Citizen-Centric Smart Cities: Empowering Public Administration through Social Media and Citizen Engagement

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UDK: 3.072.7:004.7
35.072.7:004.7
323.21:004.7
https://doi.org/10.31297/hkju.23.4.5
Original paper / izvorni znanstveni rad
Received / primljeno: 19. 06. 2023.
Accepted / prihvaćeno: 25. 11. 2023.

This paper examines the role of social media and citizen engagement in empowering public administration for citizen-centric smart city development. It focuses on the Smart Cities Marketplace, an EU initiative providing a collaborative platform. The study evaluates citizen engagement on Twitter, analysing posts from the Smart Cities Marketplace page. Objectives include assessing the

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representation of smart city dimensions: Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance, and comparing engagement levels between posts with and without related keywords. Through quantitative and qualitative analyses, the study addresses citizen engagement and representation of smart city dimensions. The findings highlight the importance of innovative and tailored approaches to leverage social media as a catalyst for smart city development. Social media is pivotal in promoting collective accountability and shaping sustainable urban development, leading to adaptable, resilient environments that improve urban liveability and life quality.

Keywords: smart cities, social media, citizen engagement, public administration, sustainable development

1. Introduction

The Smart Cities Marketplace (SCM), an initiative by the European Union, is a dynamic platform that aims to foster the development of smart and sustainable cities. It brings together various stakeholders, including city authorities, the industry, small and medium-sized enterprises, financiers, and academia, to collaborate and create smart solutions for urban living (Anthony Jr, 2023). To facilitate this multi-stakeholder engagement effectively, the use of social media tools by public administrations is becoming increasingly important. This is particularly relevant for engaging citizens and promoting their active participation in smart city initiatives (Karika, 2019).

In recent years, there has been a considerable shift in the role of citizens from being mere consumers of public services to co-creators of smart sustainable cities (Anthony Jr, 2023). It has become more crucial than ever for public administrations to build trust and foster relationships with their constituents. In this context, (Glasco, 2019) stresses the importance of clarity, communication, and civic engagement in building trust in smart cities. Transparent communication and engagement with citizens can help create a shared vision for smart cities, increase buy-in for smart city initiatives, and ensure their successful implementation.

Social media, in particular, can play a significant role in enabling such engagement. As Ortiz (2020) elaborates in his doctoral thesis, social media

provides a platform for municipal governments to enhance transparency, participation, and collaboration among users of all generations. By offering easy access to information, providing a platform for discussion, and facilitating two-way communication, social media can help bridge the gap between the government and the governed. The direct and immediate feedback that social media provides also offers an opportunity for governments to respond swiftly to citizen concerns, fostering a sense of responsiveness and accountability.

However, the utilisation of social media by public administrations for citizen engagement in smart city initiatives is not without its challenges. Toth's (2019) examination of how Canadian municipalities are engaging the public in smart city initiatives reveals that despite its potential benefits, social media is not being used optimally. His findings indicate that there is a need for a strategic approach to social media utilisation, which includes clarity on the role of social media in public engagement, understanding of the unique characteristics and expectations of social media users, and effective use of different social media platforms to reach different segments of the population.

Thus, the SCM is a significant initiative in promoting the co-creation of smart, sustainable cities, with citizen engagement being a key component. Social media provides an important tool for public administrations to engage citizens in this process. However, the effective use of social media requires a strategic approach that considers the unique opportunities and challenges it presents. As the move towards smart cities continues to gain momentum, public administrations should invest in developing such strategies to leverage the full potential of social media for citizen engagement.

2. Literature Review

The contemporary interpretation of smart cities has advanced significantly, representing urban environments that exploit digital technologies to enhance municipal services, decrease expenses, optimise resource utilisation, and augment the quality of life for their inhabitants (Halegoua, 2020; Komninos, 2019). These scholars have focused on creating theoretical models that encapsulate the concept of smart cities, evaluating the implementation and potential impacts of digital technologies across diverse urban contexts on various facets of city life.

Smart cities hold an intriguing vision of urban sustainability, with the aim of balancing economic growth, environmental preservation, and social justice (Anthony Jr, 2023; Boccanelli, 2021). This balance is pursued through intelligent design, planning, and operation that employ digital technologies, as seen in smart grids and intelligent transport systems. Bernardes and colleagues (2018) emphasise that participatory governance is a fundamental principle of smart cities, with digital tools under smart city frameworks facilitating real-time citizen engagement and transforming citizens into active participants in decision-making processes.

However, encouraging citizen involvement presents significant and intricate challenges for public administration, as noted by Bernardo (2019) and Guenduez and Mergel (2022). Administrators must ensure digital platforms' accessibility, user-friendliness, and security while advocating their usage among citizens. Furthermore, social media platforms are powerful tools for boosting citizen involvement in smart cities, providing platforms for dialogue, feedback, and collaboration (Ortiz, 2020).

Despite these advancements, several challenges remain, and a citizen-centric approach to smart cities is essential, as argued by Degbelo and colleagues (2016). Similarly, the issue of urban mobility presents a unique set of challenges and opportunities in the era of smart cities, particularly under exceptional circumstances such as the COVID-19 pandemic (Stan, Tasențe & Rus, 2023).

The diverse dimensions of smart cities, including Smart Economy, Smart Mobility, Smart Environment, Smart People, and Smart Governance, have been explored by various scholars. Caragliu, Del Bo and Nijkamp (2011) and Aivaz and colleagues (2022) discuss the implications of digital technologies for economic development and transportation, respectively. Giffinger and colleagues (2007) highlight the potential of smart environmental technologies for sustainability, while Hollands (2008) underscores the importance of digital literacy and inclusiveness. In the realm of governance, Bélanger and Carter (2009) advocate for digital technology's transformative potential.

Contributions to the discourse on the potential of smart city technologies for municipal infrastructure management include works by Vershitsky and colleagues (2021), Kumar and colleagues (2020), and Lnenicka and colleagues (2022). They explore how digital tools can optimise resources, improve administrative processes, enhance service delivery, and increase urban resilience. Sontiwanich (2022) and Caperna, Minervino and Serafini (2017) emphasise the essential role of active citizen participation in shaping urban planning and operations, while Millard (2017) and Ncamphalala

(2019) examine the potential of technology in public service delivery. Troisi and colleagues (2022) delve into the issue of technology anxiety among citizens, particularly during crises like the COVID-19 pandemic.

