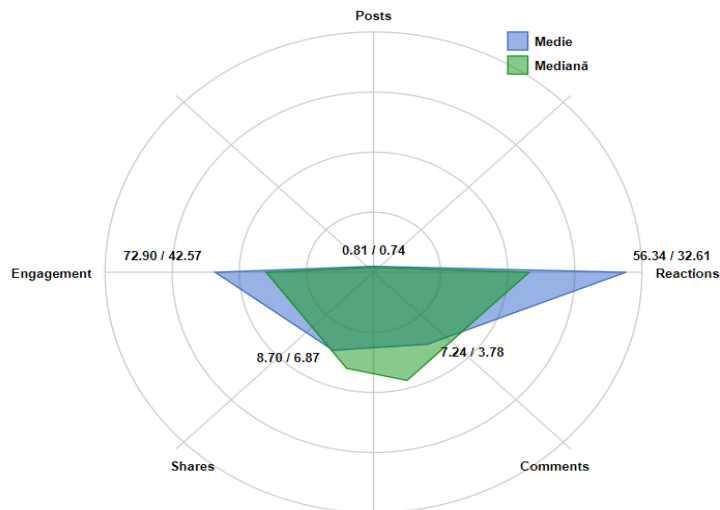
Comparative analysis of collected data

1. Comparative analysis of means and medians

To obtain insights about the distribution and central tendencies of the data for each social media indicator, we conducted a comparative analysis of the mean and median, with the same data subsequently represented through radar charts. A significant difference between mean and median will indicate an asymmetric (skewed) distribution.

The analysis by indicators shows that for *Posts* (Mean: 0.81; Median: 0.74), the points are very close, indicating a relatively symmetric distribution of posts. For *Reactions* (Mean: 56.34; Median: 32.61), a significant difference is observed, suggesting the presence of days with an exceptional number of reactions. *Comments* (Mean: 7.24; Median: 3.78) appear with a notable difference, indicating an asymmetry in the distribution of comments. *Shares* (Mean: 8.70; Median: 6.87) show a smaller difference compared to reactions and comments, but still indicate a slight asymmetry. *Engagement* (Mean: 72.90; Median: 42.57) presents the largest discrepancy in the mean and median comparison, suggesting the presence of days with exceptional engagement.

We thus observe *positive asymmetry*: for all indicators, the mean is greater than the median, indicating a positive asymmetry in the data distribution; *Reactions* and *Engagement* show the highest *variability*, visible through the large difference between mean and median, and *consistency*: *Posts* have the smallest difference between mean and median, suggesting a more uniform distribution of posts.

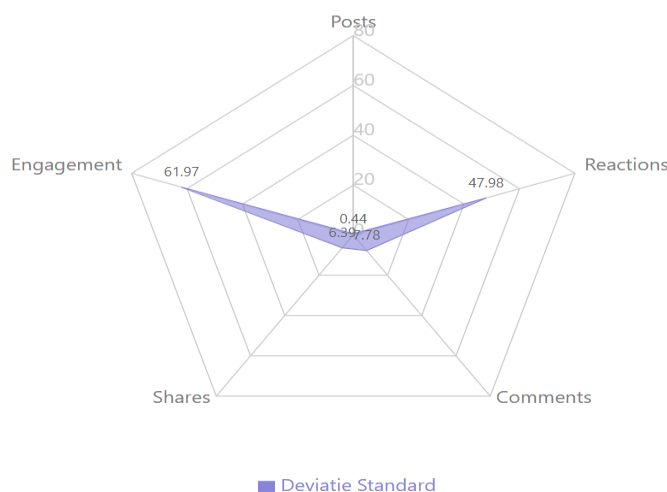


Figures 2: Mean Vs Median comparison

We observe that for all measured indicators, the mean is higher than the median, suggesting a positive asymmetry in the data distribution for each category. The largest difference between mean and median is observed in Engagement and Reactions, indicating greater variability and the presence of extreme values in these categories. Posts have the smallest difference between mean and median, suggesting a more uniform distribution of posts throughout the analyzed period.

2. Comparative analysis of standard deviation

Engagement has the highest standard deviation (61.97), creating that pronounced "peak" observable in the graphical representation (Figures 3). *Reactions* have the second-highest standard deviation (47.98), forming another extended point on the graph. *Comments* and *Shares* have moderate and similar standard deviations (7.78 and 6.39 respectively). *Posts* have the lowest standard deviation (0.44), being closest to the center of the graph.



