Natural Language Processing for Sustainable and Ethical Citizens' Participation and Public Service Co-Creation: Current Applications, Methods, and Future Challenges

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Abstract

Natural Language Processing (NLP) is increasingly adopted by government for supporting and enhancing citizens' participation and public service co-creation. However, governments that implement NLP technologies like chatbots and sentiment analysis tools for the above purposes should now address critical concerns including ethical implications and sustainability issues. The study investigates NLP uses for supporting and enhancing citizens' participation and public service co-creation and reveals outcomes as well as the ethical, energy, and sustainability challenges posed. In particular, we aim to address two research questions: the first of them concerns the impacts of NLP on public engagement, participation, and co-creation in public organizations, and the second research question addresses the ethical, energy, and sustainability challenges that the use of NLP in public organizations faces. For this purpose, we conduct a systematic literature review based on PRISMA methodology. It is concluded that NLP promises inclusive solutions for public engagement, participation, and co-creation but is hindered by algorithmic bias, data privacy risk, and the environmental impact of large-scale language models.

Keywords

Natural Language Processing, Participation, Engagement, Co-Creation, Ethical AI, Sustainability,

1. Introduction

In the last decade, Natural Language Processing (NLP), which involves artificial intelligence (AI) that enables machines to understand human language, has increasingly been adopted by public services and changes citizens participation and public services' co-creation [1]. As more governments globally adopt such technologies [2], [3], it is important to understand how they are used as well as their impact. NLP is a technology whereby machines or computers comprehend, manipulate, generate, or respond to human language in relevant contexts [4], [5]. It helps government agencies deliver more personalized and context-dependent services through automatization and enhancement of vast volumes of text-based information, such as citizen inputs [6], [7], policy briefs, regulatory guidance [8], and social media postings [9]. The usage of NLP in public administration refers to the automation of responses to citizens'

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questions using chatbots, opinion-measuring systems that gauge public opinion, multilingual support systems, and intelligent data platforms that support policymaking [10]. These enhance citizen participation in public decision-making processes, citizen engagement with government services and information and public service co-creation through the usage of collaborative platforms and other mechanisms such as feedback mechanisms. Such applications include systems with automated responses, sentiment analysis tools for gauging public opinions, multilingual support systems capable of breaking down language barriers and intelligent platforms that support citizens in contributing to design and improvement of services [11].

Citizen participation refers to the involvement of citizens in governmental decision-making processes (e.g., policy development and public consultations) [12]. Citizen engagement encompasses the broader interaction between citizens and public organizations, including information seeking, service usage and communication [13], [14]. Finally, service co-creation involves collaborative processes where citizens actively contribute to the design, development and improvement of public services alongside government officials [15], [16].

At the same time, as NLP technologies become more widely used for the above purposes, they raise significant ethical governance concerns, necessitating greater transparency to mitigate algorithmic bias, and sustainability issues due to the ecological cost of these systems[17], [18]. Ethical governance for NLP means eliminating inherent biases in its training algorithms and datasets so that public services could be more inclusive and not reinforce existing social inequalities. Also, large-scale NLP applications, particularly those that use powerful deep learning architectures like BERT, GPT, and other models, consume a considerable amount of energy, raising concerns about their carbon footprint [19]. Sustainable NLP implementation could involve innovations ranging from computational efficiency to anything that optimizes a model and eco-friendly use of data centers.

So, our study aims to address the following two research questions:

RQ1: What are the effects of the use of NLP by public organizations on citizens' participation, engagement, and services co-creation?

RQ2: What are the key ethical, energy efficiency, and sustainability challenges that the use of NLP in public organizations for these purposes faces?

For this purpose, we conduct a systematic literature review based on PRISMA methodology [20-21], as described in the following section.

Our research attempts to provide a systematic assessment of the new NLP applications in these three specific areas, identify challenges in the current approach, and make recommendations regarding future research directions. The final aim is to provide insight for policymakers, technologists, and researchers on how to apply NLP ethically and sustainably while maximizing its potential for transforming public administration into a genuinely responsive, collaborative, inclusive, and green endeavor.

The paper is structured as follows: The next section 2 describes our methodology: the systematic review process we conducted in accordance with the PRISMA guidelines. In sections 3 and 4 the results are presented, while the final section 5 includes our conclusions.

2. Methodology

As mentioned in the Introduction we performed a systematic literature review to investigate the role of NLP in citizens' participation, engagement and public service co-creation, specifically in the light of ethical and sustainability considerations. We adopted this approach as systematic reviews allow for structured and replicable synthesis of existing research on a topic. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used to enforce transparency and methodological rigor; this approach aligns with established guidelines for rigorous literature reviews [20] and recognizes varied review strategies (e.g., 'miner' vs. 'prospector' approaches, [21]). To ensure a comprehensive and inclusive collection of relevant literature, the search was conducted across Scopus and Google Scholar databases. For addressing the RQ1 a Boolean search query was formulated as follows:

" ("Natural Language Processing" OR "NLP") AND ("public service" OR "public administration" OR "public sector" OR "public governance") AND ("co-creation" OR "co-production" OR "participation" OR "engagement" OR "consultation")".

