International Journal of Computer Information Systems and Industrial Management Applications
ISSN 2150-7988 Volume 17 (2025) pp. 1-8

https://doi.org/10.70917/ijcisim-2025-0317
Article

A Multimodal Discourse Strategy Perspective on AI-Empowered Broadcasting in the Promotion of Circular Economy Policies: A Review

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Abstract: The growing urgency of environmental sustainability has positioned circular economy (CE) policies as a strategic priority in global governance. As a vital medium for public engagement, broadcasting has undergone substantial transformation with the integration of artificial intelligence (AI), giving rise to novel discourse strategies grounded in multimodality. This review critically examines existing scholarship at the intersection of AI-driven broadcasting, multimodal discourse analysis, and the dissemination of CE policies. It traces the evolution of broadcasting practices from traditional formats to AI-augmented systems and explores how AI technologies, such as speech synthesis, intelligent scripting, and multimodal coordination, reshape policy narratives. Drawing on theories of social semiotics and multimodal communication, the paper synthesizes findings on how voice, gesture, visual elements, and digital interactivity contribute to persuasive policy communication. Despite recent advances, significant challenges remain, including the lack of integrative theoretical frameworks and limited empirical analysis of AI-mediated environmental discourse. This review identifies key research gaps and outlines future directions for interdisciplinary inquiry into the ethical, communicative, and technological dimensions of AI-empowered broadcasting. By mapping the conceptual terrain of this emerging field, the paper aims to inform more effective and engaging strategies for promoting sustainable policy agendas.

Key words: Artificial Intelligence; Broadcasting; Circular Economy; Multimodal Discourse; Policy Communication

1. Introduction

The global shift toward sustainable development has positioned the circular economy not merely as an alternative economic model but as a strategic imperative embedded within national and transnational policy agendas. Its implementation necessitates not only structural economic adjustments but also the cultivation of public awareness and behavioral transformation, both of which are contingent upon effective communication mechanisms. As such, the challenge lies not only in designing coherent CE policies but also in articulating them persuasively to diverse audiences with varying degrees of environmental literacy and media consumption habits.

Concurrently, the accelerating sophistication of artificial intelligence, particularly in natural language processing, image recognition, and generative modeling, has triggered a paradigmatic transformation across communicative infrastructures, with pronounced effects on the media and broadcasting sectors. Recent advancements in AI technologies have facilitated the automated generation of linguistically coherent, semantically relevant, and emotionally adaptive content. Tools such as large language models, deep learning-based voice synthesis, and real-time facial animation engines have expanded the operational capacities of broadcasting, allowing for the orchestration of multimodal discourse at an unprecedented scale and precision[1][2]. These technological affordances have not only enhanced the efficiency of media workflows but have also initiated a fundamental reconfiguration of the relationship between message design, delivery, and audience reception.

In particular, AI-enabled broadcasting introduces a hybrid communicative ecology wherein human anchoring is supplemented,or in some instances supplanted,by algorithmic agents capable of real-time discourse adaptation. This hybridization process manifests through three interlocking dimensions: intelligent scripting systems that optimize discourse coherence and policy framing strategies; affective computing modules that modulate prosodic and visual cues to enhance emotional engagement; and dynamic multimodal integration that synchronizes visual, textual, and auditory elements to enhance cognitive accessibility[3][4]. Such configurations are especially pertinent to CE policy communication, which often involves abstract principles that require sophisticated rhetorical strategies to achieve public resonance and comprehension.

While a growing body of literature has independently examined AI-driven media production, multimodal discourse analysis, and environmental communication, there is a notable paucity of integrative research that systematically theorizes and empirically investigates their convergence. Existing studies often remain confined within disciplinary silos,focusing either on technological feasibility, rhetorical function, or policy efficacy, without fully elucidating the synergistic potential of AI-mediated broadcasting in advancing CE-related public discourse[5].

This paper aims to bridge this gap by offering a comprehensive and interdisciplinary analysis of how AI technologies can empower multimodal discourse strategies within CE policy broadcasting. It contributes to the field in three specific ways. First, it proposes a conceptual framework that maps the interaction between AI capabilities and multimodal communication principles within the context of sustainability advocacy. Second, it critically assesses representative case studies and prototypes that demonstrate innovative deployments of AI in public media, highlighting both affordances and limitations. Third, it outlines future research trajectories that attend to emerging challenges such as algorithmic transparency, ethical personalization, and cross-cultural discourse alignment. In doing so, the study not only expands the theoretical vocabulary for understanding AI-mediated public communication but also provides actionable insights for policymakers, media practitioners, and system designers engaged in the evolving nexus of artificial intelligence and circular economy promotion.