Figures 3: Standard deviation comparison

The greatest variability is observed in *Engagement*, suggesting the existence of significant differences in the level of involvement between different posts or periods. *Reactions* also show high variability, indicating that the number of reactions fluctuates considerably. *Comments* and *Shares* have moderate variability, indicating a more uniform distribution but still with some fluctuations. *Posts* has the lowest variability, which may indicate consistency in posting frequency.

3. Comparative analysis of cluster 1 Vs. cluster 2

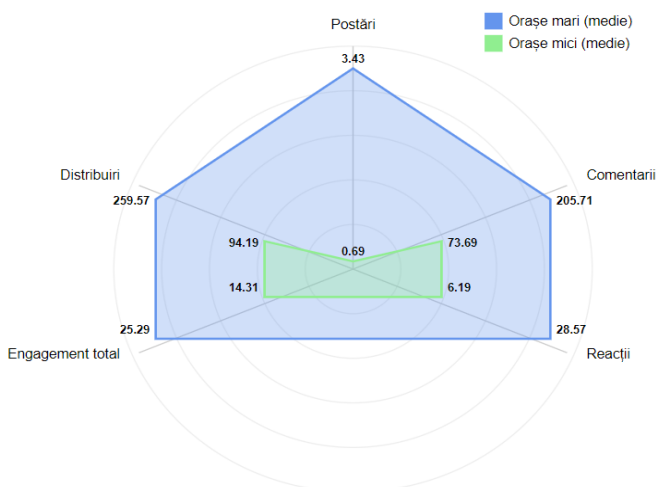
To compare the mean and median for the 23 cities in the sample for which data is analyzed, we classified them into cluster 1 and cluster 2 (Table 1). The grouping criterion is based more on the administrative and economic importance of the cities rather than strictly on population. All cities in the first group are county seats or cities with significant economic and historical importance in their region (for example, Bârlad). The cities in the second group, although some have over 10,000 inhabitants, are considered "small" in terms of their administrative or economic importance compared to those in the first group.

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Table 1: Cluster classification

Cluster	Descriptive values	Posts	Reactions	Comments	Shares	Engagement
<u>cluster 1</u> Iași, Botoșani, Piatra Neamț, Suceava, Bacău, Vaslui Bârlad	<i>Mean</i>	3.43	205.71	28.57	25.29	259.57
	<i>Median</i>	3	133	14	9	156
	<i>Standard Deviation</i>	2.18	319.89	51.76	42.18	408.76
<u>cluster 2</u> Hârlău, Târgu Frumos, Dorohoi, Flămânzi, Darabani, Roman, Târgu Neamț, Bicaz, Fălticeni, Rădăuți, Câmpulung Moldovenesc, Onești, Moinești, Comănești, Huși, Negrești	<i>Mean</i>	0.69	73.69	6.19	14.31	94.19
	<i>Median</i>	0	0	0	0	0
	<i>Standard deviation</i>	1.14	216.01	22.76	43.76	279.45

4. Statistical comparison of Mean and Median, cluster 1 Vs. cluster 2



Figures 4: Mean/Median comparison cluster 1/cluster 2

In figures representation 4, we observe the data distribution and asymmetries for cluster 1 (large cities): *Posts* (Mean: 3.43, Median: 3), the median is close to the mean, suggesting a relatively symmetric distribution. For *Reactions* (Mean: 205.71, Median: 133), the mean is significantly higher than the median, indicating a positive skewed distribution (skewed right). There are several cities with a large number of reactions pulling the mean upward. For *Comments* (Mean: 28.57, Median: 14), again, the mean is higher than the median, suggesting positive asymmetry. For *Shares* (Mean: 25.29, Median: 9), the significant difference indicates strong positive asymmetry. Some cities have a much higher number of shares than others. For total *Engagement* (Mean: 259.57, Median: 156), we see a positive asymmetry, reflecting trends observed in the individual components. In cluster 2, for all measured categories (*Posts*, *Reactions*, *Comments*, *Shares*, total *Engagement*), the median is zero, while the mean has positive values, indicating extreme asymmetry in distribution. In cluster 2, most cities have very reduced or nonexistent activity, and only a few cities have more intense activity, pulling the mean upward.

Conclusions

Asymmetry: For both cluster 1 and cluster 2, there is a positive asymmetry in data distribution. This suggests that there are a few "high-performing" cities that have much more intense online activity than the rest.