For addressing RQ2, we focused on papers within the retrieved set of papers using the above query, which specifically mentioned "ethical" OR "ethics" OR "sustainability" OR "energy" in their content, recognizing that papers addressing ethical and sustainability challenges are a subset of the broader literature retrieved by the main query.

Peer-reviewed journal articles and conference proceedings were searched for recent and related studies for the period from 2017 to date. The only language included in the publications is English to ensure uniformity in analysis. Articles that were purely technical advancements in NLP but had no reference to use and implications in government were excluded. Thus, this directly addresses RQ1 regarding the use of NLP by government in the areas of citizens' participation, engagement and co-creation, while also setting forth propositions on how ethical and sustainability issues raised in the RQ2 might be approached. Predetermined inclusion and exclusion criteria ensured the selection of valid, relevant studies while maintaining sufficient scope for comprehensive analysis. Excluded were studies unrelated to public sector context, non-peer-reviewed articles, non-English publications, and those lacking full-text access. This screening process ensured both research questions were addressed, focusing on NLP's impact on governance, inclusiveness, and ethical considerations. Figure 1 outlines the PRISMA-based screening steps.

In the identification phase, our search yielded 112 articles. With no duplicates, all were screened based on titles and abstracts for thematic relevance: 55 papers were excluded for being outside the research scope, leaving 57 for full-text review. During the eligibility stage, these 57 studies were critically evaluated for methodological quality, relevance, and alignment with research questions. Ten were excluded due to methodological flaws, unavailable full texts, or low relevance. In the final inclusion phase, 47 studies met all criteria, focusing on NLP in the areas of citizens' participation, engagement, co-creation, sustainability, and ethics. Data from each selected study was systematically collected and coded for thematic synthesis. Extraction included bibliographic details (authors, year, publication), NLP application type (e.g., sentiment analysis, chatbots, translation, text mining), and public sector domain (e-government, participatory governance, policymaking).

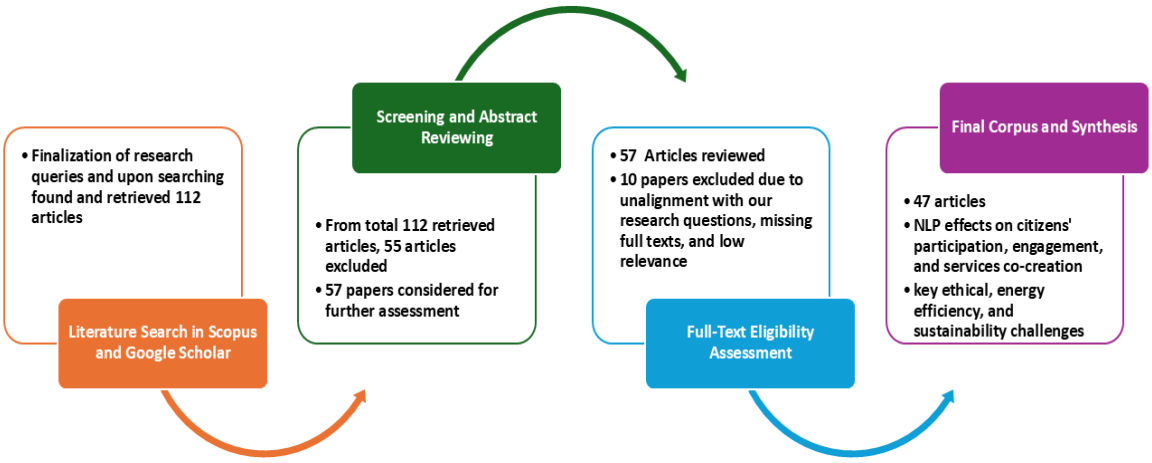

Figure 1: PRISMA-based systematic review process illustrating article selection and analysis.

For RQ1, we performed a descriptive analysis to map NLP applications and their impact on citizens' participation, engagement and public service co-creation. Key attributes (year, context, NLP tools, domains, outcomes) were extracted, tabulated, and summarized to identify dominant patterns. For RQ2, we conducted a thematic analysis focusing on the subset of studies within the identified, 25 papers that (as mentioned above) specifically mentioned "ethical" or "ethics" or "sustainability" or "energy" in their content. Study results were coded line-by-line, grouped into descriptive themes, and synthesized into higher-level analytic themes related to ethics, and sustainability. To ensure rigor, multiple researchers coded independently and resolved differences through discussion. This synthesis highlighted overarching concerns such as fairness, transparency, and environmental impact. Together, these analyses offered comprehensive insights linking study features to themes on NLP's role in governance.