In terms of digital governance, Milakovich (2021) and Esposito with colleagues (2023) highlight the transformative potential of advanced technologies in public service and municipal administration. Meanwhile, Martinicorena Gómara (2023) presents an economic perspective on smart cities, arguing that the transition to a smart economy can stimulate growth, enhance living standards, and promote sustainability. Roblek and colleagues (2020) explore the crossroads of the internet, sustainable development, and Society 5.0, suggesting that advanced technologies can facilitate a societal shift towards improved services, efficiency, and citizen engagement. Finally, Sandoval-Almazán and colleagues (2017) argue for well-structured digital government strategies that can streamline public administration and improve service delivery.

Thus, the concept of smart cities has expanded to encompass various dimensions, each integral to creating sustainable, inclusive, and efficient urban environments. Cities can fully leverage smart city initiatives by utilising digital technologies across these dimensions, enhancing services, improving the quality of life, and fostering a more sustainable future. Continued research and exploration are necessary to address the challenges and opportunities associated with each dimension, leading to the continuous evolution and advancement of smart cities.

3. Research Methodology

3.1. Research Objectives

(1) To assess the level of citizen engagement on social media, particularly Twitter, through the analysis of posts from the official Smart Cities Marketplace page.

(2) To examine the representation and emphasis of the six dimensions of smart cities (Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance) within the analysed Twitter posts.

(3) To compare the level of engagement between Twitter posts that contain keywords related to the six dimensions of smart cities and those that do not include such keywords.

3.2. Research Method

The research focused on analysing the Twitter posts from the official SCM page, covering the period from 26 June 2014 to 12 May 2023, which comprised a total of 3,222 posts. The data was centralised and collected using the Fanpagekarma platform.

The primary analysis revolved around the indicator of interactions, which is calculated by summing the total number of reactions, comments, and shares for each post. This indicator serves as a measure of the level of citizen engagement. The data analysis was conducted using the RStudio software, which facilitated data processing and allowed for the calculation of descriptive statistics.

Additionally, for qualitative analysis of the posts, a focus was placed on the six dimensions of smart cities mentioned above. Utilising the RStudio software, the posts were categorised into six distinct groups based on keywords associated with each dimension. This categorisation enabled an analysis of the representation and emphasis of the dimensions within the discourse on smart cities.

To gain further insights, the average, median, minimum, and maximum values of the interaction indicator on Twitter were calculated. This analysis was performed separately for posts that contained keywords related to the six dimensions of smart cities and those that did not include such keywords. By comparing the engagement levels between these two groups, valuable insights were obtained regarding the effectiveness of incorporating the dimensions of smart cities in social media communication.

By employing a combination of quantitative analysis using the Fanpagekarma platform and qualitative analysis based on the dimensions of smart cities, the research objectives pertaining to citizen engagement and the representation of smart city dimensions in the analysed Twitter posts were effectively addressed.

4. Findings

4.1. Smart Economy

The concept of Smart Economy is integral to the evolution of Smart Cities, acting as a vital component in their establishment and growth. Smart Economy encompasses the use of digital technologies and innovative

strategies to stimulate entrepreneurship, increase productivity, and bolster sustainable economic growth. This approach emphasises the development of a digital, innovative, and inclusive economy that is driven by knowledge and employs advanced information and communication technologies. A smart economy is intertwined with the essential elements of a smart city, like smart people, smart governance, smart mobility, smart living, and smart environment, and fuels these sectors' prosperity through digital transformation. It can contribute to solving complex urban problems, enable new business models, and create opportunities for digital innovation and entrepreneurship. The discussions around Smart Economy, therefore, represent a critical aspect of the broader discourse on smart cities, as it encapsulates the economic sustainability and resilience of urban ecosystems in the era of digitalisation.

The data at hand provide valuable insights into the online public's interest regarding Smart Economy within the broader context of Smart Cities, as evidenced through the interaction metrics of posts on the official Twitter page of the Smart Cities Marketplace (Table 1). It reveals several trends and patterns that can guide understanding and future strategic communication efforts.

Table 1: *Metrics of engagement for the "Smart Economy" dimension*

Keyword: Smart Economy	**Mean_INT**	**Median_INT**	**Min_INT**	**Max_INT**
No	9.06	0	0	138
Yes	11.60	10	0	42

Source: Authors.

Firstly, it is important to recognise that the theme of Smart Economy is relatively underrepresented, with just 0.93% of the total posts addressing it. This implies that despite the critical role of Smart Economy in Smart Cities, it does not dominate the discourse on the SCM's Twitter page. It could be an indication that other aspects of Smart Cities might be getting more attention, or perhaps the concept of Smart Economy might be inherently complex, making it less frequently discussed.

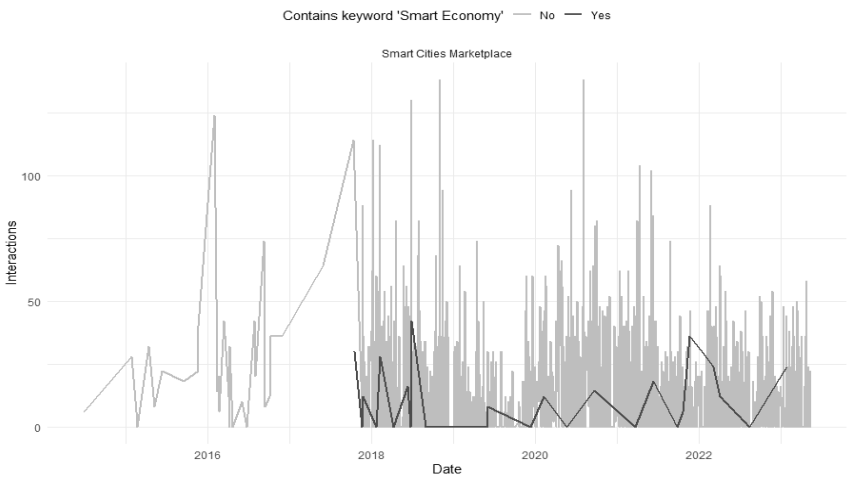
Interestingly, despite the low frequency of posts mentioning "Smart Economy", these posts appear to have a higher average level of engagement compared to those that do not. Posts with "Smart Economy" have an average interaction of 11.60 per post, while the average for posts not in-

cluding the term is 9.06. This suggests that while Smart Economy may not be a dominant theme in terms of quantity, it certainly seems to generate a higher quality of engagement, reflected in the above-average interactions.

However, it is worth noting that the median number of interactions for posts without the "Smart Economy" keyword is 0, compared to 10 for posts that do mention it. This suggests a skewed distribution, with a large number of "non-Smart Economy" posts getting minimal engagement. In contrast, posts related to Smart Economy appear to have a more consistent level of interaction, implying that this topic tends to consistently draw engagement.