Variability: Cluster 1 shows greater variability in online activity, with significant differences between mean and median.

Inactivity in small cities: Zero median for all measured variables in cluster 2 suggests that at least half of the component cities have minimal or nonexistent online presence.

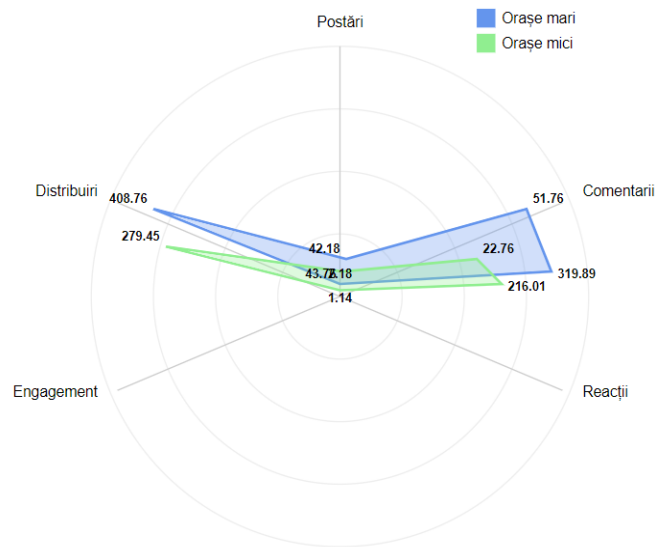
Unexploited potential: The large difference between mean and median for small cities shows that there is growth potential if more cities would adopt more active social media strategies.

Concentration vs. Dispersion: Online activity appears to be concentrated in a few cities, especially in the small cities category, while for large cities there is greater dispersion, although still asymmetric.

5. Statistical comparison of standard deviation cluster 1 Vs. cluster 2

Figures 5 visually shows a larger standard deviation for cluster 1, indicating greater variability in the number of posts (*Posts*: cluster 1: 2.18; cluster 2: 1.14); Significant difference, suggesting that regarding cluster 1, there is much greater variability in the number of reactions received (*Reactions*: cluster 1: 319.89; cluster 2: 216.01); *Comments*: cluster 1 again shows greater variability in the number of comments (cluster 1: 51.76; cluster 2: 22.76); Interestingly, here small cities have a slightly higher standard deviation, indicating similar or even greater variability in shares (*Shares*: cluster 1: 42.18; cluster 2: 43.76); Total *Engagement* shows greater variability for cluster 1 (*Engagement*: cluster 1: 408.76; cluster 2: 279.45).

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Figures 5: Standard deviation comparison cluster 1 Vs. cluster 2

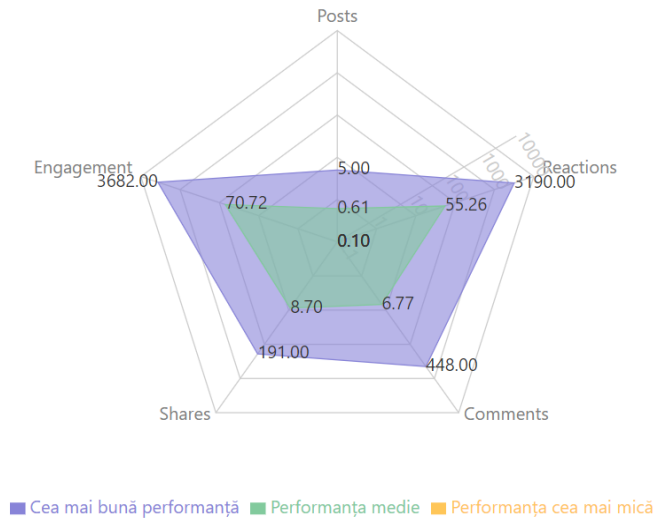
In general, cluster 1 shows greater variability in social media activity, with the exception of shares. The largest difference in variability is observed in *Reactions* and total *Engagement*. Shares appear to be the score with the smallest difference in variability between cluster 1 and cluster 2. This greater variability for cluster 1 may suggest a more pronounced difference between top performers and the rest, while cluster 2 seems to have more uniform activity (although possibly lower in general).