3. Effects of NLP on Citizen Participation, Engagement, and Services Co-Creation in Public Organizations

There are many papers describing the use of AI-based NLP applications in government that aim to enhance citizens' participation, engagement and co-creation; sentiment analysis is used to gauge public opinion on the quality of public services. Zhou et al. (2022) [22] applied pretrained Chinese language models to thousands of policy documents to assess public support for policy instruments, while Shackleford et al. (2023) [23] combined a VADER lexicon with an SVM to predict South African Twitter sentiment of citizens' opinions on various topics. Recent advances rely on deep learning models (such as BERT, GPT) for text classification and sentiment analysis, enhancing the processing of citizen feedback and decision-making. Oksama et al. (2024) implemented "Tanya Jaksa," a GPT-4-powered chatbot in a prosecutor's mobile app, streamlining citizen interactions [24]. Recent studies showcase diverse global applications of NLP in public services. Topic modeling of over 200,000 UK general practice reviews identified staff interactions and bureaucracy as key satisfaction factors [25]. In Greek municipalities, five service-related topics were extracted from Google reviews in order to guide improvements[14]. LDA analysis of 1.37 million Spanish EMS dispatch notes revealed 15 emergency-related themes[26]. In São Paulo, sentiment analysis of 7,689 primary care reviews showed mostly

positive feedback [27]. NLP was used to classify themes concerning accidents and enforcement in 1 million tweets and 8,000 police records on Kenyan traffic [28]. Social media text gauged sentiment around metro stations [29], and SemConvTree was introduced to detect various smart-city events [30].

In administrative contexts, the DODFMiner NER tool achieved F1 scores of ≈0.78 (text) and 0.85 (entities) on Brazil's official gazette [31]. NLP was also proposed for extracting definitions and constraints from service-level agreements. Delhi Metro feedback was sentiment-analyzed using an XLNet-BiLSTM model [32], and a recursive neural NLP system improved response accuracy for an electric utility's customer queries [33].

These studies highlight NLP's global role in analyzing reviews, social media, and official texts to generate insights and enhance public service delivery. NLP is being used for the development of different methods and technologies such as sentiment analysis, AI-driven chatbots, public feedback analysis, smart cities, policy analysis, legal document parsing, emergency services, and transportation analysis. We have listed the corresponding references for these solutions.

NLP technologies have emerged as disruptive methods concerning citizen participation, involvement, and co-production of services within public administrations. Recent studies demonstrate how NLP instruments can overcome the communication gap between citizens and governments, organize administration, and make democratic participation more inclusive systems.

Wan et al. [38] demonstrated the power of NLP in crisis communication through the analysis of 197,430 messages during the Zhengzhou Rainstorm, building an emotion-behavior framework on ALBERT models to detect citizen emotions (fear, anger, sadness, positive) and behavioral trends (social support provision, seeking help, deviance, avoidance). Their findings demonstrated that NLP-driven analysis converts passive citizens' data into actionable intelligence, such that government communication strategies have varying implications for citizen engagement behaviors, with the most strategies improving social support while responding passively to help-seeking behavior.

Rizun et al. [15], [16] carried out a systematic review of 75 studies on NLP and text analytics in public service co-creation. They identified ten key categories, with machine learning approaches (17.69%), chatbots (16.92%), and sentiment analysis (13.08%) standing out as the most common. The study shows that most NLP applications concentrate on the co-design phase (71.70%), in which they support consultation and the generation of new ideas. Two main benefits are revealed by the analysis: economic value, recorded in just over half of the cases (52.94%) through efficiency improvements, and citizen value (25.88%) achieved through greater transparency and administrative simplification. Two platforms in the real world illustrate the use of NLP for citizen engagement. Dumrewal et al. [39] created CitiCafe that utilizes Latent Dirichlet Allocation (LDA) to categorize complaints with a 90.6% accuracy rate and Conditional Random Fields (CRF) to extract location information with an 84.59% accuracy rate. The system has processed more than 50,000 complaints by citizens and continuously monitors worried social media posts. Similarly, Ingole et al. [40] suggested a chatbot based on BERT, which achieved 85% user satisfaction and 90% response accuracy. It was able to process around 70% of citizen queries independently, reducing the workload of human staff by roughly half.

Son et al. [6] addressed scalability challenges in participatory governance with their BERT-based approach using KR-BERT for online petition categorization within South Korean

government platforms. Their approach achieved 76% accuracy in 12 categories of petitions, demonstrating the potential for achieving significantly better performance with the inclusion of historical petition data in models trained on current platform data, pinpointing how domain-specific NLP variations can provide computationally inexpensive solutions for resource-poor government applications.

Language accessibility remains a central challenge for meaningful citizen engagement and to address this, Sangeetha et al. [41] designed a multilingual chatbot framework that integrates dynamic meta-learning with cross-lingual embeddings. In evaluation, the system achieved 92% accuracy for English, 89% for Spanish, and 84% for Luxembourgish and with the capability of real-time adaptation to different linguistic communities, their framework promotes digital inclusivity and illustrates how multilingual conversational AI can function as a practical bridge to more equitable access to government services.

Digital transformation in government services demonstrates significant NLP implementation potential. Alves et al. [42] investigated how digital transformation is unfolding in Brazilian public agencies, focusing in particular on the use of natural language processing (NLP) within the judiciary. They highlight applications such as legal document review, case management, and citizen-facing services. Their study shows that Brazilian institutions are adopting a growing number of NLP-driven tools, including platforms for virtual trials, AI-based document processing that enables citizen participation, and natural language interfaces designed to simplify access to government services and according to the authors, these technologies create new opportunities for citizen engagement. At the same time, they point out several challenges that remain, and some of them are to ensure system interoperability, to provide adequate staff training, and to safeguard cybersecurity.