The data further divulges a significant disparity in the maximum number of interactions. The post with the most interactions that does not mention Smart Economy had a whopping 138 interactions, while the most interacted post mentioning Smart Economy had 42 interactions. This difference can be due to the content and presentation style of specific posts, the time they were published, or the influence of other trending topics. Nevertheless, it reveals that non-Smart Economy posts have the potential to garner considerable engagement, even if their overall consistency of engagement is less reliable.

Figure 1: *Smart Economy: online public engagement*



Source: Authors.

Despite these insights (Figure 1), the post with the least interaction in both categories is zero, which means that certain posts fail to elicit any

engagement, regardless of their content. This could be due to a variety of factors, including the timing of posts, the use of less engaging formats, or perhaps, the topic not resonating with the audience.

In interpreting these results, it is crucial to consider the nature of social media engagement. The figures represent a quantitative aspect of the audience's interest, but they do not necessarily offer an in-depth qualitative understanding. Therefore, while the data indicates a higher level of consistent engagement with Smart Economy content, it does not explicitly reveal the audience's sentiment or the nuances of their interests.

It is also important to consider the implications of these results for the public engagement strategy of Smart Cities Marketplace. The apparent interest in Smart Economy, reflected in the higher average and median interactions, might suggest an opportunity to increase the focus on this area. By exploring more diverse and accessible ways to discuss Smart Economy, it could potentially boost overall engagement levels.

However, the maximum engagement level of 138 interactions for posts not mentioning Smart Economy also indicates that broader or other aspects of Smart Cities can attract significant interest. This may imply the need for a balanced approach in content generation, addressing various components of Smart Cities while emphasising Smart Economy in a manner that is accessible and resonates with the audience.

Upon conducting a qualitative analysis of Smart Cities Marketplace's Twitter posts pertinent to the Smart Economy, the data reveals three primary, recurring thematic strands:

– *Circular economy and sustainability*: This theme constitutes the majority of the content. It involves the transition towards a circular economy, which is an economic system aimed at eliminating waste and the continual use of resources. Smart Cities Marketplace regularly shares information and resources (like solution booklets and funding guides) that cities can use to make this transition. Emphasis is placed on cities and their role in leading the circular economy transition.
– *Decarbonisation and green economy*: A related but distinct theme is the focus on decarbonisation and the development of a green economy. There are multiple posts about the need for decarbonisation of the economy, particularly in the context of public transportation and achieving net-zero greenhouse gas emissions. The importance of green economy for the competitiveness of the European economy is also highlighted.

– *Data economy*: A third, less dominant theme, relates to the growing data economy within the context of smart cities. The *Citizen's Control of Personal Data* initiative is mentioned as an example of how citizens can manage and share their personal data, which can benefit themselves, society, and the wider data economy.

In these themes, cities are frequently depicted as key players in driving economic transitions towards more sustainable and innovative models.

4.2. Smart Mobility

Smart Mobility, a prominent concept in the discourse of Smart Cities, signifies the incorporation of technology into the transportation ecosystem to augment connectivity, efficiency, and sustainability. It is characterised by innovative utilisation of digital technologies to bolster public transport systems, advocate for electric vehicles, and optimise traffic management. Smart mobility is perceived as a crucial aspect of Smart Cities as it addresses the burgeoning needs of urban life, catalyses economic growth, and mitigates environmental impacts by prioritising sustainable and efficient transport alternatives. As urbanisation accelerates, the adoption of smart mobility solutions plays an instrumental role in achieving the larger vision of resilient and sustainable cities.

In the forthcoming analysis, the data encapsulated in Table 2 will serve as a pivotal reference point. The said table provides a comparative dissection of public interactions associated with the posts on SCM's Twitter feed, bifurcated based on the inclusion or exclusion of the keyword "Smart Mobility".

Table 2: *Metrics of engagement for the "Smart Mobility" dimension*

Keyword: Smart Mobility	**Mean_INT**	**Median_INT**	**Min_INT**	**Max_INT**
No	9.09	0	0	138
Yes	9.05	0	0	66

Source: Authors.

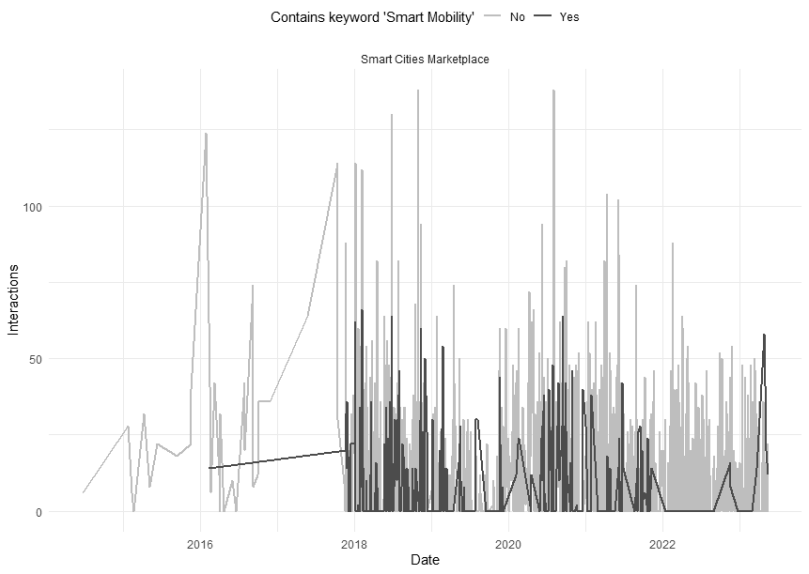
The analysis of posts from the official Twitter page of Smart Cities Marketplace indicates that Smart Mobility constitutes 11.54% of the overall content, denoting a fairly significant interest in this thematic area. This figure, however, represents only one side of the equation – the organisation's

focus. To attain a comprehensive understanding, it is equally essential to examine the audience's response, measured through the level of interaction (defined as the sum of reactions, comments, and shares) with these posts.

The interaction data bifurcates into two categories: posts containing the keyword "Smart Economy" and those without it. For posts including "Smart Economy", the average interaction per post stands at 9.05. Notwithstanding, it is crucial to recognise the potential skewing of this average by extreme values, as suggested by a median of 0. This dichotomy implies a high level of disparity within the interaction levels of these posts. While some have sparked substantial engagement (with the maximum reaching 66 interactions), others have failed to elicit any response, perhaps suggesting the specificity of this topic to a segment of the audience.

Meanwhile, posts excluding "Smart Economy" depict a slightly higher average interaction level of 9.09 per post. Here too, a similar pattern of disparity emerges with the median standing at 0, indicating a potential skewness in the data due to a few highly engaging posts. Interestingly, the maximum interaction level for this category is markedly higher, at 138 interactions, suggesting the existence of content themes that generate broader appeal among the audience.