6. Comparative analysis: best performance, average performance, and lowest performance

To compare the best performance with average performance and lowest performance, we used the maximum, minimum, and mean values for each measured category (Posts, Reactions, Comments, Shares, and Engagement) during the period May 26 - June 24. A comparative descriptive analysis of the data shows that for *Posts*: There is a significant difference between the best performance (5) and average performance (0.61), indicating that days with intense posting activity are rare. The lowest performance (0) suggests there are days without any posts. *Reactions*: An extreme variation is observed, with the best performance (3190) being substantially higher than the average (55.26). This indicates the presence of exceptionally popular posts that attract a large number of reactions. *Comments*: Similar to reactions, comments show a large discrepancy between best performance (448) and average (6.77), suggesting that certain posts generate intense discussions. *Shares*: The best performance (191) is significantly higher than the average (8.70), indicating that some content is particularly "shareable". *Engagement*: Being a cumulative measure, it shows the greatest variation.

The best performance (3682) is substantially higher than the average (70.72), reflecting days with exceptional social media activity. The data shows large variability in performance for all scores, with occasional peaks of intense activity that significantly

exceed average performance. The lowest performance being 0 for all categories suggests there are days with minimal or nonexistent social media activity. A comparative picture for best performance, average performance, and lowest performance for the 5 measured categories: Posts, Reactions, Comments, Shares, and Engagement, can be observed below (Figures 6):



Figures 6. Comparative performance analysis: high, average, low

Due to large differences between values for different categories (for example, Posts having a maximum value of 5, while *Engagement* has a maximum value of 3682), the graph may appear disproportionate. Small values are difficult to distinguish. The lowest performance being 0 for all measured categories appears as a point in the center of the graph. The larger the surface area, the better the performance. For better data interpretation, we could use separate graphs for each measured variable, which would allow a more suitable scale for each dataset; excluding the lowest performances (being 0 for all categories) and focusing only on the best performance and average performance.

7. Comparative analysis of mean and median engagement by counties

The data analysis to compare means - medians and standard deviations between counties is based on engagement data, as it is a relevant indicator of post performance.

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Table 2: Total engagement by counties

<i>COUNTIES</i>	<i>DESCRIPTIVE VALUE</i>	<i>ENGAGEMENT</i>
<i>IAȘI</i>	<i>Medie</i>	164.48
	<i>Mediana</i>	117.00
	<i>Dev. Std.</i>	106.91
<i>BOTOȘANI</i>	<i>Medie</i>	132.76
	<i>Mediana</i>	40.00
	<i>Dev. Std.</i>	175.30
<i>NEAMȚ</i>	<i>Medie</i>	92.38
	<i>Mediana</i>	16.00
	<i>Dev. Std.</i>	183.261
<i>SUCEAVA</i>	<i>Medie</i>	100.68
	<i>Mediana</i>	41.00
	<i>Dev. Std.</i>	155.71
<i>BACĂU</i>	<i>Medie</i>	344.02
	<i>Mediana</i>	128.00
	<i>Dev. Std.</i>	573.49
<i>VASLUI</i>	<i>Medie</i>	60.98
	<i>Mediana</i>	23.00
	<i>Dev. Std.</i>	90.95

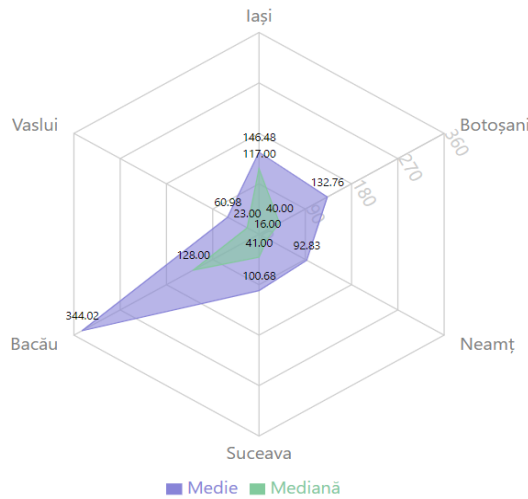
We observe that Bacău county has the highest values for all three descriptive values, indicating a high level of engagement, but also high variability. Vaslui county has the lowest mean and standard deviation, suggesting a lower but more consistent level of engagement. Neamț county has the lowest median, which may indicate that most posts have low engagement, with possible extreme values raising the mean. Iași and Suceava counties have moderate values for all statistics, placing them in the middle of the ranking. Botoșani county has a high standard deviation compared to its mean, indicating large variability in engagement.