A more recent example is provided by Oksama et al. [24], who developed SI-PEKA, a consultation system built with GPT-4. In testing, the system achieved high acceptance rates, demonstrating that large pre-trained language models can overcome many of the traditional obstacles that have limited the deployment of digital solutions in government contexts.

Morocho et al. [43] conduct a systematic review of 27 studies concerning chatbot development in the health and education domains, examining technologies, frameworks, and evaluation metrics; it demonstrates strong biases towards open-source platforms like Rasa with critical gaps identified in evaluation methods and responsible AI principles.

Spiliotopoulos et al. [44] utilized NLP architectures to engage citizens in legislative processes through semantic search engines and argument mining technologies to process human judgments over open government data. Their human-evaluated results showed that NLP semantic search achieved the greatest extent of citizen engagement, demonstrating natural language processing's significance in rendering legislative data intelligible for non-expert citizens and achieving effective policy participation.

Rommelfanger [45] examined policymaking in German national parks and found that systematic text analysis can highlight how different stakeholders work together, pointing out, at the same time, that genuine citizen participation depends less on advanced NLP applications and more on fostering open communication and inclusive practices. Additionally, text analysis tools can still add value by helping participation become more meaningful and effective.

The literature reviewed shows that NLP technologies hold considerable promise for reshaping citizen- government interaction through AI-driven content analysis, pattern

recognition, and conversational systems. Still, realizing this potential requires addressing challenges such as multilingual support, reliable evaluation methods, institutional resistance, and adherence to Responsible AI principles. Literature shows that NLP-supported platforms of civic engagement ought to balance the technological elements with democratic values so that accessibility remains fair with openness and accountability in public decision-making processes.

It can be concluded that NLP applications in public administrations are moving beyond simple automation to more sophisticated systems that can facilitate productive co-creation of public services, yet institutional and technical barriers remain significant impediments to expansion. Overall, the reviewed studies invariably note that while NLP has the potential to drive participation, engagement, and co-creation, its impact is contingent on institutional openness, thoughtful design, and inclusivity mechanisms. The main uses of NLP methods and technologies extracted from the reviewed literature are summarized in Figure 2.

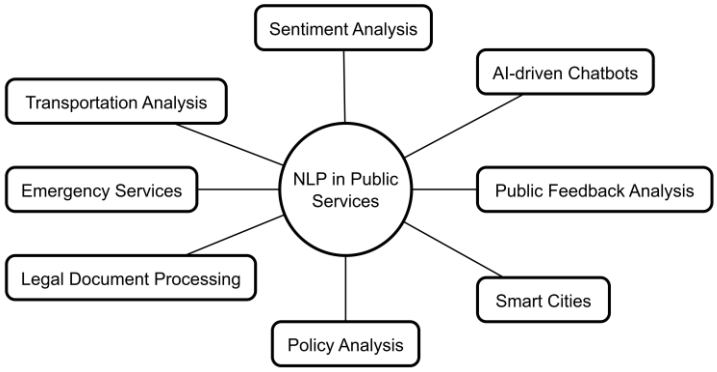

Figure 2: Natural Language Processing and its uses/effects concerning citizens' participation, engagement, and services co-creation in public organizations

4. Ethical, energy and Sustainable Aspects

Despite the potential of AI-based NLP described in the previous section, challenges do exist. Mariani et al. (2023) addressed challenges in improving access to public services through NLP like overcoming bureaucratic complexity and the need for effective Natural Language Understanding (NLU) solutions [46]. As part of the EU funded easyRights project, the study applied NLU solutions to administrative texts for services in four EU cities. Criado et al. (2019) studied the institutionalization of social media in local governments, focusing on management capacity and definition of goals in order to realize the full potential of AI benefits in public service delivery [47]. The study analyzed the level of social media institutionalization in Dutch city governments, using Social Network Analysis and automated NLP to assess data collected from Twitter. As NLP adoption in governance grows, compliance with privacy regulations such as GDPR and the upcoming AI Act is crucial. Public NLP applications handle sensitive data of citizens, and data protection, surveillance threats, and consent processes become points of concern. Although GDPR is imposing data minimization, right to explanation, and consent, NLP systems require large sets of data to learn effectively, which could cause privacy risks. Federated learning where AI models are trained without transferring personal data on decentralized data is one solution that promises safeguarding data. Second, differential privacy techniques that add statistical noise to mask individual contributions within data sets can be employed for the protection of user identity while maintaining model effectiveness. Governments should

establish stringent guidelines on how NLP-driven public services responsibly collect, store, and process citizen information. Similarly, the EU Ethics Guidelines for Trustworthy AI [48] emphasize principles like transparency, accountability, and fairness, providing a framework that complements these regulations.