Figure 2: *Smart Mobility: online public engagement*



Source: Authors.

Analysing these findings (Figure 2), it becomes evident that the theme of Smart Economy, though important in the smart city discourse, may not be the predominant driving force behind audience engagement on the Smart Cities Marketplace's Twitter page. While posts associated with Smart Economy garner considerable interaction, those without it achieve a slightly higher average and significantly more interaction at the upper end.

It is crucial to note that the "interaction" variable, being the sum of reactions, comments, and shares, inherently consists of different components that could be influenced by various factors. For instance, a controversial topic might stimulate a flurry of comments without necessarily attracting positive reactions or shares. Therefore, a more nuanced understanding could be achieved by separately investigating these components.

Furthermore, considering the median interaction level for both categories is zero, it might be beneficial for Smart Cities Marketplace to explore strategies for enhancing consistent engagement across all posts, rather than having sporadic ones that significantly outperform the others. This could involve identifying and leveraging more universally appealing themes or adopting more engaging content formats.

Additionally, delving deeper into the posts that achieved the highest interactions could uncover specific content or presentation elements that resonate well with the audience. These insights could then inform future content strategies to bolster audience engagement overall.

Based on the analysis of SCM's Twitter posts about Smart Mobility, three common themes can be identified:

– *Event participation & knowledge sharing*: A large number of posts are devoted to promoting and inviting participation in events such as conferences, workshops, and webinars focused on sustainable urban mobility, digital twins, disruptive technologies in mobility, and urban air mobility. Platforms like the *Urban Mobility Days*, *polisMOBILITY workshop*, *Nordic Edge Expo*, and the *CIVITAS Learning Centre* are often highlighted. These events serve as platforms for various stakeholders including policymakers, academics, local authorities, and practitioners to exchange experiences and success stories.
– *Funding opportunities*: Another recurring theme revolves around the availability of matchmaking services and funding for smart city projects, particularly under the European Smart Cities initiative. The intention is to encourage exploration of proven solutions and stimulate the submission of mobility initiatives for financial backing.

– *Sustainable mobility initiatives*: The posts also stress the importance of green and sustainable mobility, discussing topics ranging from clean energy to electric vehicles and from renewable energy integration to zero-emission communities. Initiatives and projects like *GrowSmarter* and the *Urban Air Mobility Initiative* receive considerable attention. There is also mention of specific European cities actively participating in these initiatives, showcasing their commitment to sustainable mobility and energy transition. The discourse further extends to urban air mobility, drones, and intelligent mobility as transformative elements of urban mobility ecosystems.

4.3. Smart Environment

The smart city concept, as it continues to evolve, is no longer confined to the integration of digital technologies to streamline services and enhance the quality of life of its inhabitants. One significant dimension of this concept that has come into focus in recent years is the "Smart Environment". This critical facet of a smart city involves the strategic use of technology to promote environmental sustainability. It encompasses a broad range of applications, including monitoring and managing air quality, improving waste management processes, efficient water management, and the use of renewable energy sources. Thus, Smart Environment is a multifaceted theme within the broader concept of smart cities, seeking to merge technology and environmental sustainability towards a healthier, more resilient urban life.

In the upcoming analysis, we will heavily reference the information compiled in Table 3. This table offers a comparative examination of public engagement associated with posts on the Smart Cities Marketplace's Twitter page, classified by whether they incorporate the term "Smart Environment".

Table 3: *Metrics of engagement for the "Smart Environment" dimension*

Keyword: Smart Environment	**Mean_INT**	**Median_INT**	**Min_INT**	**Max_INT**
No	9.06	0	0	138
Yes	11.1	10	0	56

Source: Authors.

The content analysis of the posts on the SCM's official Twitter page has shown that a rather small fraction, specifically 1.58% of the posts, addresses the theme of "Smart Environment". Considering that environmental sustainability has increasingly become a central concern globally, this relatively low percentage may seem surprising at first. However, it could be reflective of the multifaceted nature of smart city concepts, each with its unique significance and potential for public interaction.

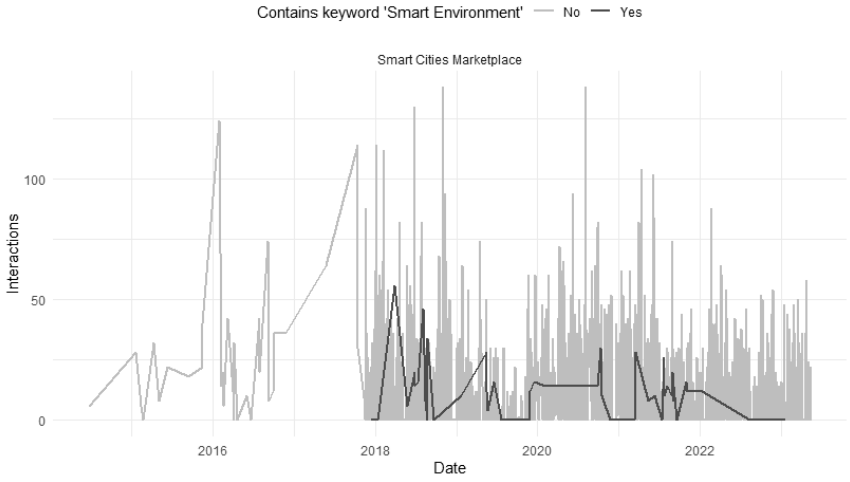
Moving on to public interest, which we have operationalised as interaction (sum of reactions, comments, and shares), an interesting observation can be made. Posts that contain the keyword "Smart Environment" show a higher mean interaction of 11.10 per post, compared to those that do not contain the keyword, which have a mean interaction of 9.06 per post. The median interaction for posts with the keyword is 10, suggesting that at least 50% of such posts garner ten or more interactions, indicating a relatively consistent level of engagement compared to posts without the keyword, where the median interaction is 0.

Despite the seemingly low percentage of posts that directly mention "Smart Environment", it is clear that when this theme is addressed, it generates more engagement from the public than other topics. This can be seen from the higher mean interaction per post for "Smart Environment" posts. This could be attributed to an increased public awareness and concern about environmental sustainability issues. It seems to suggest that the public is eager to engage with solutions that integrate technology and environmental sustainability, perhaps due to the pressing nature of climate change and environmental degradation.

However, it is essential to note that the range of interactions for posts without the keyword "Smart Environment" is broader. While the post with the least interactions registers at 0 in both categories, the post with the most interactions that do not mention "Smart Environment" peaks at 138, far exceeding the maximum of 56 interactions for posts with the keyword.