The comparative descriptive analysis of mean and median for the engagement variable indicates Bacău county as having the highest level of engagement, with a significantly higher mean than the other five counties. However, the high standard deviation suggests there is large variability between posts, with some having very high engagement, while others possibly much lower. Vaslui county, on the other hand, has the lowest average level of engagement, but also the smallest standard deviation. This indicates a more consistent but generally lower level of engagement. Neamț county presents an interesting situation, having the lowest median, but moderate mean and standard deviation. This suggests that most posts have low engagement, but there are some posts with very high engagement that raise the mean. Iași and Suceava counties have similar performance, with moderate values for all statistical data. These seem to have a stable online presence, without extreme fluctuations. Botoșani county has an engagement average close to that of Iași and Suceava, but a much higher standard deviation.

This indicates greater inconsistency in post performance, with some likely having much greater success than others.

In conclusion, each county seems to have a different social media strategy or different audience. Bacău county manages to obtain the highest engagement, but with high variability. Vaslui county has a more modest but more consistent presence. The other counties fall between these extremes, each with its own particularities regarding online engagement.

A graphical representation of mean, median, and standard deviation of Engagement for the six counties (Iași, Botoșani, Neamț, Suceava, Bacău, and Vaslui), clearly highlights Bacău county as having the largest "footprint" in the graph, especially for mean and standard deviation. Vaslui county has the smallest "footprint", indicating lower values for all three measurements. The other counties have more balanced shapes, but with notable differences between them.



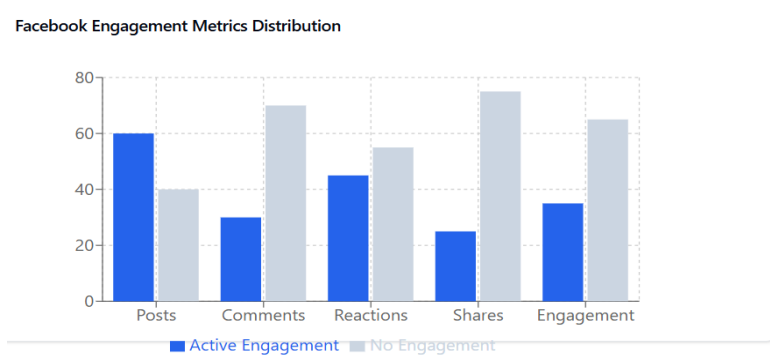
Figures 7: Mean/Median engagement comparison by counties

In figures 7, it is evident that Bacău has the largest difference between mean and median, which indicates a possible asymmetric distribution of data. Vaslui county has the lowest values for both mean and median. For most counties, the mean is significantly higher than the median, suggesting the presence of extreme values (outliers) that pull the mean upward.

Interpretation of engagement level

Represented as percentages (Figures 8), we observe that *Posts* have the highest level of active engagement, approximately 60%, indicating that users are active in content creation; *Comments*: Active engagement is lower, around 30%, with a significant difference between active and total engagement; For *Reactions*: Active engagement is approximately 40%, representing a popular form of interaction; *Shares*: have the lowest level of active engagement, around 20%, suggesting that users are more reluctant to share content; *Engagement (total)*: Active engagement is approximately 35%, representing an average of all interaction patterns.

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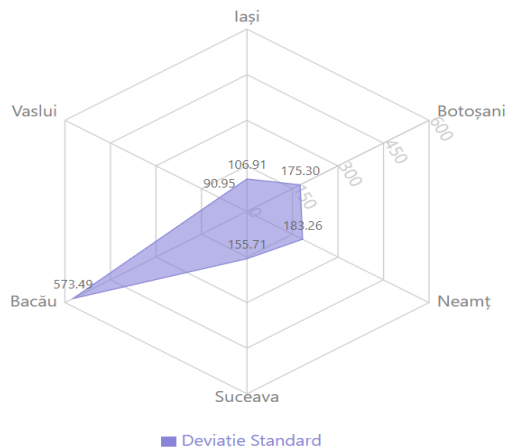


Figures 8. Interpretation of engagement level

We conclude that *Posts* generate the highest *active Engagement*, suggesting that original content creation should be encouraged to stimulate shares and comments. The difference between active and total engagement indicates potential for increasing the level of active user involvement.

1. Comparative analysis of standard deviation by counties

Bacău county clearly stands out with the highest standard deviation, creating a pronounced "peak" in the graph. Vaslui county has the lowest standard deviation, being closest to the center of the graph. Neamț and Botoșani counties have similar values, forming close points on the graph. Iași and Suceava have intermediate values, but significantly lower than Bacău county.