The digital transformation in the public sector is impeded by the digital divide, which restricts the reach of services to citizens and further citizens engagement, participation, and co-creation of the public services. For instance, rural areas continue to face challenges in accessing reliable internet and digital infrastructure [42]. Furthermore, some of the risks come from the algorithmic implementation of the NLP methods as well, as mentioned by the Mellouli et. al. 2024 [5], AI faces risks such as bias in training data, lack of explainability, lack of trust in decisions and policies, prediction mistakes and failures, and Less inclusion. These risks suspect the citizen engagement and co-creation in the public services. In NLP systems, language is considered a major source of developing the system. In some cases, as mentioned by Morocho et. al. [43], languages through which a public service is developed makes the system inclusive or exclusive. Language dependencies have been seen in the chatbot development, and English language-based NLP system, specifically, chatbots for public engagement and participation is dominant. One other sustainability challenge is less availability of open-source tools, most of them are paid, and public and private engagement is difficult in this scenario. There is a lack of global standards for the NLP services assessment is also biggest challenge in sustaining the public confidence [43].

Future research should focus on the exploration of the current strategies to reduce energy costs in training or deploying large NLP systems and establishing multilingual NLP systems for inclusivity and accessibility across different linguistic domains. In addition, any AI governance surrounding public services should be audited for ethical sustainability and, in doing so, should also be careful to emphasize fairness, transparency, and accountability. The wide variety of challenges extracted through the review are shown in Figure 3.

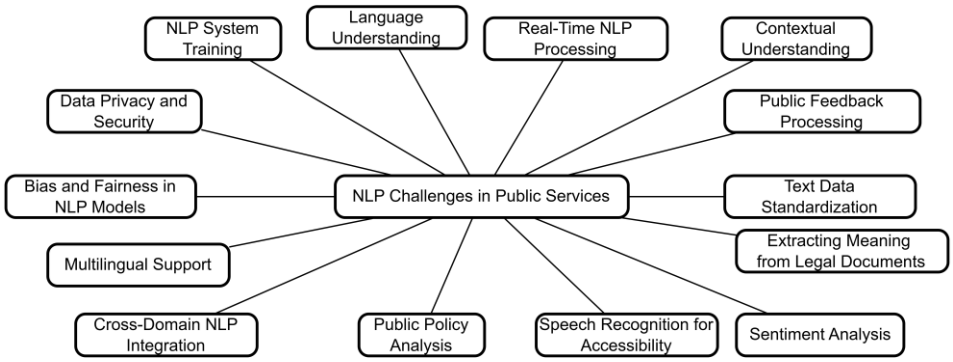

Figure 3: Natural language processing and associated challenges in the public sector

These challenges are related to NLP models' capabilities to understand the language and associated context, data privacy and security, bias and fairness, multilingual support, speech recognition for accessibility of NLP services, meaning extraction from legal documents, sentiment analysis, public feedback processing, and real-time processing. With the advent of transformer architecture in 2017[2], there has been a noticeable surge in the NLP realm. Transformers are capable of both understanding and generating natural language processing by

[2] https://arxiv.org/abs/1706.03762

their architecture, which is encoder and decoder blocks. The large language models developed using the transformer architecture are capable of solving most of the current problems being faced in the public sector regarding the NLP capabilities. A few examples of these models are ChatGPT, Mistral, DeepSeek, and Perplexity. These models are multilingual and some support multimodal inputs and outputs, enhancing their utility in diverse public service contexts. However, these models require considerable computational resources (memory, processing power, & storage). Most are openly available for adaptation to specific tasks, enabling public agencies to leverage them for improved service applications.

5. Conclusions and Further Steps

This study reviews a broad range of NLP applications in government for supporting citizens' participation, engagement and co-creation, such as sentiment analysis, named entity recognition, machine translation, and chatbots, demonstrating their deep integration in policy design, citizen feedback analysis, and administrative efficiency. It has been concluded that NLP plays a vital role in enhancing public service by supporting and enhancing evidence-based decision-making, citizens' participation, engagement as well as co-creation, leading finally to an increase of service responsiveness. However, large-scale models can perpetuate biases, requiring mitigation. Their high energy demands require greener strategies (model pruning, efficient hardware, cloud optimization). Effective NLP requires strong policies (accountability, transparency, controlled data sharing) and explainable systems to build trust. Interoperability across agencies, interdisciplinary collaboration (policymakers, legal experts, data scientists), and citizen involvement (priority setting and feedback) further enhance NLP's impact. Since most pretrained models are English-centric, future research should develop inclusive models for local dialects and scripts. Low-cost, energy-efficient NLP solutions are also needed for resource-constrained governments.

The study has some limitations: only English-language literature was reviewed, based on two databases (Scopus, Google Scholar), excluding non-English studies, gray literature, and industry reports. Also, it focuses on the use of NLP in 'extrovert' functions of government agencies concerning their interaction with their external environment (citizens' participation, engagement and co-creation), so it has not examined the use of NLP in internal functions of government agencies for increasing their efficiency and effectiveness.

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References

[1] Miss. A. A. S. Ali, "AI-Natural Language Processing (NLP)," *IJRASET*, vol. 9, no. VIII, pp. 135–140, Aug. 2021, doi: 10.22214/ijraset.2021.37293.

[2] C. Bouras *et al.*, “A Chatbot Generator for Improved Digital Governance,” in *Information Systems*, vol. 501, M. Papadaki, M. Themistocleous, K. Al Marri, and M. Al Zarouni, Eds., in Lecture Notes in Business Information Processing, vol. 501. , Cham: Springer Nature Switzerland, 2024, pp. 123–134. doi: 10.1007/978-3-031-56478-9_9.