2. Evolution of Broadcasting and Hosting in the Era of AI

The integration of artificial intelligence into broadcasting and hosting practices has brought about a significant transformation in the ways public discourse is generated, delivered, and received. Early developments in broadcasting optimization models focused on message transmission stability and prediction, laying the computational foundation for later intelligent communication systems. Venu et al. developed an optimized Hello Message Broadcasting Prediction Model to enhance network stability in wireless communications, using performance evaluation metrics such as transmission success rate and latency to predict optimal broadcasting intervals[6]. Although primarily technical in scope, their work contributes to a broader understanding of AI-based efficiency in digital information dissemination.

As broadcasting technologies advanced, the focus shifted from transmission mechanics to content construction and strategic communication,particularly in the policy domain. Research by Coibion et al. and Masciandaro et al. explored how monetary and policy discourse, including central bank messaging, influences public expectations and behavior. Experimental approaches in media economics have demonstrated that the framing and modality of policy communication can significantly influence audience interpretation and behavioral intention. These findings emphasize the necessity of integrating multimodal design principles into AI-mediated policy broadcasting, especially in contexts requiring cognitive accessibility and emotional resonance[7]. Similarly, Masciandaro et al. analyzed central bank social media strategies through longitudinal content analysis, highlighting the shift from conventional silence to interactive discourse on platforms such as Twitter[8]. These studies underscore the increasing importance of multimodal, strategically designed policy communication in digital environments.

This communicative turn in policy broadcasting is further exemplified in work by Sala et al., who traced how life cycle assessment evolved as a communication tool within European policy frameworks. By conducting a policy document analysis over three decades, they demonstrated how technical data became gradually adapted for public outreach through visual and narrative simplification, a move that parallels the broader transformation in hosting strategies driven by AI-assisted discourse personalization[9].

The emergence of the circular economy as a focal point of sustainability policy has intensified demands for effective communication. Scholars such as Corvellec et al. and Velenturf and Purnell critically examined the normative assumptions and communicative challenges surrounding CE discourse. Corvellec et al. conducted qualitative textual analyses to unpack implicit ideological tensions within CE narratives, arguing that the economy-centered framing often overshadows environmental justice concerns[10]. Meanwhile, Velenturf and Purnell proposed six guiding principles for a sustainable CE after reviewing over 150 policy documents, emphasizing the need for inclusive, intelligible, and

participatory communication strategies[11]. These findings reveal both the complexity of CE messaging and the necessity for advanced hosting methods capable of aligning technical accuracy with public resonance.

In response to these challenges, researchers have increasingly turned to multimodal discourse analysis as a methodological bridge between message design and audience engagement. Drawing on visual grammar and social semiotics, Kress and Bezemer offered a theoretical framework for analyzing how image, layout, gesture, and sound contribute to meaning-making in mediated texts[12]. Peng, using the same framework, conducted a case study on Chinese film posters, illustrating how multimodal resources reinforce cultural values and emotional appeal[13]. Likewise, Ruiz-Madrid and Suchek applied a multimodal lens to academic presentations, identifying patterns in gesture-voice coordination that enhance persuasive efficacy[14][15]. These approaches provide critical tools for analyzing how AI-generated or AI-assisted broadcasting content operates across semiotic channels to promote CE policies effectively.

Collectively, these studies demonstrate a coherent evolution: from the technical optimization of message delivery, to the strategic shaping of policy communication, to the ethical and multimodal challenges in CE advocacy. As broadcasting continues to integrate AI technologies, it increasingly positions itself not just as a channel for information transfer but as a dynamic platform for multimodal meaning construction and public engagement in sustainability discourse.

3. Multimodal Discourse Strategies in Policy Communication

As policy communication becomes increasingly multimodal and digitally mediated, the strategic deployment of linguistic, visual, and auditory resources is critical for enhancing public understanding and emotional engagement. Multimodal discourse, grounded in social semiotic theory, treats all modes,language, image, sound, gesture,as semiotic resources that contribute collectively to meaning-making. Within the context of circular economy policy dissemination, these strategies enable communicators to bridge the gap between abstract policy concepts and the lived experiences of diverse audiences.