This wider range and higher peak (Figure 3) might imply that although posts on "Smart Environment" generally draw more consistent interaction, other topics within the Smart Cities paradigm can potentially ignite more significant public interest and engagement. It suggests that the public's interest in smart cities is diverse, and although "Smart Environment" does elicit a consistently higher interaction, other aspects of smart cities can drive even greater engagement, possibly due to their novelty, immediate applicability, or the unique context of each post.

Figure 3: *Smart Environment: online public engagement*



Source: Authors.

Upon reviewing the Twitter posts from SCM on the topic of "Smart Environment", we have categorised them under three broad themes for a qualitative analysis:

- *Sustainability and environmental management*: Numerous posts highlight the initiatives and efforts directed towards ensuring environmental sustainability, reducing the environmental impact, and managing resources efficiently. These include promoting sustainable urban freight logistics, discussions about Positive Energy Districts, encouraging the use of e-bikes, and sustainable solutions in public transportation systems.
- *Innovation and technological solutions*: The posts reflect a significant emphasis on innovative solutions to environmental and urban challenges. For instance, references are made to the use of big data, digital energy solutions, and smart technologies like drones for environmental monitoring. The call for the creation of "living labs" also falls under this theme, encouraging the co-creation of solutions for environmental and urban problems.
- *Community engagement and public participation*: Several posts underscore the importance of community involvement in urban environmental management. Engagement initiatives range from hosting webinars to facilitate knowledge sharing, calls for video submissions, invitations to action cluster meetings, to encouraging public partici-

pation in environmental monitoring. Public participation is seen as a critical element for achieving environmental and urban development goals.

4.4. Smart People

The notion of "Smart People" in the realm of smart cities refers to the digital literacy of the population, the inclusiveness of digital services, and the participation of citizens in the digital society. The emergence of smart cities pivots on the capacity of the population to utilise adeptly digital technologies to navigate an increasingly data-driven society. This requires not only access to digital services but the capability to use these services effectively. Digital literacy signifies the ability to use digital technology, communication tools, or networks to locate, evaluate, use and create information. Inclusiveness, on the other hand, concerns how these digital services are made accessible and beneficial to all, ensuring no one is left behind in the digital society. It is also pivotal to consider the role of citizen participation as this fosters a sense of ownership, ensures accountability, and paves the way for sustainable development of smart cities.

Our analysis and interpretation of the data gathered from Twitter posts on the official Smart Cities Marketplace page will provide insights (Table 4) into the online public's interest in smart cities, particularly the Smart People dimension.

Table 4: *Metrics of engagement for the "Smart People" dimension*

Keyword: Smart People	Mean_INT	Median_INT	Min_INT	Max_INT
No	9.07	0	0	138
Yes	10.3	0	0	48

Source: Authors.

Within the data, Smart People-themed posts account for 1.48% of total posts. The key question that arises is whether this relatively small percentage resonates with the audience and garners significant interactions.

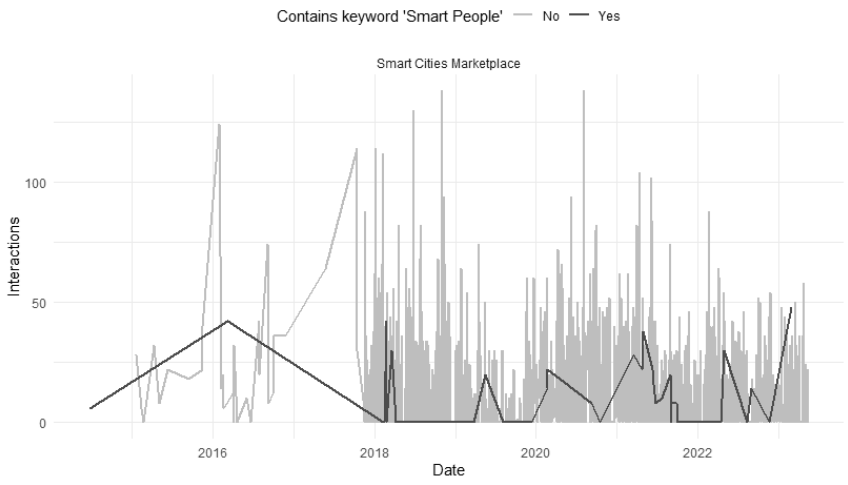
To investigate this, we utilise a measure of interaction, which includes reactions, comments, and shares on posts. We compare posts with and without the keyword "Smart People" to glean potential disparities in audience engagement.

Posts containing "Smart People" average 10.30 interactions per post, with a median of 0. The range of interactions spans from 0 to a high of 48. On the other hand, posts that do not contain the keyword "Smart People" average 9.07 interactions per post, also with a median of 0, yet with a wider range from 0 to a maximum of 138 interactions.

This data suggests that although "Smart People" related posts constitute a small percentage of total posts, they still generate a higher average interaction rate compared to other posts. This implies a degree of interest from the audience in topics relating to digital literacy, inclusiveness, and citizen participation in digital societies. The higher average could indicate that the "Smart People" content is resonating with and engaging the audience, leading to more interactions.

However, a contrasting observation emerges when we look at the maximum interactions recorded (Figure 4). Posts unrelated to "Smart People" have achieved a far higher peak of interaction, specifically 138, versus the 48 from "Smart People"-centric posts. This discrepancy could point towards the potential for certain non-"Smart People" topics to ignite substantial interest among the audience and trigger an outpour of interactions, despite the lower average.

Figure 4: *Smart People: online public engagement*



Source: Authors.

The observed medians reveal another aspect of the engagement pattern: half of both "Smart People" and non-"Smart People" posts record zero

interactions. This trend indicates that a significant portion of content, regardless of the theme, fails to stimulate any visible audience response. This could be due to various factors, such as the time of posting, the format of content, or even algorithmic visibility issues.

Based on the analysis of the tweets, it is possible to identify three main thematic categories concerning the "Smart People" initiative from the Smart Cities Marketplace:

– *Events and webinars*: This theme appears frequently in the tweets, announcing various upcoming events, webinars, and forums. These engagements aim to foster discussions about the implementation and advancement of Smart City projects. The target audience includes both individuals and organisations interested in learning about and contributing to Smart City initiatives. Examples of tweets in this category include the promotion of matchmaking events and forums.
– *Citizen engagement and participation*: The Smart Cities Marketplace emphasises the importance of involving citizens in the transition to smarter cities. The tweets in this category stress the significance of considering citizens' needs, opinions, and aspirations when planning and implementing Smart City initiatives. Furthermore, there is a focus on the importance of citizen participation in decision-making processes, the use of personal data, and the advancement of digital services.
– *Innovation and sustainable development*: Several tweets focus on innovative practices, projects, and sustainability in the context of Smart Cities. The content shared includes advancements in Urban Data Platforms, energy-efficient solutions, and the development of new models for better environmental impact. The goal of these tweets is to promote sustainable urban development that improves the quality of life for the maximum number of people with the least environmental impact.