[3] T. Papadopoulos *et al.*, “Evaluation of Chatbot Technology: The Case of Greece,” *IJNLC*, vol. 12, no. 5, pp. 13–28, Oct. 2023, doi: 10.5121/ijnlc.2023.12502.

[4] M. Önder and U. Akkucuk, “Introduction: AI Tools for Sustainable Public Administration,” in *Advances in Public Policy and Administration*, U. Akkucuk and M. Onder, Eds., IGI Global, 2025, pp. 1–22. doi: 10.4018/979-8-3693-8372-8.ch001.

[5] S. Mellouli, M. Janssen, and A. Ojo, “Introduction to the Issue on Artificial Intelligence in the Public Sector: Risks and Benefits of AI for Governments,” *Digit. Gov.: Res. Pract.*, vol. 5, no. 1, pp. 1–6, Mar. 2024, doi: 10.1145/3636550.

[6] J. H. Son, M. Kovacs, S. Salama, and U. Serdült, “Facilitating Online Petition Topic Categorization in South Korea: A BERT-Based Approach,” in *2025 Eleventh International Conference on eDemocracy & eGovernment (ICEDEG)*, Bern, Switzerland: IEEE, Jun. 2025, pp. 198–205. doi: 10.1109/ICEDEG65568.2025.11081576.

[7] X. Fu, T. W. Sanchez, C. Li, and J. Reu Junqueira, “Deciphering Public Voices in the Digital Era: Benchmarking ChatGPT for Analyzing Citizen Feedback in Hamilton, New Zealand,” *Journal of the American Planning Association*, vol. 90, no. 4, pp. 728–741, Oct. 2024, doi: 10.1080/01944363.2024.2309259.

[8] V. Ribeiro *et al.*, “Natural Language Processing Applied in the Context of Economic Defense: A Case Study in a Brazilian Federal Public Administration Agency:,” in *Proceedings of the 25th International Conference on Enterprise Information Systems*, Prague, Czech Republic: SCITEPRESS - Science and Technology Publications, 2023, pp. 630–637. doi: 10.5220/0011991900003467.

[9] J. I. Criado and J. Villodre, “Delivering public services through social media in European local governments. An interpretative framework using semantic algorithms,” *Local Government Studies*, vol. 47, no. 2. pp. 253–275, 2020. doi: 10.1080/03003930.2020.1729750.

[10] H. S. Balci and İ. Balci, “Natural Language Processing (NLP) for Sustainable Public Administration:,” in *Advances in Public Policy and Administration*, U. Akkucuk and M. Onder, Eds., IGI Global, 2025, pp. 243–276. doi: 10.4018/979-8-3693-8372-8.ch009.

[11] Y. Guo, *Digital Government and Public Interaction: Platforms, Chatbots, and Pub-lic Satisfaction: Platforms, Chatbots, and Public Satisfaction*. IGI Global, 2024.

[12] J. Romberg and T. Escher, “Making Sense of Citizens’ Input through Artificial Intelligence: A Review of Methods for Computational Text Analysis to Support the Evaluation of Contributions in Public Participation,” *Digit. Gov.: Res. Pract.*, vol. 5, no. 1, pp. 1–30, Mar. 2024, doi: 10.1145/3603254.

[13] L. Yun, S. Yun, and H. Xue, “Improving citizen-government interactions with generative artificial intelligence: Novel human-computer interaction strategies for policy understanding through large language models,” *PLoS ONE*, vol. 19, no. 12, p. e0311410, Dec. 2024, doi: 10.1371/journal.pone.0311410.

[14] M. Ali, M. I. Maratsi, L. Euripidis, C. Alexopoulos, and Y. Charalabidis, “Analysis of Reviews on Greek Municipalities to Improve Public Service Delivery and Citizen Satisfaction: A Tool for Co-creation and Co-design,” in *Proceedings of the 26th Pan-Hellenic Conference on Informatics*, Athens Greece: ACM, Nov. 2022, pp. 296–303. doi: 10.1145/3575879.3576008.

[15] N. Rizun, A. Revina, and N. Edelmann, “Text analytics for co-creation in public sector organizations: a literature review-based research framework,” *Artif Intell Rev*, vol. 58, no. 4, p. 125, Feb. 2025, doi: 10.1007/s10462-025-11112-1.

[16] N. Rizun, A. Revina, and N. Edelmann, “Application of text analytics in public service co-creation: Literature review and research framework,” *24th Annual International Conference on Digital Government Research (DGO 2023)*. Association for Computing Machinery (ACM), New York, NY, USA, pp. 12–22, 2023. doi: 10.1145/3598469.3598471.

[17] H. Kang and J. Kim, “Analyzing and Visualizing Text Information in Corporate Sustainability Reports Using Natural Language Processing Methods,” *Applied Sciences*, vol. 12, no. 11, p. 5614, Jun. 2022, doi: 10.3390/app12115614.