Kress and Bezemer emphasize that meaning in contemporary discourse is rarely produced through language alone; instead, communicative intent is realized through intermodal orchestration, where elements such as visuals, color schemes, sound effects, and spatial design are coordinated with verbal language to reinforce key messages[12]. This approach has been especially influential in public-facing environmental campaigns, which rely heavily on visual salience and emotional resonance to prompt behavioral change. For instance, Figure 1 could schematically illustrate how voice intonation, animated visuals, and on-screen text function in synchrony during AI-generated policy announcements to enhance cognitive uptake and recall.

An illustration of how different semiotic resource, voice, visual elements, and on-screen text, interact in AI-generated policy broadcasting to enhance audience understanding and emotional impact.

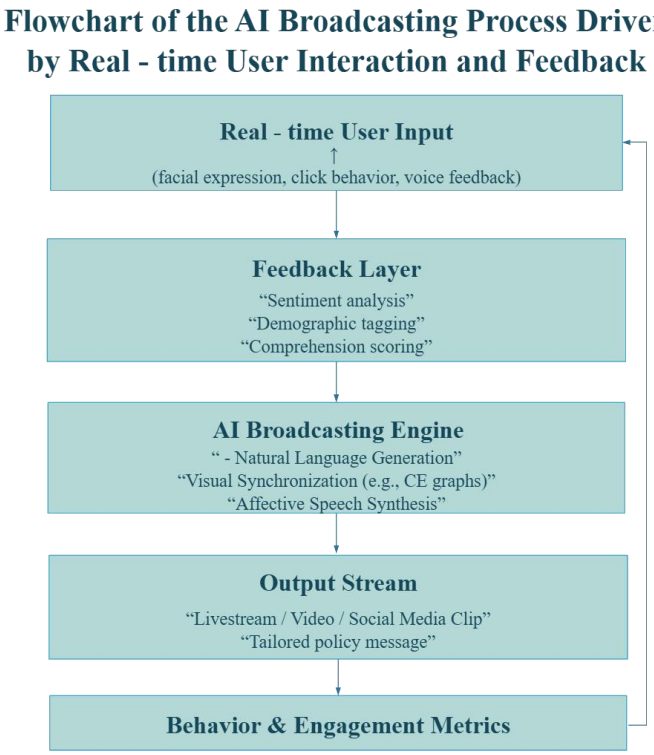

Figure 1. Flowchart of the AI Broadcasting Process Driven by Real - time User Interaction and Feedback.

Building on this framework, Peng's study of film poster design through visual grammar analysis demonstrates how color, composition, and iconography contribute to thematic coherence and emotional appeal in visual narratives[13]. Although situated in a cultural product context, her findings are transferable to policy messaging, where posters, infographics, and online banners often serve as the first point of public contact. Similarly, Ruiz-Madrid's analysis of academic presentations using gesture and vocal modulation reveals how multimodal alignment facilitates audience persuasion and clarity, offering implications for AI-driven voice synthesis and avatar design in policy broadcasts[14].

These findings, while originating in cultural or academic contexts, illustrate transferable semiotic principles that inform the orchestration of multimodal policy messaging. When integrated into AI-driven systems, such strategies enable dynamic adaptation of content through visual-verbal interplay, enhancing resonance across demographic divides.

In line with these observations, a comparative review of policy communication tools can be captured in Table 1, summarizing the modes employed, communicative goals, and platform affordances.

Table 1. Comparison of Traditional vs AI-Augmented Multimodal Policy Communication.

Mode/Strategy	Traditional Hosting	AI-Augmented Broadcasting	Communicative Function
Verbal Language	Human narration	AI-generated voice (TTS with emotion modeling)	Information delivery; tone modulation
Visual Elements	Static slides, posters	Animated infographics, real-time data visualization	Concept illustration; data simplification
Gesture & Facial Expression	Human anchoring	AI avatars with programmed facial-gesture sync	Emotional cues; speaker-audience connection
Text on Screen	Fixed captions or titles	Real-time subtitles; adaptive keyword highlighting	Accessibility; key message reinforcement
Interactivity	Limited (e.g., Q&A session)	AI-powered chat, click-to-expand graphics, audience feedback	Engagement; feedback-driven content customization

Platform Usage	TV, radio, print	Livestreaming, short video platforms, VR/AR environments	Multichannel reach; personalized delivery

This table would help distinguish between traditional and AI-augmented strategies, highlighting how different combinations of modes can be tailored for specific demographic targets.