Figures 8: Standard deviation comparison by counties

Main identified patterns

Total absence of activity on certain days: June 9 shows zero scores for all measurements (*Posts, Reactions, Comments, Shares, Engagement*); We explain this pattern as being caused by legislative restrictions on local election day.

Patterns in small cities cluster: Zero median for all variables measured in cluster 2 (small cities) shows that at least half of small cities have minimal or nonexistent online presence.

Inactivity patterns on weekends: Lower or zero scores are frequently observed on weekends, suggesting reduced administrative activity outside normal working hours.

Significance of zero scores

Administrative significance: Indicates lack of consistent digital communication strategy; Suggests possible human and technical resource limitations, especially in small cities; May reflect absence of standardized procedures for online communication.

Significance on public authority-citizen relationship: Zero scores indicate interruptions in dialogue with citizens; May signal periods when citizen feedback is not collected or processed; Suggests potential lost opportunities for community interaction.

Statistical significance: Creates asymmetric data distribution; Significantly influences medians, especially for small cities cluster; Affects calculation of central tendency and dispersion measures.

Implications for E-Government development: Indicates need for administrative capacity development in digital environment; Suggests need for clearer policies regarding online presence; Highlights disparities between large and small cities in digital tool adoption.

Perspectives and research directions

Significant potential for engagement growth in small cities; Need for standardization of digital communication practices; Possibility of developing customized strategies based on patterns identified through this and similar analyses; Analysis of factors influencing *Reactions, Comments, and Shares* separately, instead of combining into a single *Engagement* score. Investigation of other variables that could influence *Engagement*: type of content posted, posting time, or audience demographic characteristics. A longitudinal analysis could provide more valuable information about how *Engagement* evolves over time and what factors influence it. Using more advanced regression techniques, such as ridge or lasso regression, could be useful for managing the multicollinearity problem.

Discussions

The analysis of the collected data reveals several significant aspects regarding the digital communication of local public authorities with citizens through institutional Facebook pages:

Digital communication disparities at local level: We observed important differences between large and small cities regarding the frequency and efficiency of digital communication. The zero median for all variables in the small cities cluster indicates a structural problem in digital communication adoption. The high variability in engagement (standard deviation 573.49 for Bacau vs. 90.95 for Vaslui) suggests a lack of consistent communication strategies.

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Engagement patterns: Reactions represent the dominant form of interaction (mean 56.34), followed by shares (mean 8.70) and comments (mean 7.24). A positive skewness is observed in the engagement distribution for all measured categories. Weekdays show significantly higher engagement compared to weekends.

E-governance implications: The large differences between clusters suggest the need for more territorially balanced digitalization policies. Frequent zero scores indicate the need for a more consistent online presence, while the high variability in engagement suggests opportunities for optimizing communication strategies.

Limitations and challenges

The analyzed period (30 days) may not be representative of long-term trends. Legislative restrictions (e.g., election day) influence communication patterns. The lack of data about human and technical resources of the institutions limits the understanding of the causes behind the observed disparities.

Conclusions

The analysis of engagement patterns in digital communication of local public authorities from the North-East region reveals the following concrete results:

Significant disparities between clusters: large cities record an average engagement of 259.57, almost three times higher than that of small cities (94.19). The high standard deviation (408.76 for cluster 1 vs. 279.45 for cluster 2) indicates high variability in communication efficiency.

Different performance across counties: Bacau County leads with the highest average engagement (344.02), Vaslui County records the lowest level (60.98). The variability between counties suggests different adoption of digital communication strategies.

Specific patterns identified: Systematic inactivity during weekends, higher engagement on weekdays, more concentrated activity in county capital cities.

Performance Indicators: Reactions dominate the forms of Engagement (mean 56.34), Shares and Comments have lower but more stable values, while Posts show the lowest variability (standard deviation 0.44).

Practical implications: The need for a standardized digital communication strategy, the opportunity for administrative capacity development in the digital environment, significant growth potential in small cities.

Recommendations: Implementation of consistent digital communication policies; Development of resources dedicated to online presence; Continuous monitoring and optimization of engagement strategies.

The results of our analysis provide an empirical basis for developing more efficient digital communication strategies in local public administration, highlighting both current challenges and opportunities for improvement.

Authors' Contributions:

The authors contributed equally to this work.

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