[18] I. Gorelova, Z. Lachana, M.-A. Loutsaris, F. Bellini, Y. Charalabidis, and F. D'Ascenzo, "The e-government initiatives in the smart cities. Insights from the European Commission's Intelligent Cities Challenge," in *ITAIS 2023*, 2023. [Online]. Available: https://aisel.aisnet.org/itais2023/7

[19] A. S. George, A.S.Hovan George, and A.S.Gabrio Martin, "The Environmental Impact of AI: A Case Study of Water Consumption by Chat GPT," Apr. 2023, doi: 10.5281/ZENODO.7855594.

[20] M. Templier and G. Paré, "A Framework for Guiding and Evaluating Literature Reviews," *CAIS*, vol. 37, 2015, doi: 10.17705/1CAIS.03706.

[21] D. Breslin and C. Gatrell, "Theorizing Through Literature Reviews: The Miner-Prospector Continuum," *Organizational Research Methods*, vol. 26, no. 1, pp. 139–167, Jan. 2023, doi: 10.1177/1094428120943288.

[22] L. Zhou, D. Dai, J. Ren, X. Chen, and S. Chen, "What is policy content and how is the public's policy support? A policy cognition study based on natural language processing and social psychology," *Front. Psychol.*, vol. 13, p. 941762, Oct. 2022, doi: 10.3389/fpsyg.2022.941762.

[23] M. B. Shackleford, T. T. Adeliyi, and S. Joseph, "A Prediction of South African Public Twitter Opinion using a Hybrid Sentiment Analysis Approach," *IJACSA*, vol. 14, no. 10, 2023, doi: 10.14569/IJACSA.2023.0141017.

[24] M. H. Oksama, A. Marsal, M. L. Hamzah, Syaifullah, and N. E. Rozanda, "Transforming Public Service: AI Chatbot Integration in SI-PEKA Mobile App Development," in *2024 2nd International Symposium on Information Technology and Digital Innovation (ISITDI)*, Bukittinggi, Indonesia: IEEE, Jul. 2024, pp. 234–240. doi: 10.1109/ISITDI62380.2024.10796019.

[25] R. Kowalski, M. Esteve, and S. Jankin Mikhaylov, "Improving public services by mining citizen feedback: An application of natural language processing," *Public Administration*, vol. 98, no. 4, pp. 1011–1026, Dec. 2020, doi: 10.1111/padm.12656.

[26] P. Ferri, C. Sáez, A. Félix-De Castro, P. Sánchez-Cuesta, and J. M. García-Gómez, "Discovering Key Topics in Emergency Medical Dispatch from Free Text Dispatcher Observations," in *Studies in Health Technology and Informatics*, B. Séroussi, P. Weber, F. Dhombres, C. Grouin, J.-D. Liebe, S. Pelayo, A. Pinna, B. Rance, L. Sacchi, A. Ugon, A. Benis, and P. Gallos, Eds., IOS Press, 2022. doi: 10.3233/SHTI220607.

[27] C. Melo, F. Cordeiro, and F. Berssaneti, "ONA-Accredited Primary Health Care Quality through Google Review Analysis," in *ICQEM 2024*, 2024. [Online]. Available: https://publicacoes.riqual.org/icqem-24/

[28] J. Muguro, W. Njeri, K. Matsushita, and M. Sasaki, "Road traffic conditions in Kenya: Exploring the policies and traffic cultures from unstructured user-generated data using NLP," *IATSS Research*, vol. 46, no. 3, pp. 329–344, Oct. 2022, doi: 10.1016/j.iatssr.2022.03.003.

[29] W. Gao, X. Sun, M. Zhao, Y. Gao, and H. Ding, "Evaluate Human Perception of the Built Environment in the Metro Station Area," *Land*, vol. 13, no. 1, p. 90, Jan. 2024, doi: 10.3390/land13010090.

[30] M. A. Kovalchuk *et al.*, "SemConvTree: Semantic Convolutional Quadtrees for Multi-Scale Event Detection in Smart City," *Smart Cities*, vol. 7, no. 5, pp. 2763–2780, Sep. 2024, doi: 10.3390/smartcities7050107.

[31] A. G. Guimarães, A. Couto, and A. Lobo, "Rail freight production in Brazil: Projecting scenarios in times of global uncertainty," *Journal of Rail Transport Planning & Management*, vol. 27, p. 100403, 2023, doi: https://doi.org/10.1016/j.jrtpm.2023.100403.

[32] V. Shukla, D. Kuanr, S. Juneja, and A. K. Sharma, "Sentiment Analysis for Citizen Feedback in Smart Cities with XLNet-BiLSTM: Delhi Metro as a Case Study," in *SCCTT-2024: International Symposium on Smart Cities, Challenges, Technologies and Trends*, Delhi, India: CEUR, Nov. 2024.

[33] D. A. Dutan-Sanchez, P. S. Idrovo-Berrezueta, and R. I. Hurtado-Ortiz, "The Development of an Architecture Using Traditional and Modern Recursive Neural Networks and Natural Language Processing to Increase the Accuracy of Response on Client Doubts Related to Public Services," in *Information Technology and Systems*, vol. 933, Á. Rocha, C. Ferrás, J. Hochstetter Diez, and M. Diéguez Rebolledo, Eds., in Lecture Notes in Networks and Systems, vol. 933. , Cham: Springer Nature Switzerland, 2024, pp. 119–128. doi: 10.1007/978-3-031-54256-5_11.