Beyond technical affordances, the integration of multimodality into CE policy discourse also speaks to a broader ideological project: constructing inclusive, participatory, and emotionally resonant narratives around sustainability. Corvellec et al.'s critique of CE discourse points out that current framings often exclude marginalized voices by emphasizing technocratic or economic language[10]. In this regard, multimodal strategies offer an opportunity to democratize communication through storytelling, personalization, and visual simplification. When embedded in AI-powered systems, these strategies become scalable, adaptable, and context-sensitive, enabling more nuanced engagement with linguistically or culturally diverse audiences.

Moreover, Suchek et al. note in their systematic review that innovation in CE is not only technological but communicative; successful CE implementation depends heavily on how circular practices are framed and socially embedded[15]. AI-empowered multimodal discourse thus serves a dual role: as a medium of transmission and as a mechanism of social negotiation, where meaning is co-constructed across modalities and user interactions.

To further illustrate this interplay, Figure 2 may present a conceptual model of AI-mediated multimodal communication for CE policy, integrating input, AI processing, and output.

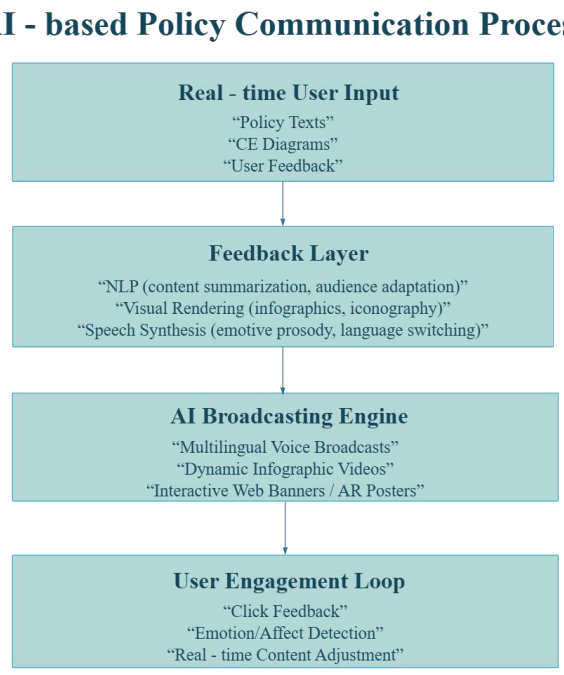

Figure 2. AI - based Policy Communication Process.

Such a model can elucidate how AI agents orchestrate diverse semiotic resources to produce adaptive, persuasive content in real time.

In summary, the strategic use of multimodal discourse in policy communication is both a response to and a driver of digital transformation in public governance. As CE initiatives grow in complexity and urgency, the capacity to deliver intelligible, engaging, and emotionally compelling messages, which enabled by AI, is becoming a central component of effective environmental advocacy.

4. Challenges and Research Gaps

Despite growing enthusiasm for the use of AI in multimodal policy communication, several theoretical and practical challenges remain unaddressed. One key challenge lies in the integration of AI-generated modalities into public discourse systems that are already highly context-dependent and culturally nuanced. While natural language processing (NLP) and image generation models can produce coherent content, they often lack the pragmatic sensitivity required for localized environmental policy

communication, especially in multilingual or marginalized communities.

Moreover, although multimodal discourse theory provides a rich analytical framework, its application in AI-mediated settings is still under-theorized. Current approaches primarily rely on descriptive typologies (e.g., image-text interaction, sound-symbol coordination), but offer limited insight into how these semiotic resources function dynamically across temporal layers, such as in video, livestreams, or interactive media. This is especially problematic in the broadcasting context, where timing, rhythm, and prosodic variation interact with visuals to shape meaning reception.

Ethical concerns also persist regarding algorithmic transparency, audience manipulation, and equity. CE policy narratives often exclude critical perspectives, and embedding these narratives within AI systems may reproduce such exclusions at scale. Furthermore, affective computing systems used in broadcasting AI may inadvertently engage in emotional steering without clear mechanisms for consent or contestation.