Even though most tweets do not stimulate visible audience engagement, the thematic trends observed in the dataset underline the core mission of the Smart Cities Marketplace: fostering discussions, encouraging citizen involvement, and promoting innovative solutions for sustainable urban development.

4.5. Smart Living

The concept of "Smart Living" encapsulates the profound changes and improvements that digital technology can bring to various aspects of hu-

man life. It reflects an integrative approach to the digitalisation of many vital domains, such as safety, health, housing, and cultural activities. The key premise of "Smart Living" is the use of digital technology to significantly enhance the quality of life for individuals and communities. This may involve the utilisation of intelligent surveillance and emergency response systems for safety, the application of telemedicine and health tracking devices for health, the implementation of smart home systems for efficient and sustainable housing, and the employment of digital platforms that foster community connections and cultural exchange. The vision of "Smart Living" foresees a future where digital technology plays an indispensable role in building and maintaining liveable, sustainable, and vibrant cities.

The analysis of Twitter posts (Table 5) from the official Smart Cities Marketplace page provides intriguing insights into public engagement with the concept of "Smart Living" and the broader discourse on smart cities.

Table 5: *Metrics of engagement for the "Smart Living" dimension*

Keyword: Smart Living	Mean_INT	Median_INT	Min_INT	Max_INT
No	9.06	0	0	138
Yes	19.6	12	0	48

Source: Authors.

From the total Twitter posts analysed, a small fraction, 0.27%, specifically address the topic of "Smart Living". This low frequency might initially suggest a lack of emphasis or focus on "Smart Living" within the smart cities narrative from the SCM page. Given the wide-ranging aspects "Smart Living" encompasses, this percentage may underestimate the total focus on "Smart Living" if related topics are discussed under different keywords or themes.

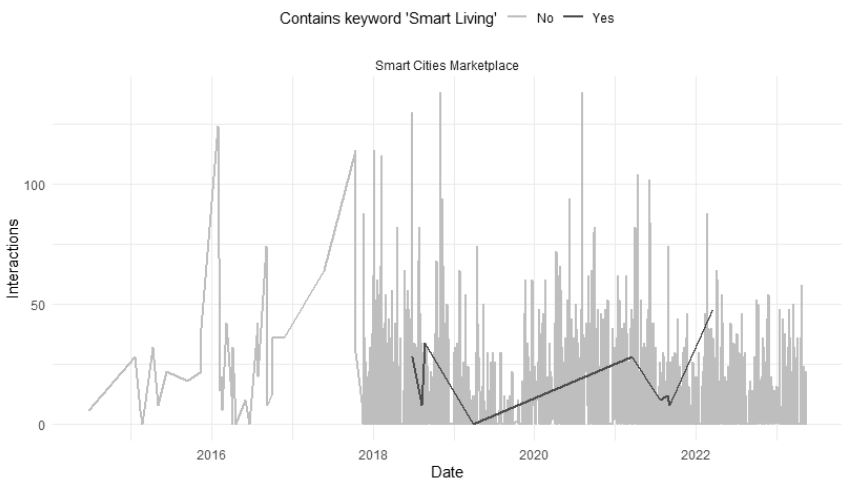
However, when we delve into audience engagement—measured by the sum of reactions, comments, and shares—an interesting pattern emerges. Posts that contain the keyword "Smart Living" have an average interaction of 19.60 per post, with the median interaction at 12. The post with the least interactions stands at 0, while the one with the most interaction received 48 interactions. Despite the low percentage of posts that directly discuss "Smart Living", these posts garner more average interactions compared to other posts.

Contrastingly, posts that do not contain the keyword "Smart Living" have an average interaction of 9.06 per post, with the median standing at 0. These posts range from 0 to 138 interactions, with the post with the highest interaction markedly outperforming any "Smart Living" post.

There are several interpretations of these results (Figure 5). Firstly, the higher average interactions on "Smart Living" posts may indicate that although the term is not frequently used, when it is, it resonates with the audience, perhaps due to its comprehensiveness and vision of a technology-integrated lifestyle. This could suggest that the audiences of the Smart Cities Marketplace Twitter page have a vested interest in the holistic improvements digital technology can bring to everyday life, thus engaging more when this theme is addressed.

Conversely, the significantly high interaction count (138) for a non-"Smart Living" post suggests that specific topics outside of "Smart Living" can spark substantial engagement. This implies that there are other themes or issues within the broader smart cities discourse that strongly resonate with the audience.

Figure 5: *Smart Living: online public engagement*



Source: Authors.

The analysis of the selected tweets from Smart Cities Marketplace reveals three key themes within the discourse around "Smart Living". The themes include:

– *Quality of life and citizen wellbeing*: A recurrent topic within these tweets is the emphasis on improving the citizens' quality of life. Many tweets, including those promoting the Smart Cities Marketplace Forum 2022 and those quoting Paul Cartuyvels, highlight the drive to improve the quality of life for as many people as possible. This aligns with the essential vision of Smart Living, which seeks to leverage digital technologies to enhance the quality of life. Notably, Commissioner Mariya Gabriel's quote explicitly states that the "smartness" of cities and communities is contingent on supporting the quality of life of their citizens, underscoring that citizen wellbeing is a central tenet of the Smart Living discourse.
– *Innovation and environmental sustainability*: Several tweets encapsulate the symbiosis between innovation and environmental sustainability, a defining characteristic of the Smart Living vision. For instance, Paul Cartuyvels' quotes explicitly link the pursuit of quality of life to achieving the lowest environmental impact, thereby integrating the environmental sustainability dimension. In another tweet, the connection between a Smart City, innovation, the Internet of Things, and environmental sustainability is explicitly made. Here, the focus is on harnessing innovative technologies, like IoT, to create smart cities that not only improve residents' lives but also ensure environmental sustainability.
– *Urban mobility and infrastructure*: Another common theme is the focus on urban mobility and infrastructure as critical components of the Smart Living concept. One tweet emphasises that the successful management of urban mobility will determine how well future cities can guarantee the quality of life for their citizens. This suggests that an effective and sustainable urban mobility system is a prerequisite for Smart Living. The Smart Cities Marketplace seems to recognise the importance of urban mobility, a key infrastructure element, in creating cities that are not only technologically advanced but also liveable.