[34] L. Lu, J. Xu, and J. Wei, “Understanding the effects of the textual complexity on government communication: Insights from China’s online public service platform,” *Telematics and Informatics*, vol. 83, no. N/A. p. [1-17] Paper no. 102028, 2023. doi: 10.1016/j.tele.2023.102028.

[35] Y. Shu, Y. Ma, W. Li, G. Hu, X. Wang, and Q. Zhang, “Unraveling the dynamics of social governance innovation: A synergistic approach employing NLP and network analysis,” *Expert Systems with Applications*, vol. 255, p. 124632, Dec. 2024, doi: 10.1016/j.eswa.2024.124632.

[36] K. Agarwal, S. Deepa, R. V. SivaBalan, and C. Balakrishnan, “Performance Analysis of Various Machine Learning Classification Models Using Twitter Data: National Education Policy,” in *2023 International Conference on Intelligent and Innovative Technologies in Computing, Electrical and Electronics (IITCEE)*, Bengaluru, India: IEEE, Jan. 2023, pp. 862–870. doi: 10.1109/IITCEE57236.2023.10091034.

[37] X. Wang, M. Oussalah, M. Niemelä, and T. Ristikari, “Mapping Insights from News Articles to Tackle Low Birth Rate and Parenthood in Finland,” *SN COMPUT. SCI.*, vol. 5, no. 1, p. 172, Jan. 2024, doi: 10.1007/s42979-023-02492-8.

[38] X. Wan *et al.*, “An emotion-behavior perspective of understanding public and government responses to rainstorm disasters: A case study of Zhengzhou Rainstorm in China,” *Cities*, vol. 164, p. 106077, Sep. 2025, doi: 10.1016/j.cities.2025.106077.

[39] A. Dumrewal, A. Basu, S. Atreja, P. Mohapatra, P. Aggarwal, and G. B. Dasgupta, “Citicafe: conversation-based intelligent platform for citizen engagement,” in *Proceedings of the ACM India Joint International Conference on Data Science and Management of Data*, Goa India: ACM, Jan. 2018, pp. 180–189. doi: 10.1145/3152494.3152511.

[40] B. S. Ingole *et al.*, “AI Chatbot Implementation on Government Websites: A Framework for Development, User Engagement, and Security for DHS Website,” in *2024 International Conference on Intelligent Cybernetics Technology & Applications (ICICyTA)*, Bali, Indonesia: IEEE, Dec. 2024, pp. 377–382. doi: 10.1109/ICICYTA64807.2024.10912857.

[41] S. B, S. K. G, K. N, B. Sundarambal, S. K. S, and C. Selvaganesan, “Multilingual Chatbot for Government Services,” in *2025 International Conference on Data Science and Business Systems (ICDSBS)*, Chennai, India: IEEE, Apr. 2025, pp. 1–8. doi: 10.1109/ICDSBS63635.2025.11032052.

[42] V. L. Medina Alves, J. O. Imoniana, and & W. Lopes Da Silva, “eGovernment Technology Digital transformation and data stewardship towards sustainable development agenda in Brazil,” *Procedia Computer Science*, vol. 257, pp. 1032–1038, 2025, doi: 10.1016/j.procs.2025.03.134.

[43] V. Morocho, C. Ordoñez-Crespo, and V. Viloria-Ramírez, “Systematic Review of Chatbot Development in Health and Education: Technologies, Frameworks, and Evaluation Metrics,” in *2025 Eleventh International Conference on eDemocracy & eGovernment (ICEDEG)*, Bern, Switzerland: IEEE, Jun. 2025, pp. 231–238. doi: 10.1109/ICEDEG65568.2025.11081666.

[44] D. Spiliotopoulos, D. Margaris, and C. Vassilakis, “Citizen engagement for transparent and accountable policy modelling,” in *11th International Conference on Management of Digital EcoSystems, MEDES 2019*, 2019, pp. 158–165. doi: 10.1145/3297662.3365813.

[45] J. Rommelfanger, “Management of German national parks: The role of institutions and actors in defining goals and making decisions,” *Forest Policy and Economics*, vol. 148, p. 102914, Mar. 2023, doi: 10.1016/j.forpol.2023.102914.

[46] I. Mariani, M. Mortati, and F. Rizzo, “Strengthening e-participation through design thinking. Relevance for better digital public services,” *24th Annual International Conference on Digital Government Research (DGO’23)*. Association for Computing Machinery, New York, NY, USA, pp. 224–232, 2023. doi: 10.1145/3598469.3598494.

[47] J. Ignacio Criado, J. Villodre, and A. Meijer, “From experimentation to public service delivery in social media. An analysis of institutionalization dynamics in Dutch local governments,” in *Proceedings of the 20th Annual International Conference on Digital Government Research*, Dubai United Arab Emirates: ACM, Jun. 2019, pp. 342–352. doi: 10.1145/3325112.3325250.

[48] European Commission (High-Level Expert Group on AI), “Ethics Guidelines for Trust-worthy Artificial Intelligence,” European Commission, 2019.