From a technological standpoint, the lack of evaluation standards for multimodal AI-generated messages poses a significant obstacle. Unlike traditional media analysis, which can rely on viewer ratings or expert critique, AI-augmented communication requires novel cross-modal evaluation metrics, potentially combining usability studies, affective response analysis, and semantic coherence measures. To summarize, the main research gaps may be categorized as follows:

Table 2. Summary of Challenges and Research Gaps in AI-Driven Multimodal Policy Communication.

Domain	Challenge	Gap
Discourse Theory	Contextual integration of AI modalities	Lack of dynamic multimodal temporal models
Cultural & Ethical Aspects	Risk of exclusion and affective manipulation	Limited participatory frameworks and consent protocols
Evaluation Methodologies	Difficulty assessing multimodal output quality	Absence of validated cross-modal performance metrics
Policy Application	Generalization across policy sectors and audience types	Inadequate adaptation to linguistic, regional, and demographic diversity

5. Future Directions

Future research in AI-augmented broadcasting for circular economy policy communication should proceed along three complementary trajectories: theoretical expansion, methodological innovation, and systems integration.

First, theoretical models of multimodal discourse must be adapted to AI-generated communication environments, emphasizing temporality, interactivity, and audience feedback. This includes developing cognitive-affective models that account for how users process AI-generated speech, gesture, and visuals in real-time. Cross-disciplinary convergence,especially between multimodal discourse studies, AI ethics, and communication design,will be essential for this theoretical deepening.

Second, methodological innovation is required to evaluate the effectiveness of multimodal AI broadcasting. Novel experimental designs incorporating eye-tracking, affective computing, and semantic differential techniques could be developed to understand how different modes influence perception, trust, and behavioral intent. Additionally, longitudinal field studies in local policy campaigns can provide valuable insight into the socio-political impacts of AI-mediated discourse.

Third, the development of adaptive, user-centered AI broadcasting systems presents a significant opportunity. As suggested by others, digital communication strategies must evolve from one-way messaging to dialogic, interactive models that reflect public concerns in real time. AI agents could be equipped with feedback loops to recalibrate tone, terminology, or visuals based on live user data, ensuring greater inclusivity and responsiveness.

6. Discussion

This study provides a critical intervention in the field of AI-enhanced multimodal discourse, particularly within the domain of circular economy policy broadcasting. It interrogates not only the operational affordances of intelligent systems in shaping communicative practices but also offers a conceptual reframing of their epistemological and sociopolitical implications. Unlike conventional perspectives that frame AI primarily as a medium of efficiency, our findings emphasize its active role as a discursive agent, co-constructing meaning, modulating affect, and recalibrating the semiotic hierarchy of CE narratives across diverse public interfaces.

Drawing on multimodal discourse analysis (MDA) frameworks and the epistemology of broadcasting

science, we demonstrate that the infusion of AI into policy communication expands the design space for meaning-making through algorithmically coordinated orchestration of auditory, visual, and textual modalities. For instance, prosodic alignment between synthetic voice output and on-screen textual emphasis,achieved through AI-driven sentiment analysis and lexical prioritization,facilitates semiotic convergence that human broadcasters would struggle to perform with consistent accuracy. The architecture of these systems increasingly mirrors the multimodal interdependence articulated by Kress and Bezemer, but introduces computational scalability and dynamic reconfigurability as novel affordances[12].

At a granular level, our analysis reveals how AI systems can synthesize multimodal output through iterative learning loops, thereby enabling context-sensitive re-articulations of CE policies in response to shifting audience feedback. This includes adaptive image-text pairings, localized language calibration, and paralinguistic cue modulation,functions which, while technical in nature, embed rhetorical and ideological consequences. In contrast to prior works that primarily focus on transmission efficacy, we foreground the performative nature of AI-generated discourse and its implications for public reasoning, deliberation, and value alignment[4][5].

However, this transformative potential is not without critical tensions. The integration of intelligent systems into CE policy communication raises epistemological and ethical questions concerning meaning fidelity, cultural interpretability, and the transparency of communicative intent. While affective computing enables the algorithmic simulation of empathy or urgency, it does not guarantee the presence of intentionality or interpretive accountability,qualities that are foundational to legitimate political communication. In this regard, the concern is not merely technical misalignment but the semantic drift that may occur when machine learning models generalize across culturally heterogeneous contexts. As Coibion et al. have argued, the credibility of institutional communication hinges upon trust and intelligibility,criteria which AI, absent human oversight, may inadvertently undermine[7].