4.6. Smart Governance

Smart Governance is a concept that applies digital technology to enhance governance processes, promote transparency, foster citizen participation, and deliver public services more effectively. It is a vital component of smart cities, helping to streamline public administration, ensure efficient resource

allocation, and promote civic engagement. By leveraging digital technologies and data analytics, smart governance can provide solutions that are responsive, inclusive, and efficient, thereby fostering a more democratic, transparent, and service-oriented approach to public administration.

From the data provided (Table 6), it can be seen that Smart Governance is a minor theme in the Twitter posts from the official page of Smart Cities Marketplace, with only 0.40% of total posts discussing this topic. Despite the low number of posts, the public interest, as gauged by interactions (the sum of reactions, comments, and shares), is relatively high.

Table 6: *Metrics of engagement for the "Smart Governance" dimension*

Keyword: Smart Governance	Mean_INT	Median_INT	Min_INT	Max_INT
No	9.08	0	0	138
Yes	10.3	10	0	48

Source: Authors.

Posts with the keyword "Smart Governance" have an average of 10.30 interactions per post, with the median being 10. The post with the least number of interactions has none, while the post with the most interactions has 48. Compared to the posts without the keyword "Smart Governance", which have an average of 9.08 interactions per post and a median of 0, posts concerning Smart Governance seem to draw slightly more engagement from the audience. The highest number of interactions for a post without the keyword is significantly high at 138, suggesting that certain topics other than Smart Governance can generate significant interest.

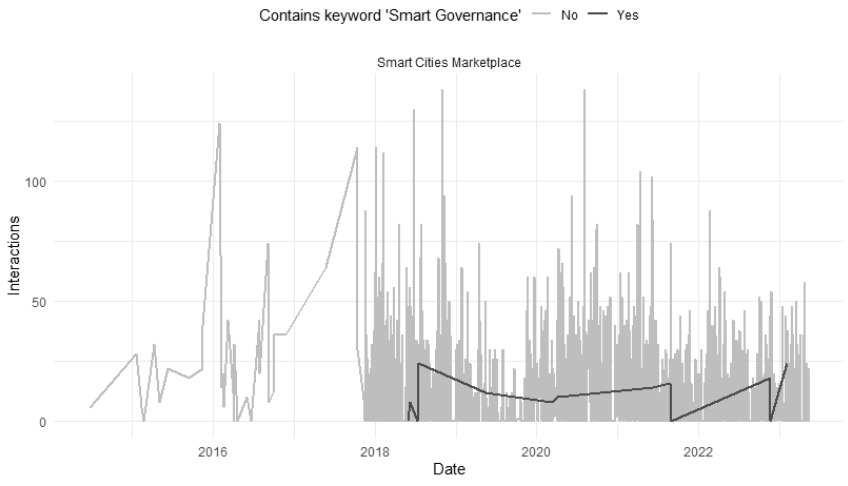
The slightly higher average number of interactions on posts about Smart Governance suggests that there is a modest but notable interest in this theme among the followers of the Smart Cities Marketplace Twitter page (Figure 6). The fact that the median number of interactions is also higher for posts about Smart Governance further indicates that such posts tend to generate a consistent level of engagement. This suggests that discussions about Smart Governance resonate with a certain segment of the audience, who may be interested in the ways digital technology can be harnessed to improve governance and public administration.

However, the relatively small percentage of posts about Smart Governance (0.40% of total posts) implies that this topic is not a major focus of the discourse on the Smart Cities Marketplace Twitter page. This could

be due to a variety of reasons, such as the focus of the Smart Cities Marketplace on other aspects of smart cities, or the perceived complexity or niche nature of the topic of Smart Governance.

The maximum number of "interactions" on a post about Smart Governance (48 interactions) is significantly lower than the maximum number of interactions on a post without this keyword (138 interactions). This suggests that while Smart Governance can attract a consistent level of interest, it may not have the same potential to generate viral posts or to engage a wider audience outside of those specifically interested in this theme.

Figure 6: *Smart Governance: online public engagement*



Source: Authors.

Upon analysing the provided Twitter posts from SCM that contain the keyword "Smart Governance", the following three common topics emerge:

– *Research and publications*: Several posts reference and promote research and publications that relate to smart governance. Examples include a publication regarding "Systemic Changes in Governance" and the research project DIGISER that measures digital innovation of governance on the local level. These posts emphasise the Marketplace's role in producing, curating, and disseminating knowledge in the field of smart governance.
– *Events and workshops*: A number of posts announce and recap events, such as workshops and forums, that focus on aspects of smart govern-

ance. These posts highlight the involvement of the Smart Cities Marketplace in organising and participating in events to foster dialogue, exchange ideas, and build capacity in the area of smart governance. For instance, the "Governance & Digitalisation" workshop, the Local Collaborative Governance Booth Session at the Smart City Expo, and the "Smart Economy & Governance" session at the International Forum of Smart Cities and Communities all underscore the importance of events as platforms for learning and networking in smart governance.

– *Collaboration and citizen engagement*: Several posts emphasise the importance of collaboration and citizen engagement in smart governance. I.e., the mention of the UAM Initiative Cities Community's new membership, the invitation to participate in the development of a "new open integrated governance model" via the Smarticipate Horizon 2020 project, and the promotion of the "SmartEnCityAcademy" all underscore the role of collaboration, community engagement, and learning in the realisation of smart governance.

5. Discussion

The role of social media in shaping the narrative and fostering citizen engagement around smart city initiatives cannot be overstated. The Smart Cities Marketplace's Twitter page serves as a powerful platform for promoting the multifaceted aspects of smart city development. By effectively leveraging this platform, public administrations can not only increase transparency but also encourage citizen participation in the co-creation of sustainable urban environments.

However, a nuanced approach to social media utilisation is critical. As the data analysis indicates, different smart city themes elicit varying levels of engagement. While some topics consistently resonate with the audience, others may generate fewer average interactions but have the potential to reach broader engagement peaks. Therefore, public administrations need to adopt a strategic approach to content creation and dissemination, understanding the unique characteristics and expectations of social media users.

Moreover, social media platforms should not only be viewed as tools for broadcasting information but also as spaces for dialogue and collaboration. Encouraging and facilitating citizen engagement in discussions around

smart city themes can provide valuable insights, help to build trust, and foster a sense of shared responsibility for sustainable urban development.

Finally, given the increasing importance of digital literacy in contemporary society, public administrations should also invest in enhancing the digital skills of the population. This will ensure that citizens are not just passive consumers of digital services, but active participants in the digital society, able to leverage the potential of technology for their benefit and the sustainable development of their cities.