To mitigate such risks, we argue for the development of human-AI co-production models that foreground transparency, interpretive depth, and participatory calibration. These models should be designed not only to optimize computational performance, but also to uphold the deliberative integrity of CE discourses. In particular, embedding ethical guardrails and socio-rhetorical heuristics into algorithmic architectures can facilitate more responsive and inclusive public communication. This requires a reconfiguration of professional roles, wherein discourse analysts, communication ethicists, and AI system designers collaboratively engage in the design, evaluation, and iteration of policy broadcasting infrastructures.

Furthermore, our research challenges the instrumentalist view that equates AI integration with communicative enhancement. Instead, we conceptualize AI-mediated broadcasting as a sociotechnical reconfiguration,one that redefines the spatial, temporal, and affective dynamics of public engagement. As Velenturf and Purnell underscore, CE frameworks thrive not through top-down dissemination but via dialogic, participatory mechanisms that nurture behavioral transformation and civic commitment[11]. If AI systems are deployed without discursive contextualization or normative anchoring, they risk entrenching technocratic paternalism under the guise of innovation. This not only contradicts the inclusive ethos of CE, but also delegitimizes the policy's communicative foundation.

In sum, this study contributes a theoretically grounded and empirically informed account of AI-enabled multimodal broadcasting within the CE policy domain. It advances the field by reconceptualizing AI not merely as a technological amplifier but as a semiotic actor embedded within evolving structures of meaning-making and political mediation. Our findings call for a recalibration of future research agendas, towards a more reflexive, interdisciplinary exploration of how intelligent technologies mediate, distort, or democratize public discourse in the age of ecological transition.

This review therefore advances the proposition that AI-driven multimodal policy communication constitutes a paradigm shift from representational to performative semiotics, where meaning emerges through algorithmic orchestration and iterative user interaction.

7. Conclusion

This review has systematically explored the intersection between artificial intelligence and broadcasting strategies for circular economy policy dissemination, with particular attention to the affordances of multimodal discourse. By moving beyond general discussions of AI integration, this study foregrounds a nuanced framework that situates AI not merely as a technological enabler, but as a discursive agent capable of reshaping the semiotic architecture of policy communication. Through a critical synthesis of current practices and scholarly developments, this paper delineates how AI systems,particularly those involving natural language processing, emotion recognition, and real-time content generation,can be strategically deployed to enhance message coherence, multisensory engagement, and audience-specific adaptation in the context of circular economy advocacy.

The contribution of this study lies not only in mapping the terrain of AI-mediated broadcasting but also in proposing a set of theoretical coordinates for understanding the communicative logic of multimodal policy narratives. Unlike previous accounts that treat multimodality as a fixed template, this review highlights its procedural dynamism: how text, image, voice, gesture, and data visualization are algorithmically orchestrated to produce persuasive environmental messaging. In doing so, the analysis reveals critical inflection points where AI technologies may either amplify or undermine message reception,depending on the inclusivity of design, calibration of cultural relevance, and transparency of algorithmic operations.

Nevertheless, the deployment of AI in this domain remains fraught with conceptual and ethical uncertainties. Key challenges include the standardization of evaluative criteria for multimodal efficacy, the mitigation of bias in audience modeling, and the articulation of accountability mechanisms when communicative errors occur. These challenges underscore the need for an interdisciplinary research agenda that bridges computational linguistics, cognitive semiotics, environmental humanities, and science communication.

Looking ahead, future research should not merely apply AI tools to existing broadcasting models but should interrogate and reconfigure the epistemological assumptions underlying 'intelligent' discourse production. This includes developing responsive evaluation mechanisms capable of capturing real-time audience feedback, as well as integrating principles of universal design and linguistic justice to ensure accessibility across diverse demographic and linguistic groups. Importantly, methodological innovation must be accompanied by ethical reflexivity,particularly when AI-generated discourse intersects with policy agendas that have tangible material and social implications.

In conclusion, the integration of AI into multimodal broadcasting for circular economy policy is not a linear process of technological augmentation but a complex semiotic negotiation with the potential to transform how sustainability is communicated and perceived. By attending to both the affordances and limitations of AI-mediated discourse, this study contributes to a more critically informed and technically grounded understanding of how intelligent systems may foster participatory, transparent, and resonant public engagement in the era of ecological transformation.

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