Thus, while the journey towards smart, sustainable cities presents several challenges, the effective utilisation of social media, fostering citizen engagement, and promoting digital literacy can go a long way in ensuring the successful realisation of this vision.

6. Conclusions

Based on the collected evidence, it is clear that social media is not merely an accessory but an indispensable tool in establishing and maintaining smart, sustainable cities. This importance derives from its versatility as a platform for public administrations that seek to engage citizens in a more direct and interactive way. To reflect the intricacy of contemporary urban ecosystems, public authorities need to develop adaptable tactics that surpass conventional governance methods. They ought to furnish dynamic frameworks which not only inform but also foster active engagement from the public in generating a shared outlook on sustainable urban lifestyle.

Moreover, the significance of social media in promoting group responsibility and enabling transparent communication cannot be exaggerated. It facilitates the development of more resilient and adaptable urban environments. Social media is, therefore, a dependable tool to encourage collective dedication to sustainability, fairness, and democratic leadership from both citizens and policymakers.

Our findings highlight the extended definition of digital literacy in contemporary society. It goes beyond the mere proficiency in digital tools and software. The new paradigm also entails in-depth comprehension and critical analysis of the technological ecosystem and its intricate societal implications. Consequently, elevating digital literacy to a central tenet of public administration strategy instead of being a peripheral objective is pivotal. This will guarantee that citizens are not passive consumers, but rather active contributors to the shaping of smart and sustainable cities.

Public administrations face significant difficulties in navigating the complexities of smart city development. However, this research argues that the deliberate incorporation of social media strategies can aid in surmounting many of these challenges. By promoting digital literacy and encouraging active civic engagement, public administrations can better align with the aspirations and needs of their citizens, driving the collective journey towards smart, sustainable urban living.

In conclusion, it is crucial to recognise the transformative potential that social media platforms offer when used strategically and inclusively. They serve as more than just means for exchanging information; they also facilitate dialogue, collaboration, and co-creation, enhancing urban mobility, promoting economic growth, and improving transparency in governance.

Moving forward, numerous ground-breaking areas for research could expand upon the initial insights of this study. Conducting longitudinal studies could delve into the long-term effects of social media integration in smart city development, whilst comparative analyses between cities could uncover best practices. Additionally, formulating quantitative impact metrics, examining the policy implications, and exploring the ethical concerns surrounding citizen data are all promising avenues for scholarly inquiry. These designated areas of concentration may facilitate a deeper, multidimensional comprehension of social media's ability to endow both public administrations and citizens with potential in the pursuit of smarter, more sustainable cities.

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CITIZEN-CENTRIC SMART CITIES: EMPOWERING PUBLIC ADMINISTRATION THROUGH SOCIAL MEDIA AND CITIZEN ENGAGEMENT

Summary

The European Union's Smart Cities Marketplace fosters multi-stakeholder collaboration to promote smart, sustainable cities. Social media platforms, notably Twitter, are leveraged to engage citizens actively in these urban sustainability initiatives. Despite its potential, social media remains underutilised by public administrations, highlighting the need for a strategic approach to capitalise on its unique characteristics, such as immediate feedback and two-way communication. In recent years, the concept of smart cities has broadened to cover various dimensions, including Smart Economy, Smart Mobility, Smart Environment, Smart People, Smart Living, and Smart Governance, all of which aim to create more sustainable, efficient, and inclusive urban environments. However, fostering citizen participation through digital platforms presents challenges, necessitating accessibility, user-friendliness, and security. This study analysed 3,222 posts from the official Smart Cities Marketplace Twitter page using Fanpagekarma and RStudio. Results indicated varying levels of engagement across the six dimensions, suggesting that strategic content diversification may enhance overall audience engagement. Despite representing a smaller share of total posts, themes like "Smart Economy" and "Smart Environment" showed a higher average level of engagement, while themes like "Smart Mobility" and "Smart Governance", despite their importance, may not be the primary drivers of audience engagement. This study concludes that a balanced approach towards content dissemination, factoring in various smart city dimensions, can maximise overall audience engagement. It underscores the social media's transformative potential for dialogue, collaboration, and co-creation in smart city development when strategically utilised.

Keywords: *smart cities, social media, citizen engagement, public administration, sustainable development*

PAMETNI GRADOVI USMJERENI NA GRAĐANE: OSNAŽIVANJE JAVNE UPRAVE PUTEM DRUŠTVENIH MEDIJA I UKLJUČIVANJEM GRAĐANA

Sažetak

Platforma 'Smart Cities Marketplace' Europske unije potiče suradnju više dionika u promicanju pametnih i održivih gradova. Društveni mediji, posebice Twitter, koriste se za aktivno uključivanje građana u ovakve inicijative urbane održivosti. Unatoč potencijalu, javne uprave i dalje nedovoljno koriste društvene medije što naglašava potrebu za strateškim pristupom u iskorištavanju njihovih jedinstvenih karakteristika kao što su neposredna povratna informacija i dvosmjerna komunikacija. Posljednjih godina koncept pametnih gradova proširio se na različite dimenzije, uključujući pametnu ekonomiju, pametnu mobilnost, pametan okoliš, pametne ljude, pametno življenje i pametno upravljanje, a sve u cilju stvaranja održivijeg, učinkovitijeg i uključivijeg urbanog okruženja. Međutim, poticanje sudjelovanja građana putem digitalnih platformi predstavlja izazove čije rješenje zahtijeva pristupačnost, lakoću korištenja i sigurnost društvenih medija. Ova studija analizirala je 3.222 objave sa službene Twitterove stranice Smart Cities Marketplace koristeći programe Fanpagekarma i RStudio. Rezultati su pokazali različite razine uključivanja u navedenim dimenzijama što sugerira da strateška diverzifikacija sadržaja može povećati ukupni angažman javnosti. Unatoč tome što predstavljaju manji udio u ukupnim objavama, teme poput pametne ekonomije i pametnog okoliša pokazale su višu prosječnu razinu uključivanja, dok teme poput pametne mobilnosti i pametnog upravljanja, unatoč njihovoj važnosti, nisu primarni pokretači angažmana javnosti. Studija zaključuje da uravnotežen pristup širenju sadržaja, uzimajući u obzir različite dimenzije pametnog grada, može povećati ukupni angažman javnosti. Studija naglašava transformativni potencijal društvenih medija za dijalog, suradnju i zajedničko stvaranje u razvoju pametnih gradova kada je njihovo korištenje strateški usmjereno.

Ključne riječi: *pametni gradovi, društveni mediji, uključivanje građana, javna uprava, održivi razvoj*